International Science Council

SCIENCE CREATING SOLUTIONS

ISC Science Action Plan: 2019-2021

DRAFT

PART 1:
ISC PURPOSE AND CONTEXT

1. Vision, Mission and Strategic Objectives

The International Science Council (ISC) is the world's premier representative scientific organization and as such has a particular set of responsibilities and challenges. It works on behalf of the international scientific community to advance science, to catalyse and convene scientific expertise, and to provide advice and influence on issues of major concern to both science and society. These roles are growing in need and importance in a changing environment.

The Council's growing membership comprises national academies, research councils and other scientific organizations in over 140 countries, 40 international scientific unions and associations and a large number of associated scientific bodies and networks. Through its members and associates, its partnerships with other international scientific organizations, UN agencies and inter-governmental bodies, and its wider networks of expertise, the Council is unique in its capacity to bring together scientific excellence and science policy expertise from all fields of science and all regions of the world.

The ISC's **vision** is of science as a global public good. Its **mission** is to be the global voice for science; a trusted voice that speaks for the value of all science with the following **strategic objectives**:

- promoting international research and scholarship on key global challenges;
- increasing evidence-informed understanding and decision-making at all levels of public policy, discourse and action;
- promoting the continued and equal advancement of scientific rigour, creativity and relevance in all parts of the world;
- protecting scientific freedom and advocating principles for the responsible practice of science.

2. The Contemporary Context

2.1 The role of science and the International Science Council

Science in the modern era is heavily funded by states and other public and private bodies in the belief that its outputs and the skills of those that embody them are crucial to economic and social wellbeing, to the development of relevant public policies, and to success in addressing the global challenges that humanity collectively faces. The purpose of science is to serve the public good. It is implicitly licensed to do so through the funding priorities of national governments, which often, in practice, distinguish between a "discovery" funding mode, particularly in exploring fundamental phenomena that animate nature and society, and a "thematic" funding mode, in which research is directed towards the solution of specific socio-political problems. They are mutually supportive modes, parts of a continuum that has been the source of some of the profound discoveries of science that have contributed to the making of the modern world. Their essential value to society lies in creating robust and reliable concepts and making discoveries based on evidence that is open to scrutiny and tested against reality.

This forms the frame for the ISC's vision to "advance science for the public good" and its mission to act as the "global voice for science". The Council is committed to supporting the development of all science, from discovery to application, and including the full range of disciplines, from the natural and social sciences to the behavioural, data and technological sciences. In this context it has a unique role: to ensure that the science disciplines and their unions and associations work together in an integrated manner to address major contemporary human concerns, to represent, champion and apply them at a global level, and to stimulate policies for science that continually adapt it to a changing world. The ISC's national members have critical leadership roles in addressing these challenges in their domestic societies and through their stimulus of interdisciplinary collaboration, where the ISC is able to assist them through mutual learning, connectivity and in linkages to disciplinary bodies.

A plan for action within this frame must therefore respond to the contemporary environment of concerns and priorities, whilst being sensitive to their international diversity. Some priorities emerge from socio-political changes, in which trust in science and evidence may be at risk, some from the social and environmental and economic challenges of the sustainable development goals, some from developments within science itself, such as the potential for technological transformation of the human, the environment and society. Irrespective of their origin however, addressing them requires an interactive dialogue between science and society, with resulting pressure for change in public policy or in the dynamic of science itself.

2.2 An environmental analysis: contemporary issues of concern to the ISC

An analysis of the contemporary global environment within which science operates is crucial in determining the ISC's priorities and ways of working. As the "global voice for science" it is important that the ISC is responsive to public priorities and concerns, that it promotes and applies ways of working that maximise the role of scientific understanding in policy and in public discourse, and that it works to ensure that the science system itself is efficient and creative in these purposes. The following environmental analysis was used by the ISC Science Planning Working Group (WG) to identify **potential** priorities for the next three years as set out in Part 2 of this document.

Planetary sustainability

Human society has become a defining geological force that has re-configured the global ecology to produce one that is novel to the Earth in ways that are inimical to many of the natural processes that have created and sustained the biosphere, atmosphere and hydrosphere, that form the bedrock of the human economy and the life support system for the planet's inhabitants. The urgency of these issues is annually more pressing. The challenge to science is to define actionable pathways to sustainable use of the planet that also address endemic issues of conflict, poverty and inequality.

Social transformation

Responding to the challenge to manage global travel along a sustainable pathway increasingly goes hand-in-hand with calls for deep social change. But how does real social transformation come about and how – if at all – can it be initiated, fostered or steered? What are the possible levers and who are the potential agents of change? What types of decision-making processes are required to foster democratic processes of transformation?

The digital revolution

The technologies of the digital revolution constitute a rare phenomenon, a "general-purpose technology" that continually transforms itself, progressively penetrating almost all domains of private and public life. It increasingly pervades all the other issues included here. It is disruptive and presents challenges to ethical and legal systems. It offers profound opportunities for science, particularly in recognizing patterns in nature and society that have been hitherto inaccessible, in analyzing the complexity that is at the heart of many major global challenges, and in swiftly and equitably sharing data and information around the globe.

Transformation of the human

Rapid progress in life science and digital technologies has not only generated major capacities and huge potentials for social benefit through improving human health, enhancing societal interactions, business opportunities, governmental efficiency and scientific discovery, but has also created problematic dilemmas. Artificial intelligence can be used to deliver more efficient solutions to important problems, but also to "programme" much social and individual behaviour, to create learning machines that replace human efforts, or autonomous systems with the potential to dispense with the human decision-maker. Gene editing can be applied to the treatment of genetic disease, but can also create permanent changes in the human germline with a eugenic purpose that poses serious ethical questions. Although the beneficial potential of some of these technologies is profound, they also raise important ethical, philosophical, societal issues and even existential questions that will at times place scientific development and societal concerns in conflict.

The science-policy interface

An essential contribution of science to society lies in the effective use in policy and public discourse of scientific concepts and evidence that is open to scrutiny and tested against reality. The bridge between science and policy requires effective structures and expertise at the interface, skill sets within the science community, competencies within the policy community, and trust-building between them. The tension between short-term and long-term policies must be addressed, which is, for example, a vital issue for the implementation of the SDGs.

Trust in and engagement with science

Although indicators of public trust for science generally remain stably high, the web and social media have introduced a new dynamic, in which the rate of circulation of misinformation far exceeds that of tested evidence, for example in areas such as climate science and infant vaccination. Scientists have often erroneously presumed that instances of public rejection of scientific postulates can be

resolved by clearer, simpler re-statements. Understanding cognitive processes in individuals and groups, adapting to the experience of those that have successfully engaged in public dialogue, and better understanding the role of digital media are all crucial priorities for science as a public enterprise.

Access to knowledge

Technology companies are increasingly invading the knowledge space, including privatizing publicly funded data, with the danger of also privatizing and controlling access to knowledge.

Science systems

The organization of national scientific systems and of international science comes under pressure from changing priorities and evolving societal norms. There are pressures for even greater effective mobilization of international funding to address urgent global challenges, for better cross-disciplinary collaboration, for the promotion and recognition of under-represented groups, for incentives that are better adapted to current priorities, for adaptation to the opportunities and challenges of the digital revolution, including open data and open access to scientific results. The impact on society of powerful science-based technologies has generated a developing paradigm that calls for a more open, more engaged science, to create actionable knowledge that has credibility, practical relevance and socio-political legitimacy.

The "industrialization" of publicly-funded research

Most publicly-funded research now takes place in universities, where, over the last 3 decades, there has been significant growth in research funding, of person-hours dedicated to research, and in student numbers. Research articles published and citations reaped from them have become the predominant assessment indices and criteria for reward and advancement for academics. This has largely driven the growth in numbers of scientific journals, estimated to be about 30,000, and the number of articles published, estimated to be about 2 million per annum, but where a very small proportion (~5%) record significant indices of impact. It has been questioned whether this represents an efficient use of public funds in creating and applying knowledge; whether and how it might have impact on the role of universities in educating the rising generation; and whether the systems of publication and assessment have become dysfunctional and in need of repair.

A world in flux?

The last decade has seen major changes in the geopolitical landscape. The rules-based international system, developed in the last 70 years, is under pressure, and the configurations of power and influence internationally are changing. Several decades of globalization that increasingly integrated national economies within a global market and increased the mobility of capital and labour, appear to have stalled, with a reaction of resurgent nationalism. There has been an increase in inter-state migration, driven by conflict, climate change, land degradation and annexation. Some states have responded to these trends by increasing barriers to mobility, reflected in recent years by increased difficulties in travelling to international meetings. In this setting, it will be important to maintain and strengthen the culture of cooperation, exchange and benefit sharing that has been developed by the international scientific community and its funders, where scientific challenges of global significance have led to international cooperation that transcends political difference and societal conflict. It is a community however, that remains divided, with some countries and regions having enormous resources to advance science and its use, whilst others struggle to remain engaged. How can the science system itself address global inequalities, encourage benefit sharing, global exchange and cooperation at all levels, at a time of increased geopolitical complexity?

PART 2
SCIENCE CREATING SOLUTIONS: PRIORITIES FOR ACTION

3. Strategic Objectives, Challenge Domains and (possible) Priority Projects

The ISC's four **strategic objectives** set out in Part 1 were adopted by ISC members in 2017 as part of the Council's High-Level Strategy. They address long-term generic issues and are likely to be key objectives for science in any era.

In October 2018 the ISC Governing Board (GB) identified four **challenge domains** to frame the Council's activities in the coming years. Each represents a broad landscape of issues, like those identified in the environmental analysis presented in Section 2.2 above, that are of particular contemporary importance and in relation to which the global voice for science is most needed and could be most effective. The challenge domains are headlines for the ISC Science Action Plan. They were shared with members in the November 2018 Governing Board (GB) communiqué and are summarized in Box 1.

Box 1. ISC Challenge Domains

The 2030 Agenda for Sustainable Development

Scientific knowledge has a major role to play in identifying transformative pathways towards the sustainable and equitable use of planetary resources. The 17 Sustainable Development Goals (SDGs) provide an integrated framework for better understanding the globally coupled natural, physical and social systems of our planet. To be successful they must draw on integrated knowledge from across all scientific disciplines.

The Digital Revolution

Digital technologies are revolutionising the means by which information and knowledge are acquired, stored, communicated and used. There are few areas of human concern that are unaffected by this pervasive, world historical process. It is imperative to understand and respond to the powerful opportunities and disruptive challenges that the digital revolution poses to both science and society.

Science in Policy and Public Discourse

Science fuels the perpetual human quest for understanding of the world. It is also essential to the development of effective public policies at all levels of governance and to informing an increasingly contentious public debate about contemporary global priorities. Strengthening the use of scientific evidence in policy and public action will require institutional structures, skills and competencies that promote knowledge sharing, counteract misinformation and support relationships of trust between science and its wider publics.

The Evolution of Science and Science Systems

In the face of increasing societal demands for scientific solutions, rapid technological developments, ever-growing concerns about persistent inequalities and related calls for openness, diversity and inclusivity, the practices of scientists and the policies of the institutions in which they work are under pressure to change. For the progress of science and its essential social utility, it is important that science systems throughout the world adjust to these developments in ways that safeguard scientific freedom and advance scientific responsibility, rigour and relevance.

The actionable **priority projects** that the Science Planning WG has identified for concrete action within each of the four domains are listed in Figure 1 below, where they are correlated with the ISC strategic objectives. Each project is described in further detail in Section 3.2. The projects are offered at this stage of discussion as a proposed menu from which the work of the Council in the next three years will be selected.

Figure 1. Overview of priority projects in each challenge domain, plotted against strategic objectives

Projects outlined in red are ones that would include or build on current ISC activities

Challenge Domains and Priorities for Action		Strategic Objectives			
		Promote **international research and scholarship** on key global challenges	Increase **evidence-informed understanding and decision-making** at all levels of public policy, discourse and action	Promote the continued and equal **advancement of scientific rigour, creativity and relevance** in all parts of the world	Protect the **freedom of science** and advocate principles for the **responsible practice of science**
Domain 1: The 2030 Agenda for Sustainable Development					
1.1	Science for sustainability: Complexity, coherence and accelerated impact	✓	✓	✓	
1.2	Funding science for sustainability: A global forum of funders	✓	✓	✓	
Domain 2: The Digital Revolution					
2.1	Tackling complexity: Data-driven interdisciplinarity	✓	✓		
2.2	Global data governance	✓	✓	✓	
2.3	A machine learning society: The science narrative	✓	✓	✓	✓
Domain 3: Science in Policy and Public Discourse					
3.1	Science-policy interfaces at the global level: Strategy development		✓		
3.2	Policy and public action: The role of engaged science		✓	✓	
3.3	The public value of science	✓	✓	✓	
Domain 4: The Evolution of Science and Science Systems					
4.1	What works for women in science			✓	
4.2	Refugee scientists: Awareness and action			✓	✓
4.3	Open science: Avoiding a global divide	✓		✓	✓
4.4	The future of scientific publishing	✓	✓	✓	
4.5	The industrialization of science: Assessment, evaluation and possible action			✓	✓

The overall programme of strategic objectives, challenge domains and priority projects presented in this draft Science Action Plan is entitled "**Science Creating Solutions**" to emphasize the need for actionable knowledge and the conditions that enable it. The Action Plan offers a solutions-oriented spectrum that addresses major challenges within the four domains and provides the basis for a balanced portfolio. There are multiple interconnections between the domains and between the various priority projects proposed in Section 3.2. This should be regarded as a strength of the Plan.

3.1 Criteria for choice of priority projects

The criteria used by the Science Planning WG in selecting priority projects (from the longer lists of possible topics included in the Governing Board's November 2018 communiqué about the challenge domains) are:

Importance: Is the topic important to international society (science for policy) or to science itself (policy for science), or is it based on new developments that are so important that it should be brought to public attention.
Strategic fit: Is the project centrally relevant to the ISC vision, mission and strategic objectives.
Pathways to influence and impact: Is there a clear pathway to impact for the "global voice", a clear and knowledgeable identification of desired outcomes, target audiences and timeframes for completion.
Timeliness: If it is an existing public issue, is there anything left for ISC to add; if a new issue, is it sufficiently developed to be launched.
Distinctive ISC role: Is there a clear, possibly unique role for the ISC, the possibility for the Council to adopt an early leadership role, to help establish its credibility. Is the ISC ready to seize a major unexpected opportunity.
Relevance to Members: Strengthening the voice of science and its public recognition strengthens all. Is there an opportunity to showcase the importance of members' contributions, support knowledge exchange and policy learning.
Partnerships: Are there valuable and influential potential partners who could assist in delivering outputs and helping to realize impactful outcomes.
Resources: Does the issue exploit existing ISC activities; could it be effectively managed within the human resource envelope of the secretariat; will it require external funding and is ISC able to access resources adequate to the task.

These criteria will be re-visited for those priority projects presumptively selected for action – on the basis of membership feedback and further GB deliberations – particularly in regard to resourcing, partnerships and pathways to impact.

3.2 Description of priority projects

In practice, the priority projects selected by the Science Planning WG are diverse in nature, timescale and demand for resources. Project 1.1 is perhaps the most immediately onerous, including a large part of current ISC activity, including ISC co-sponsored international initiatives and the Council's engagement in global policy processes (see the Appendix for further information on these and other existing ISC activities). It is described as one project (perhaps better as a "programme") rather than a series of individual projects, reflecting a scientific view that a shift in gear is needed in this domain

towards a more holistic, integrated and coherent scientific attack on sustainability. At the other end of the spectrum, Projects 2.2 and 4.5 propose exploratory studies with partners, to consider options for and the desirability of developing them into major projects. Project 1.2 is not a science project, but an initiative to improve the focus and impact of funding in the sustainability domain. Project 4.1 proposes to initiate a "What Works" series to spread proven effective practice on issues of importance to science and to members, whilst Project 4.4 describes how a recent initiative could develop into a recurrent outreach mechanism. Project 4.3 focuses on ISC support for activity driven by partners and regional offices; in this case ISC support would be important but not onerous.

Selecting from this variety of 13 possible priority projects to identify and initiate a balanced portfolio for the next three years will depend upon the preferences expressed by members, the capacity to raise external financial support for them and the tessellation of projects into a portfolio that is manageable by the ISC Secretariat. The intention is to create a Science Action Plan that has global significance, justified by the environmental analysis in Part 1, that will enhance the reputation and visibility of the ISC, bring benefit to its members and rally international partners.

DOMAIN 1: THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT

Project 1.1: Science for Sustainability: Complexity, coherence and accelerated impact

The issue:

Identification of pathways to sustainability, and the creation and advocacy of actionable policies that advance global society along those pathways are the greatest contemporary challenges to science and to the ISC. Answers to two fundamental questions lie at the heart of these challenges:

- What are the critical scientific knowledge gaps and how should they be addressed?
- What are the barriers to policy implementation and are there scientific approaches that could help to overcome them?

The global ecology, of which humanity is an integral part, is a complex system, where interventions designed to achieve specific outcomes require understanding of the whole system. It is not 17 systems represented by the 17 SDGs, but one system with 17 facets. Translating such vital understanding into policy demands two essential attributes:

- greater policy coherence that reflects systemic rather than only sectoral understanding;
- policies whereby the natural short-term priorities of government (on issues such as health, education, jobs) can be optimised with longer-term sustainability priorities.

The ISC is located in the core of an international scientific network of immense relevance to global sustainability and the major global policy frameworks it embraces, including the SDGs, the Sendai Framework on Disaster Risk Reduction, the Paris Climate Agreement and the New Urban Agenda. Apart from many of the Council's scientific unions or associations and national members, the network includes major relevant research programmes, committees, data bodies and observing systems of which the ISC is a (co-)sponsor (see points 1 and 3 in the Appendix). All represent strengths in research, technology and policy for sustainability.

There is no greater challenge to the global voice for science than to take a leadership role in ensuring that this powerful stock of relevant knowledge has the greatest impact on global policy. Driving

synergistic collaboration and mobilizing coherent action by this network in response to the complex systemic challenges described above would be a highly creative step.

Anticipated impact:

- Easier access to relevant scientific knowledge for bodies implementing actions to achieve the 2030 Agenda
- Readier adoption by decision makers because of their involvement in co-designed solutions
- Increased impact (coherence and relevance) of international scientific input, advice and influence within global policy processes
- Use of tools, concepts and policy-ready outputs at national levels of policy making
- Enhanced capacity for impact of the international science effort through greater coordination of efforts that reflect new insights (e.g. into complexity) and new ways of working through new technologies

Key target audiences:

- International scientific community
- UN Agencies/Programmes and Heads of Member States
- National governments, policy makers and a wide variety of societal actors

Actions:

- In early 2019 the ISC will convene a meeting of the scientific leaders and co-sponsors of all ISC-sponsored programmes and other international bodies, as well as a core group of external experts, to discuss and agree on:
    - Concrete opportunities for collaboration, such as the call from the UNISDR for the ISC to convene a scientific working group to develop an initiative focusing on the issue of new technologies for Disaster Risk Reduction, as well as the possibilities offered by the ISC's partnership in the National Urban Policy Programme of the OECD, UN Habitat and the Cities Alliance.
    - A common approach to coherent action in response to upcoming UN priorities and intervention opportunities. Examples of the latter include the focus, within the UN's 2019 agenda on climate change, culminating in the UN Climate Summit in September of this year.
    - Priorities for further strengthening the science base for a system of systems approach to global sustainability that would offer policymakers the basis for manageable, tractable and well-found pathways to sustainability. An example would include the possible establishment of a common platform to compare, develop and validate global system models for relevant scenario building and prediction.
    - An efficient mechanism (such as an annual leadership forum) for securing sustained coordination across international initiatives and with related partner organizations operating in this domain.

- The operational phase of the ISC's 'SDG Interactions as a National Policy Driver' project, initiated in 2018, will be launched in early 2019. This project is based on the perception that the SDGs' primary current use is as a reporting mechanism rather than a driver of policy, where short-term priorities tend to exclude the longer term perspectives of the SDGs. The project is being

delivered in partnership with the International Institute for Applied Systems Analysis (IIASA), the International Network for Government Science Advice (INGSA), the Stockholm Environment Institute (SEI), the European Commission's Joint Research Center (JRC), and UNDP. The aim of the project is to develop a tool and associated process to systematically analyze key interactions across the SDGs and connect them to national policy processes in order to accelerate the implementation of the SDGs. The project will develop an online tool enabling the mapping of key interactions across the goals and targets, and a deliberative process involving scientists, policy-makers and stakeholders that will identify potential synergies and conflicts between SDGs and support the coherent prioritization, implementation, and monitoring of SDG implementation in particular national or local contexts. The tool and process approach will be co-designed and tested in a variety of contexts over the course of 12-24 months (2-4 pilots are envisaged over the course of 2019-2020, subject to fundraising). Dissemination and scale-up of project outputs will be undertaken in coordination with the ongoing STI-for-SDGs Road Mapping work of the UN Technology Facilitation Mechanism's Inter-Agency Task Team.

Relevance to members:

- An overarching frame for the many members involved in work relating to SDGs.
- Showcasing their science at within the UN and other intergovernmental policy fora.
- Creating a policy interface with national governments for scientific results.

Project 1.2: Funding Science for Sustainability: A Global Forum of Funders

The Issue:

Promoting and securing the international scientific community's effective responses to the challenges of the 2030 Agenda is a systemic responsibility, shared by scientists themselves, the institutions in which they work, the policy makers that shape the conditions under which they work, the regional and international platforms that support their research, and the funders that influence and resource priority agendas.

Within the broader science funding community we are seeing a diversification of actors that fund science and a growing response amongst them to the policy pull of the SDG framework through the alignment of their strategic priorities. Increased giving beyond national borders is often accompanied by an increased willingness to undertake joint action in support of international scientific collaboration. At the same time these developments occur primarily within specific sectors of the funding community. There is little evidence of strategic dialogue, partnership and collective action between national funders, philanthropic foundations and international development aid agencies. Here there is a need to move into a higher gear, to increase investments in science for the SDGs and to maximize the efficiency of existing investments by reducing fragmentation and the duplication of efforts across funding sectors. There is an opportunity for the ISC to play a leading role in facilitating the connections and convening the discussions that will be required to move in this direction. It would underline the Council's strategic objective of promoting international research and scholarship in the SDG domain.

Anticipated impact:

- Increased understanding of the international landscape of science funders, shifting trends and new opportunities in the funding of international scientific collaboration.
- Increased coordination and collaboration amongst science funders aimed at accelerating the global impact of funding science for the SDGs.
- Establishment of a powerful platform for ISC engagement with a global consortium of science funders.

Key target audiences:

Lead organizations from different funding sectors: national research agencies, private foundations and international development aid agencies.

Actions:

In July 2019 the ISC will convene a meeting of the leadership of national research funding agencies, philanthropic foundations and development aid agencies from around the world. This 'Global Forum of Funders' will be hosted by the US National Academy of Sciences. It is being organized by the ISC in collaboration with a consortium of funders and international scientific partners, including:

- the Belmont Forum (represented by the US National Science Foundation),
- the Volkswagen Foundation,
- the Swedish International Development Cooperation Agency (Sida),
- the International Development Research Centre (IDRC)
- Science Granting Councils Initiative in Sub-Saharan Africa (represented by the National Research Foundation of South Africa)
- Future Earth, and
- The International Institute for Applied Systems Analysis (IIASA).

Depending on the outcomes of the Forum, further ISC involvement and concrete follow-up activities will be considered. Such activities may include the development of a global science agenda identifying critical SDG-related knowledge and policy implementation gaps. The ISC is uniquely placed to lead on such an agenda-setting initiative and could undertake it as part of the action defined in 1.1(a) above.

Relevance to members:

- More powerful funding opportunities for major scientific challenges in the SDGs.
- Clearer pathways to funders.

DOMAIN 2: THE DIGITAL REVOLUTION

Project 2.1: Tackling complexity: Data-driven interdisciplinarity

The Issue:

"The next [21st] century will be the century of complexity" (Steven Hawking, 2000). Modern science faces a set of demands for solutions to problems that are inherently complex. They are problems embedded in complex systems that exhibit emergent behaviour: behaviour that cannot be predicted from any single driver, but can only be adequately understood by analysing the system in which they

are embedded. Fortunately, the vast and varied data fluxes of the digital revolution provide the means to characterise and understand the complexity at the heart of many global challenges. Crucial to this task is the linking, integration and analysis of data and information from different disciplines in ways that yields deeper, more holistic understanding of complexity, on scales from the molecular to the cosmic, and on issues from individual social preferences to the operation of cities. It is an essential part of the intellectual infrastructure for the 21st century. The barrier to its achievement lies in the different standards that are applied in characterising, storing and accessing data in different disciplines and inadequate vocabularies and ontologies that make rigorous interoperation between datasets difficult or impossible. Individual disciplinary groups have seized the opportunity to create "information communities" that have made great strides in integrating data within their fields and making them openly and widely available (e.g. bio-informatics, astronomy, crystallography, areas of social science, Earth science, nanotechnology and archaeology), but there are many where this has not happened. The ISC would seek to work with and support the disciplines of science in adopting procedures that enable interdisciplinary data integration and to stimulate its application to the complex systems that comprise major challenges.

Anticipated impacts:

- Increasing the number of science disciplines that adopt rigorous standards and ontologies for their data.
- Take-up of generic approaches to data integration by scientific disciplines.
- Application of integrated, inter-disciplinary data to the characterisation of system complexity in global challenges.
- Take-up by policymakers and other users of solutions for complexity.

Target audiences:

- Science disciplines.
- Global challenge bodies (e.g. researchers on complex systems – infectious disease, urban resilience, disaster risk).
- Funders.
- Users.

Actions

a) The ISC has supported activity to develop generic approaches to data integration, to be tested through interdisciplinary pilot applications in the areas of *infectious disease, disaster risk reduction* and *resilient cities* (issues relevant to Domain 1).
b) An ISC *Commission on Data Standards* should be created with the purpose of:
    - working with unions and associations that already address these issues, to agree good practice and develop the metadata infrastructure required for inter-operability;
    - encouraging unions and associations of disciplines that have not yet taken up this issue to develop vocabularies and standards that avoid ambiguity or misinterpretation, allowing data and applications to be joined up, or analysed in ways that avoid category errors;
    - supporting bids for funding;
    - stimulating application of these approaches to complex global challenges.
c) A paper on these issues and a detailed approach will be submitted to the GB by the ISC's Committee on Data for Science (CODATA). The involvement of CODATA, the World Data System

(WDS), the UN World Data Forum, the Research Data Alliance (RDA), and engagement with governmental statistical bodies will be important. The project is likely to be the work of a decade.

Relevance to Members:

- Developing enhanced capabilities of data use for disciplines currently lying behind the curve.
- Enhancing the capacity of interdisciplinary collaboration to address major complex global challenges.

Project 2.2: Global Data Governance

The Issue:

The data-rich era that has emerged at the beginning of the 21st century offers powerful new opportunities for all the sciences, although the ease, mode and speed with which they individually adapt and exploit the opportunity will vary from discipline to discipline. What is shared by all however is the need to find, have access to and be able to use and re-use data relevant to their priorities. This implies two imperatives:

- that data is findable, accessible, and useable, and ideally interoperable with other, cognate data (characterised as FAIR by Force 11: findable, accessible, interoperable, reuseable; www.force11.org/group/fairgroup/fairprinciples);
- that important data will be properly preserved, curated and accessible in robust, trustworthy databases (for example in the core-trust-seal certification of the World Data System; www.coretrustseal.org) and operate with a long-term, sustainable business model.

The urgency of these issues is exemplified by the 2030 Agenda for Sustainable Development. Managing an effective and efficient pathway towards global sustainability will require that data is used effectively in understanding the complexity of that task and in finding solutions (projects 1.1 and 2.1), but also that data that monitors the temporal changes in the human and global system is progressively accumulated in accessible, robust, reliable and sustainable repositories as a vital global asset. Unfortunately, many important databases are supported by short term funding, and some have been lost by the lack of it. It is therefore an important priority for science that:

a) a sustainable business model for proper curation of global scientific data is developed;
b) an international concordat is developed for rules of access and use;
c) there is improved planning for acquisition and access to data relating to global sustainability.

Anticipated impacts:

- Agreement amongst key players of the urgency of the issues.
- Effective, possibly ISC led process.
- Ultimately, achievement of points a) to c) above.

Target audiences:

In the first instance:

- ISC unions and associations
- RDA, WDS, CODATA,
- Science Funders
- Data holding bodies

- Governmental statistical agencies
- UNESCO, UNEP, GEO

Actions:
It is proposed that the ISC should take the initiative, ideally under UN auspices, to convene interested parties to discuss whether and how these objectives could be met, with a view to creating a plan for implementation. Relevant parties would include UN bodies (UNEP, UNESCO, World Data Forum), representatives of national statistical offices and governmental databases, GEO, science funders, representatives of major data disciplinary repositories and data platforms, and representatives of relevant private sectors. This would be an exploratory meeting with the potential to lead to a major international initiative, with the ISC well placed for a high profile lead position.

This could be a substantial step in ensuring sustained access to critical data across the disciplines, and an important enabler of interdisciplinary data-intensive science. If an exploratory meeting were successful in plotting a way forward, a highly significant contribution from the ISC would be to ask unions and associations to identify core databases in their field that should be considered part of the global patrimony of knowledge. The life sciences for example have identified about 100 such core databases. It would consider both databases that are sustainably maintained in national or international repositories and those that are less securely maintained, and both Earth-based and space-based data.

Relevance to members:
- Increasing the quality of data curation and availability of vital importance to disciplines and for interdisciplinary science.

Project 2.3: A Machine Learning Society: The science narrative

The Issue:
As the flux of data collected in both private and public domains continues to increase, and the analytic techniques used to process them become more sophisticated, unprecedented depths of information are revealed about individuals and communities and their habits that have not been sanctioned by them and can be used in ways that may or may not reflect their best interests. Large data fluxes are also necessary feed-stocks for machine learning; a branch of artificial intelligence that allows computer systems to learn directly from experience (represented by a diversity of powerful data streams). This contrasts with conventional computers that follow pre-programmed rules. As a result of recent advances, such systems can now out-perform humans in an increasing variety and number of specific tasks. Though most of us are unaware of it, we interact daily with machine learning systems, for example through image and voice recognition systems and in online retailing. Machine learning systems promise transformative advances in many areas: in healthcare, for better diagnosis and treatment; in improving the efficiency of transport networks through autonomous systems; in public services for targeting those in need or tailoring services to users; and in science, where it helps to make sense of the vast amount of data increasingly available to researchers, offering new insights in many fields. But there is a "down side": in ubiquitous surveillance through face recognition; in autonomous weaponry; in financial fraud; and in the displacement of humans from jobs and roles hitherto assumed to be uniquely theirs.

How do national science systems, particularly those that are poorly funded, develop capacities to reap the benefits and avoid the dangers? What is the trade-off between the benefits and the down-sides of these data-enabled technologies? How should educational curricula be changed, at all levels, to prepare students for the challenges they meet? Should we attempt to prepare young children with the skills and habits to navigate an information environment that is more complex and confusing than ever before? How should societies respond to the fact that existing data governance concepts, such as privacy, consent, publishing, do not easily apply in this new environment and are under unprecedented strain, whilst their meanings in policy, law and public discourse have shifted, and will continue to do so in new and unpredictable ways? These are questions that need to be posed and addressed in all societies, where scientific understanding of present trends and implications, and reflections on possible future trends need to be broadcast and debated. It is a necessary exercise of the responsibility of science.

Anticipated impacts:

- Greater awareness of the nature, implications and potential developments of data and machine learning technologies.
- Policy debate and action on pathways to benefit, on regulation, on governance, and for education.

Target audiences:

- Scientists
- Educational and research institutions
- Politicians, policymakers, civic society and citizens.

Actions:

Debate on these issues has been variously animated, hyped, diverse, speculative, uninformed, and occasionally careful, precise and rigorous. Notwithstanding the pace of change in the field, but because of it, there is an urgent need for a measured, rigorous explanation and narrative on the issues; one that is accessible to the whole target audience. Its purpose would be to stimulate the debate that is currently needed to address problems that are already with us, and to prepare for challenges with which we may be confronted in the near future. If a report on these issues could be produced within a relatively short timeframe, the ISC should mobilize its network of unions, associations and national members, in chain-reaction mode, to disseminate it. Equally, national members should be encouraged to broadcast its policy narrative within their national governance systems. Fortunately, some national members have published series of reports on the issues, which could be the basis on which an ISC document might be built. (We should consider the possibility that ISC might work to “internationalize” national reports by its members that have international implications).

Relevance to members

- Supporting national members in their tasks of raising awareness about vital issues for their societies.
- Enhancing awareness of the implications of key areas of AI for their disciplines.

DOMAIN 3: SCIENCE IN POLICY AND PUBLIC DISCOURSE

Project 3.1 Science-Policy Interfaces at the Global Level: Strategy development

The issue:
Based on its formal role as a lead coordinator of the United Nations (UN) Major Group for the Scientific and Technological Community, as well as its existing partnerships with several UN Programmes and Specialized Agencies (e.g., UNESCO and WMO), the ISC is actively engaged in major inter-governmental and multi-stakeholder policy fora, including those relating to the post-2015 processes. The latter include the 2030 Agenda for Sustainable Development, the Paris Agreement on Climate Change, the Sendai Framework for Disaster Risk Reduction and the New Urban Agenda. The purpose of this engagement is to ensure that science is integrated in key policy making and implementation plans at the global level (see also point 3 in the Appendix).

The challenge for the Council is to further increase the impact it has in this area of work: to secure a strengthened mandate for science in global policy, to build a recognized ISC identity and presence at the highest political levels, and through that to amplify the visibility and voice of the international scientific community within the UN and, ultimately, in other global policy fora, including the G7 and G20. Meeting this challenge will require the development of a longer-term vision of the role of science in global policy processes and the identification of a corresponding range of strategic actions to be taken by the ISC. This should be based on an understanding of the complex political landscape at the global level, the most effective access routes and pathways to influence for science, the required capacities for UN policy horizon scanning, and options for efficient response strategies, including the development of an effective and efficient science advisory ecosystem at the global level.

Anticipated impact:
A coordinated, effective and independent science-policy interface at the global level – within the UN System and beyond – in which the ISC is positioned as the global go-to for scientific input, advice and influence.

Key target audiences:
- The ISC and its membership, communities and partners
- Heads of UN Programmes and Specialized Agencies

Actions:
As a first step, the ISC will prepare and publish two strategy papers – a White Paper on 'Science in and for the United Nations' [exact title to be confirmed] and a paper on opportunities for engagement in other global policy fora. Both outputs will make recommendations – to be reviewed and agreed by the ISC GB – for concrete actions to be implemented by the ISC in order to achieve the intended impact. The preparation of the strategy papers will be guided by an expert resource group established from the ISC membership and broader ISC community (e.g., INGSA, and other sponsored programmes/committees) and including invited scholars with expertise on science-policy interfaces at the global level.

Relevance to members:

- Understanding global policy processes and possibilities for effective science-policy interfaces
- Stronger representation through ISC
- Showcasing and contributing relevant work in global policy processes

Project 3.2: Policy and Public Action: The role of engaged science

The issue:

For more than a decade, and particularly in the field of sustainability science, trans-disciplinarity (TD) has been advocated and promoted by scientists, science policy makers and funders as an approach to supporting solutions-oriented science, producing knowledge that is socially credible and actionable. The ISC supports TD. It has promoted it in the design of international programmes such as Future Earth, it has developed TD training schemes and it funds TD research via the ISC programmes on T2S and LIRA2030 (see point 2 in the Appendix).

TD is understood as a process which brings academics and non-academics together in processes of knowledge co-production, with scientists working with decision makers, policy shapers, citizens and the private sector as knowledge partners in networks of mutual learning and problem-solving. TD builds on earlier discourses about participatory action research, the democratization of science, the triple helix, and citizen science, and is now increasingly embedded in discussions about the nature and scope of 'open science' or 'science as a public enterprise'. Terms like TD and open science remain misunderstood. The essential idea of a new relationship between science and society – of science working with rather than for society – is perhaps best captured by the notion of 'engaged science'.

Engaged science poses significant challenges to the science system: to the processes and practices of science, of scientific review and evaluation, of incentives and of reward systems. It affects how research is supported in higher education, as well as civic and civil society organizations. It requires systems adaptation, policy renewal and challenges scientists to develop TD skills. At the same time interventions to better equip the system for engaged science should be informed by evidence of its impact on policy, public discourse and action.

Anticipated impact:

- Increased understanding of the engaged science approach, the challenges and opportunities it poses for science, and implementation of relevant support actions (skills development, policy renewal) by research performing organizations/institutions, science funders, policy makers and managers at national level.
- Increased awareness of the strategic opportunities and enablers for engaged research, both at national and international levels.

Key target audiences:

- ISC members, with a request to national academies to convene debate with relevant national science policy makers
- Networks of funders: the Belmont Forum, the Global Research Council, and the Global Forum of Funders

- Heads of universities – via partnership with the International Association of Universities (IAU)
- UNESCO member state delegations

Actions:
The ISC could convene an expert working group to design and oversee the preparation of a report on engaged science, which could be the first in a series of ISC Global Science Policy Reports.
The report should assess whether engaged science affects the quality of research, its uptake and societal impact. It should provide recommendations relevant to research performing organizations, funding agencies, STI policy makers, and publishers on structural changes that are required for enabling engaged science.

The report could include a focus on:
- mapping existing global schemes that promote engaged science;
- demonstrating the diversity of understanding and practices of engaged science across different global schemes;
- building an understanding of key outputs, outcomes and the longer-term impacts of engaged science across different global schemes;
- identifying essential capacities and skills required for engaged science;
- specifying structural changes that are required within current science systems, including higher education institutions, funding agencies and publishers, to enable and reward engaged science;
- identifying existing approaches for assessing the quality and impact of engaged science;
- outlining best practices for dealing with ethical issues associated with engaged science;
- identifying ways of maximizing the potential of engaged science (e.g. creating national strategic vision that connects science, policy and innovation).

Relevance to members:
- Contribute examples of engaged science.
- Learn from best-practice guidelines.
- Resource for national-level action to be driven by, e.g. academies.

Project 3.3: The Public Value of Science

The issue:
Realizing the ISC's vision of science as a global public good will require a convincing, coordinated and sustained campaign against anti-scientism in relevant debates at global, regional and national levels. This effort will require creative, accessible articulation of the social, political, economic and cultural values of science, and the deployment of powerful communications and outreach strategies/tools.

The essential resource for such a campaign lies within the ISC membership and the scientific communities that they represent. It would be the work of their national and disciplinary scientific communities that provides the material for the campaign, and their experience at the nexus of science education, communication and public outreach that will guide its development. It is also important to recognise that merely repeating a scientific view, either more clearly or even more loudly, is not the way to success. A deeper understanding of how people receive and respond to messages through their cognitive psychology will be vital.

Its purpose would be to provide a global science outreach platform, profiling the value of contemporary scientific work (and breakthroughs) from different countries/regions of the world, different disciplines and inter-disciplinary efforts. Emphasis would be on the solutions and insights that science offers society. The platform could take a variety of approaches; focusing for example on specific thematic issues (e.g. transformation to sustainability); a disciplinary approach (what solutions we find from disciplinary advances); workshops to illustrate scientific method in action; the importance of error and uncertainty, and the nature of consensus; a regional approach (the solutions that science offers to specific regional challenges); and/or a sectoral approach (e.g., science and the private sector).

Anticipated impact and targets:
Increased awareness and recognition amongst wider publics of science as a global public good

Actions:
The ISC would need to work with science journalists, association of science museums, UNESCO, and in partnership with existing organizations e.g. 'Sense about Science' and relevant experts from the membership to identify the niche, an approach, as well as an action and business plan.

Relevance to members:
- Showcase scientific work of members
- Amplify outreach work of members

DOMAIN 4: THE EVOLUTION OF SCIENCE AND SCIENCE SYSTEMS

Project 4.1: What Works for Women in Science

The Issue:
A fundamental and persistent inequality in science concerns the relative lack of agency and representation of women, the gendered nature of scientific institutions, and related social pressures and prejudices throughout the system. It is the subject of ongoing academic research, of an ever-growing resource of case studies and advisory reports, and of longstanding debate and policy intervention at institutional and political levels within national, regional and international scientific communities. It is the focus of work supported directly by the ISC, and an issue of priority concern to most if not all the Council's members, to its partners and to the broader communities of scientists, science policy-makers and funders with whom the Council works. But effective, successful practice remains elusive in many systems. A "what works for women in science" initiative is intended to address this challenge.

Anticipated impact:
Improved sharing and use of evidence of what works for women in science in different societies and their science systems; by scientific and related policy institutions/organizations at national, regional and international levels.

Key target audiences:

- The ISC, its members and co-sponsored initiatives
- Other international scientific organizations
- Funders
- UN agencies and interagency mechanism like UN-Women

Actions:

ISC should establish a virtual ISC "what works" centre on women in science, based on the 'what works' concept used by the UK government. The centre would:

- collect and collate existing evidence from ISC members on effective policies, programmes and practices to advance gender equality in science;
- assess the efficacy of those interventions against an agreed set of outcomes;
- share findings in an accessible way;
- encourage policy makers and practitioners to use the findings to inform their decisions and shape their responses.

The ISC should consider discussing the idea of a group of national academies taking the lead on establishing this initiative, with the support of the ISC, and with the longer-term possibility of others using the "what works" idea to address other specific issues of concern related to the inclusivity and diversity of global science systems.

Note: The ISC would need to consider overlap and possible partnership with the Harvard Kennedy School Women and Public Policy Programme (with a 2016 What Works publication on gender equality by design)

Relevance to members:

- Contributing evidence / showcasing success stories.
- Policy learning.
- Influence at global level.

Project 4.2: Refugee Scientists: Awareness and action

The issue:

In the second decade of the 21st century, the world is witnessing the largest global movement of people since World War II. These migrations are driven by conflicts, climate change, "land grabbing" and degradation, etc., and are unlikely to diminish in the coming years. These forced migrations affect some of the world's poorest regions, with relatively low levels of scientific capacity, as well as countries such as Iraq and Syria, which had strong science systems that are now largely destroyed. Although very difficult to assess, the total number of scientists "on the move" is currently estimated to be approximately 60,000 worldwide. Whereas the issue of "migrations" is high on the global agenda, little attention is given to the consequence, at the global level, of tens of thousands of scientists interrupting their work, in terms of lost national capacity, knowledge and investment. Such loss ultimately affects the capacity of those societies affected to engage in post-conflict reconstruction. A few national and philanthropic initiatives currently help hundreds of individual scientists worldwide to find institutions in which they can continue their research activities. Clearly

more can be done to coordinate these efforts and maximise the number of scientists supported by relevant initiatives. More significantly, no organization is currently approaching the issue from the perspective of the ISC, as a global scientific community, to collectively maximise the protection and support of refugee and displaced scientists, to minimise the capacity, knowledge and investment loss incurred by forced migrations, and to strengthen the capacity of societies to engage in post-conflict reconstruction of their knowledge systems. A global awareness campaign would focus on the extent of the need and the types of concrete support actions that different science institutions can undertake to help refugee and displaced scientists.

Anticipated impact:
An awareness campaign should call the international community's attention to the global significance of refugee and displaced scientists. ISC should work with its partners in *Science International* (the Inter-Academy Partnership – IAP, and The World Academy of Sciences – TWAS) and others, to collaborate in coordinating efforts to respond by developing processes to help rebuild national science in a post-conflict era.

Key target audiences:
- ISC members
- International and national science organisations (from UN agencies to universities)
- Funders and philanthropy
- The wider public

Actions:
a) Operational phase of an agreed Science International Initiative, led by TWAS, and involving IAP and the ISC.
b) Production of a draft "position paper" by *Science International* and a roadmap of initiatives to be undertaken in the first 3 months to disseminate, discuss and develop the position paper.
c) Design and lead an awareness campaign about the extent of the needs and the types of support that institutions can put in place to help refugee scientists.
d) Consider on that basis a strategy for more ambitious partnerships and actions, such as an international resources hub for refugee and displaced scientists or a support fund for presentation of "interrupted studies" at international disciplinary conferences, to a global "University in Exile" or study of post-conflict reconstruction of knowledge systems.

Relevance to members:
- Showcasing examples of how refugee and displaced scientists can be supported by different types of science organisations.
- Capacity to mobilise their membership base for coordinated support action at the global level.
- Influence at global level.

Project 4.3: Open Science: Avoiding a global divide

The issue:
The modern storm of digital data coupled with pervasive communication have profound implications for society, the economy and for science. National science systems worldwide are struggling to

adapt their infrastructures, priorities and processes to the opportunities and challenges of this new, data-intensive world of science. In an era when solutions to global problems need global engagement, the danger is that yet another knowledge divide will be created between global north and global south, not only to the detriment of the latter, but to the detriment of all. The enhancement of global scientific collaboration and community that has occurred in recent decades (referred to in Part 1), and to which the ISC has been a major contributor, provides the rationale for its engagement in efforts to avert such an outcome. The ISC, together with CODATA, has played a major role in the creation of the pan-African Open Science Platform (AOSP) which is currently being established, and which will be a major priority for the ISC Regional Office for Africa (ROA). There is now a parallel initiative in the process of development led from the ISC Regional Office for Asia and the Pacific (ROAP), and a Latin American interest in a further analogous development that could involve the ISC Regional Office for Latin America and the Caribbean (ROLAC). In the latter case, steps are being taken, with the support of the ISC, to seek funding for a South-South network between these three initiatives. The potential for a South-South collaboration augurs well for healthy global collaboration as equals rather than as in the donor-recipient model of the recent past. The role of the ISC should be to foster growth of this South-South network and connect it to developments in the global North.

Anticipated impact:
The emergence of a major, successful South-South network would improve regional infrastructure, increase the potential of regional science, strengthen the scientific input to the SDGs, thereby enhancing the prospect of achieving them, and encourage more targeted and coordinated support from international donors. The project would also create a shared priority for the ISC Regional Offices and a basis for effective joint working.

Key target audiences:
- Regional members of the ISC; ISC unions and associations and their links with regional members
- Regional scientific and governmental bodies
- UN agencies
- Major donors

Actions:
The ISC will:
- support its Regional Offices in promoting and delivering the platforms;
- promote development of a South-South network through its contacts with UN agencies and procedures and its relationships with funders;
- encourage contributions from its unions and associations in supporting engagement of their disciplines in enhancing the impact of developing platforms and the network;
- encourage and work with its national members in providing strong regional scientific and policy support for these developments.
- discuss the extent to which these developments might provide the strategic core for ISC's network of regional offices.

Relevance to members:
The project gives opportunities for unions and associations to enhance the benefits they offer to their regional communities, and benefits national members in the regions of the proposed networks.

Project 4.4: The Future of Scientific Publishing

The issue:
Scientific journal publishing is a fundamental part of the scientific enterprise, but one still largely based on the procedures and assumptions of obsolescent paper-based production. This, together with the development of a new "open science" paradigm, has generated a growing movement advocating open access publishing, together with attempts to replace a unique, one-sided business model, in which many publishers make, by any standard, extraordinary profits from funds that ultimately come from national science allocations. So-called "open access" journals have increased in number, impact and popularity, whilst the European Commission has recently published Plan S, which requires that, from 2020, scientific publications resulting from research funded by public grants must be published in compliant Open Access (OA) journals or platforms. This latter development has been endorsed by many national funders whilst receiving a more reserved response from others, together with voices urging caution about the potential for unintended consequences. Recognizing that Plan S has effectively created a space for a global debate on the principles and models of scientific publishing, the ISC initiated in January 2019 a blog series focusing on the issues raised by OA in different geographical and disciplinary contexts. The first interviews of the series have explicitly called for the Council to become more actively involved in the critical discussions on OA and the future of scientific publishing.

Anticipated impact:
- The interest of science is that the mode of scientific publishing should optimise cost, quality, reach and accessibility irrespective of income level. Helping to achieve this would a major victory for the scientific community.
- A debate platform evolved from the current blog series would be an opportunity for the ISC to test a new way to convene and lead global debates.
- If successful it could demonstrate a unique capacity to convene and influence global discussions on issues relevant to all science in all parts of the world.
- It could result in the development of a global network of top experts on scientific publishing, which could be relied on for further initiatives.
- It would speak directly to our mission, and help substantiate the ISC claim to advance science as a global public good.

Key target audiences:
- Scientists, science institutions
- Learned society publishers
- Funders of science
- National science ministries
- UN agencies

Actions:

Depending on the progress of the current blog series, this could, if deemed successful, be enlarged and integrated into a web-based platform that would investigate critical issues, opportunities and points of contention on the future of scientific publishing more broadly. The platform, which would require careful conceptual design, could combine an extended series of interviews, a variety of related resources, and other tools for engagement with membership and the global scientific community. It would provide a basis from which the ISC could, in due time, develop additional initiatives on the issue (e.g., a world forum or a world report). It might also create a model for other initiatives, for example, in providing a powerful tool for Project 3.3 on Global Outreach. The ISC communications group anticipates:

a) continuing on OA for a month and interviewing international experts to assess and comment on the arguments as they develop and the issues raised in the series;
b) designing and launching a web-based platform to engage more broadly with the future of scientific publishing, including a new blog series, resources, and perhaps additional tools allowing members and anyone to contribute;
c) considering, towards the end of 2019, additional ideas for impactful initiatives on the future of scientific publishing (led by the Council or partners).

Relevance to members:

- Platform to access information and engage with the critical issues pertaining to the future of scientific publishing;
- Capacity to influence the development of a new initiative on science publishing.

Project 4.5: The industrialisation of science: Assessment, evaluation and possible action

The Issue

In the last three decades there has been an enormous growth in the rate and volume of scientific publication and in the number of journals that have been created to cope with, and financially benefit from, these pressures. It has been associated with the rise of predatory journals and publishers that publish low or marginal quality research. It is a trend that has put the traditional peer review system under great pressure. This process has been driven at the level of individual scientists by use of publication, and the citations that they attract, as indices of their value to their universities, as a reflection of the esteem within which they are held and a criterion for advancement. At the level of universities, these outputs are regarded as a vital means of demonstrating institutional excellence and their position in the tables of university rankings that have become important drivers of institutional strategies and means of marketing their brands to potential students and star researchers. There are issues of whether current modes of research assessment, institutional assessment and evaluation of the work of individuals are fit for purpose. Two large questions are increasingly raised. Is it in the best interests of a national science and educational system to generate a mountain of low impact publications, to the potential disadvantage of the rising generation seeking the benefits of a robust higher education? Is it in the national interest for universities to prioritise competition for high rankings, where the criteria induce them to converge towards a research-based model, thereby reducing the diversity of national higher educational systems?

Anticipated impact:
Some of these issues could be highly contentious to take up, with a number of major vested interests at stake. Thus, one outcome might be that the ISC would be heavily criticised as "unhelpful" by many we would otherwise seek as allies on other issues.
On the other hand, we might be successful in promoting a developing debate that many would regard as timely and appropriate.

Key target audiences:
- Academics, universities, student bodies
- Ministries of education
- National academies of science
- The IAP, TWAS, Global Young Academy
- UNESCO

Actions:
A first step could be to seek advice from national members about the timeliness of an ISC intervention. Depending on the response, we could either decide to take no further action, or consider:
- having a small working group undertake a synthesis review of existing views on the issue from a wide variety of interested sources and from all regions;
- contacting university representative bodies, at all levels of ranking systems, to ascertain their views;
- developing an online debate such as the ISC is conducting for Plan S, with the view to producing a synthesis report or statement.

Relevance to members:
Most members, whether national or disciplinary, have an interest in the issue, would be invited to contribute to the debate and, depending on its outcomes, consider further awareness raising, debate and possible policy review at the national level.

3.3 Summary of possible timeframes

The following table is an indicative summary of possible start dates and durations of the projects listed above. Depending on the expressions of priorities of members and the Governing Board, a prescriptive version of this table would be generated to show the proposed phasing of projects that have a high priority in the 2019-2021 planning period, noting that some flexibility in the planning space will be required to accommodate unanticipated opportunities for the ISC in delivering its strategy and establishing its reputation.

Figure 2. Overview of anticipated timeframes for the initiation and duration of priority projects

Challenge Domains and Priorities for Action	Timeframes					
	Jan-June 2019	July-Dec 2019	Jan-June 2020	July-Dec 2020	Jan-June 2021	July-Dec 2021
Domain 1: The 2030 Agenda for Sustainable Development						
Science for sustainability: Complexity, coherence and accelerated impact		→ Follow-up / Ongoing Activity				
Funding science for sustainability: A global forum of funders						
Domain 2: The Digital Revolution						
Tackling complexity: Data-driven interdisciplinarity		→ Follow-up / Ongoing Activity				
Global data governance						
A machine learning society: The science narrative						
Domain 3: Science in Policy and Public Discourse						
Science-policy interfaces at the global level: Strategy development	→ Follow-up / Ongoing Activity					
Policy and public action: The role of engaged science						
The public value of science			→ Follow-up / Ongoing Activity			
Domain 4: The Evolution of Science and Science Systems						
What works for women in science						
Refugee scientists: Awareness and action						
Open science: Avoiding a global divide			→ Follow-up / Ongoing Activity			
The future of scientific publishing						
The industrialization of science: Assessment, evaluation and possible action						

3.4 Membership engagement

The ISC is committed to increasing the level of membership engagement in the shaping of its agenda, as well as the design and delivery of its activities. This issue will be given priority in the GB's further detailed work of planning and developing the projects to be included in an agreed Science Action Plan. In this regard the GB will rely on the inputs of its Outreach and Engagement Working Group. It will also invite members to indicate their interest and capacities to actively support the effective delivery of projects, whether on their own or in collaboration with other members. Such

support could include the secondment of support staff, the hosting of expert working group meetings, the facilitation of access to relevant funders, etc.

In addition to the benefits associated with active membership engagement, the proposals for possible priority projects to be taken forward in the coming three years are also based on consideration of their relevance to the interests and priorities of all ISC members. As a package, the projects should enable members to:

- access information on international scientific and related policy developments;
- gain better understanding of and build networks with the actors, processes and priorities of relevant international landscapes, including specific domains (e.g. sustainability science), of the UN system and other major global policy processes, of the world of science funders, etc;
- gain more effective access to / representation in processes of international policy influence;
- contribute expertise to scientific and policy matters of global public concern;
- showcase examples of the scientific and policy-related work of the national/disciplinary communities they represent, amplifying awareness of the strengths of those communities and of members' outputs at the international level;
- share information / know-how with other ISC members, and learn from the exchange and synthesis of best-practice guidelines;
- gain access to intellectual inputs/resources to enhance their own influence within scientific, policy and funding communities, including national governments.

3.5 Opportunism

In a fast-changing world where reliance on scientific knowledge and understanding is essential but cannot be taken for granted, it will be important for the ISC to be able to intervene in a timely manner on emerging science-relevant public issues. As the Council's visibility and reputation grows, it should be able to respond to the increasing number of requests that are already received for targeted scientific input and advice, coming from the UN and other global policy fora, and for related partnership invitations from other international scientific organizations. It should, in other words, ensure the maintenance of sufficient operational flexibility – and associated capacities – to be agile and timely in responding to opportunities.

Appendix: Summary Overview of Current ISC Activities

1. International scientific initiatives (co-)sponsored by the ISC

The ISC sponsors a number of high-profile international scientific initiatives. Many of these are co-sponsored by other international scientific partners, including UNESCO and other specialized UN agencies.

- The International **Network for Government Science Advice** (INGSA) provides a forum for policy makers, practitioners, and scientists to advance the theory and practice of using scientific evidence to inform policy at all levels of government. https://www.ingsa.org/
- International **Research Programmes** promote international scientific collaboration and science-policy interfaces related to specific global challenges.
    - Comparative Research on Poverty Programme (CROP)
      https://www.crop.org/
    - Future Earth
      http://www.futureearth.org/
    - Integrated Research on Disaster Risk Programme (IRDR)
      http://www.irdrinternational.org/
    - Urban Health and Wellbeing Programme (UHWB)
      https://sites.google.com/view/uhwb
    - World Climate Research Programme (WCRP)
      https://www.wcrp-climate.org/
- International **Scientific Committees** coordinate international science in specific thematic fields.
    - Antarctic Research (SCAR)
      https://www.scar.org/
    - Frequencies for Radio Astronomy and Space Science (IUCAF)
      http://www.iucaf.org/
    - Oceanic Research (SCOR)
      https://scor-int.org/
    - Space Research (COSPAR)
      https://cosparhq.cnes.fr/
    - Solar Terrestrial Physics (SCOSTEP)
      http://www.yorku.ca/scostep/
- International **Data Bodies** develop and promote global policy in data science, build data science capacities, and bring together and make openly available relevant global data sets to enable scientific analysis across scientific domains.
    - Committee on Data for Science and Technology (CODATA)
      http://www.codata.org/
    - World Data System (WDS)
      https://www.icsu-wds.org/
- Global **Observing Systems** collect global sets of internationally agreed key data, which provide the basis for scientific analysis and assessment and support global modelling and projection activities.
    - Global Climate Observing System (GCOS)
      https://public.wmo.int/en/programmes/global-climate-observing-system
    - Global Ocean Observing System (GOOS)
      http://www.goosocean.org/index.php?option=com_content&view=article&id=8&Itemid=109

The work of these initiatives contributes in important ways to the delivery of the ISC's strategic objectives by promoting international, inter- (and, in some cases trans-) disciplinary research and related science-policy interfaces, supporting capacity building, and developing and advocating policy frameworks for national and regional science systems throughout the world. Additional benefits for the ISC of sponsoring these initiatives include:

- Access to wider networks of scientific research and expertise, which strengthens the ISC's capacity to deliver on its own projects and campaigns, and to provide input into global policy processes;
- Visibility for the ISC amongst the scientific and policy communities convened by these bodies; and
- Partnership development opportunities with other international scientific organizations and UN agencies that co-sponsor them.

The ISC's role as a sponsor includes the following responsibilities:

- Strategy and activity development: Contributing to the development of strategic plans, facilitating partnership building and activity-based synergies across ISC sponsored initiatives
- Quality assurance: Conducting regular reviews of scientific quality and impact, monitoring progress on the delivery and outcomes of activities
- Governance and Management: Providing legal hosting facilities and/or managing hosting agreements in support of International Programme Offices or Secretariats, participating in governance meetings and appointing advisory/steering committees
- Resource mobilization: Advising on resource mobilization strategies and funding opportunities (but not assuming direct fundraising responsibilities)
- Communications and outreach: Providing access to UN policy processes, publicizing achievements and events via the ISC website and other media tools

2. International research funding initiatives managed by the ISC

The ISC manages two international funding initiatives, both of which are supported by the Swedish International Development Cooperation Agency (Sida). They include:

- The **Transformations to Sustainability** Programme (T2S): This initiative was established by the International Social Science Council (ISSC) in 2014 with the goal of increasing social science contributions to solving global environmental change and sustainability challenges. The first phase of the programme ended in 2017. A second phase, which was launched in January 2017, is being managed by a consortium of funding agencies from the Belmont Forum and the NORFACE network of European social science funders. With the support of Sida, the ISC is a partner in this consortium, which is supporting 12 international research projects for the period 2018-2021. https://transformationstosustainability.org/

- The **Leading Integrated Research for Agenda 2030 in Africa** Programme (LIRA2030): This is a five-year initiative, which was launched by the International Council for Science (ICSU) in early 2016 and is implemented in collaboration with the ISC's Regional Office for Africa and the Network of African Science Academies (NASAC). The programme seeks to increase the production of high-quality, integrated (inter- and transdisciplinary), solutions-oriented research on global sustainability by early career scientists in Africa. It currently supports 20 collaborative research projects focusing on various issues of sustainable urban development in Africa.
  https://council.science/what-we-do/funding-programmes/leading-integrated-research-for-agenda-2030-in-africa

In addition, the ISC currently supports three international projects that were selected for funding under the former ICSU **Grants Programme**. They include:

- A global approach to the gender gap in mathematical and natural sciences: How to measure it, how to reduce it (led by the International Mathematical Union and International Union of Pure and Applied Chemistry)
- Trans-disciplinary research-oriented pedagogy for improving climate studies and understanding (led by the International Unions of Biological Sciences and the International Union of Quaternary Research)
- Utilisation of light source and crystallographic sciences to facilitate the enhancement of knowledge and improve the economic and social conditions in targeted regions of the world (led by the International Union of Pure and Applied Physics and the International Union of Crystallography)

Further information on each of these three projects is available at: https://council.science/what-we-do/funding-programmes/icsu-grants-programme

3. The ISC's work with global policy frameworks, assessments and inter-governmental networks

The ISC is a lead coordinator of the UN Major Group for Science and Technology. In this role the Council works with the World Federation of Engineering Organizations (WFEO) to secure a mandate for science at the UN and to integrate science in major global policy processes, assessments and inter-governmental networks, including:

- The 2030 Agenda for **Sustainable Development**
- The UN Framework Convention on **Climate Change** (UNFCCC), the Intergovernmental Panel on Climate Change (IPCC) and the Paris Agreement on Climate Change
- The Sendai Framework for **Disaster Risk Reduction**
- The New **Urban Agenda**
- The Intergovernmental Science-Policy Platform on **Biodiversity and Ecosystem Services** (IPBES)
- The International **Resource** Panel (IRP)
- The Group on **Earth Observations** and Global Earth Observation System of Systems (GEOSS)

The ISC's engagement in these processes includes a wide range of actions related to the following roles and responsibilities:

- Enabling the participation of scientists in inter-governmental meetings that are typically open only to accredited non-governmental organizations
- Representing the international scientific community by participating in UN events and preparing and issuing statements during such events on behalf of the Major Group for Science and Technology
- Convening and coordinating scientific inputs (e.g. briefings, reports, etc.) on the need for evidence-based decision-making and/or relevant scientific expertise on the specific policy domains covered
- Advising the UN on and participating in science-related processes and advisory structures such as the Technology Facilitation Mechanism
- Supporting representatives of the scientific community's direct engagement in global policy processes by providing information on how these processes work and assisting with the identification of UN priority agendas and associated opportunities for engagement, so that they can target their own advocacy or research
- Leading the development of relevant independent activities, which typically involves the design and delivery of expert advisory reports

4. International Events

The ISC endorses or co-sponsors and participates actively in many international scientific events, including **International Years or Decades of Science** initiated and implemented by ISC members and/or partners. Current Years/Decades endorsed by the Council include:

- International Year of the Periodic Table of Chemical Elements: 2019
  Organized under the leadership of the International Union of Pure and Applied Chemistry
- International Year of Basic Sciences for Development: 2020
  Organized under the leadership of the International Union of Pure and Applied Physics
- UN Decade of Ocean Science for Sustainable Development: 2021-2030
  Organized under the leadership of the Intergovernmental Oceanographic Commission of UNESCO

The ISC is also a co-organizing partner of the biennial **World Science Forum**, which was initiated by the Hungarian Academy of Sciences with the support of UNESCO and the International Council for Science, and which now includes as partners the American Association for the Advancement of Science (AAAS), the World Academy of Sciences (TWAS), the European Academies Science Advisory Council (EASAC) and the InterAcademy Partnership (IAP).

5. International Partnerships

Through the various activities outlined in points 1 to 4 above the ISC partners with a wide range of regional and global scientific organizations, as well as specialized UN agencies and programmes. The nature of those partnerships varies, from **co-sponsoring** international initiatives or **co-organizing** international events to **collaborating** in the context of specific joint projects. Partnerships of a more formal nature are held with UNESCO, the Belmont Forum (an international consortium of science funders) and, in the context of a series of Science International initiatives, with the IAP and TWAS.