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Second Background Paper. Input to the 2nd Consultation

Bouncing Forward Sustainably: Pathways to a post-COVID World

Strengthening Science Systems

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Abstract

This Background Paper was prepared to frame the discussion in the 2nd Consultation on Strengthening Science Systems within the IIASA-ISC Consultative Science Platform “Bouncing Forward Sustainably: Pathways to a post-COVID world”.

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Preamble

The COVID-19 crisis has highlighted the critical role of science in acquiring knowledge of the pandemic and its effects, as well as communicating that knowledge to policy makers. The IIASA-ISC Consultative Science Platform on Strengthening Science Systems assesses how science has responded to the COVID-19 crisis and, utilizing this understanding, is advancing a number of proposals to strengthening the capacity for science to serve society in the future.

The 1st Consultation took place on 19 June 2020. A draft report on the 1st Consultation accompanies this paper. This background paper, building on the 1st Consultation, provides a list of draft recommendations selected for discussion in the 2nd Consultation. The 2nd consultation will take place on 20 July 2020; participants to this meeting are funders, the private sector, science journalists, publishers and those concerned with public understanding of science.

The aim of the 2nd Consultation is to critically review and further develop these draft recommendations, and to provide guidance as to how these recommendations might be implemented.

The Background Paper to the 1st Consultation (link) identified three axes of improvement that are required so as to ensure that science can react more efficiently and effectively to global exogenous threats: *increased agility, enhanced reliability* and *a more effective science-policy-society interface*. Collectively, the proposed policy recommendations should have the potential to advance on all three axes, thus lifting the science system to a new frontier.

Draft Policy Recommendations

Ten selected draft recommendations are presented here in three buckets. The first bucket, Access and partnership, focuses on issues of open science, peer review system, and partnership with the private sector, which are critical means to achieve *increased agility* and *enhanced reliability* of science in its service to society. *Increased agility* and *enhanced reliability* of science will also be facilitated through the recommendations from the second bucket, Agility and quality, that covers research priorities, funding, and scientific cooperation as key enablers of scientific progress. Finally, the third bucket, Public, policy and science, focuses on the public understanding of science, trust in science, and the science-to-policy advisory system, which ultimately help advancing towards *a more effective science-policy-society interface.*

Access and partnership

- **Efficient and effective peer review**: The peer-review system should be seriously re-examined with regard to rigidity and slowness of paper processing.

The swift dissemination of quality research is a pre-requisite for both rapid progress in science and effective science advice to policy and society, particularly in crisis situations. As many as 3 million peer-reviewed research articles are published globally every year (link). The current peer-review system as a research quality assurance and legitimacy mechanism has been subject to question prior to COVID-19 (link and link). COVID-19 and the associated proliferation of pre-prints and other grey literature has further highlighted weaknesses of the peer review system in slowing the response to a rapidly developing exogenous crisis that requires swift and high-quality research. Delays resulting from peer review include a long processing time for publication of papers and a decision to publish which is dependent upon the outcomes of review processes and hence on the choice and availability of reviewers.

Adequate peer review is especially critical to ensure the quality of interdisciplinary research as well as to promote high degree of innovation. As interdisciplinary research combines knowledge from various disciplines in a novel way, it requires review by relevant disciplinary experts as well as by those who specialize in the practice of interdisciplinarity. Such a comprehensive review is usually very difficult to obtain, and thus interdisciplinary research review outcomes are particularly contingent on the different approaches of reviewers. The use of new technologies such as AI-based tools for the identification of possible reviewers; recognition of reviewing as a community service requirement for career development; allowing for dispute between the authors and reviewers (link); developing and enforcing standards of review quality (link); training of scientists in how to review (link); and even making peer review a profession -- are some possible measures that could be employed to improve the agility of the peer review process while simultaneously increasing its quality.

- **Open science**: The move to open science – open access publishing; open methods, models, data; open to society – is a priority for science.

Most original research findings are still presented in formally published peer-reviewed journals, monographs and books, the access to which imply subscription fees. These fees impose high paywalls, inhibiting access by scientists and citizens. In the context of COVID-19, a number of major commercials provided free access to relevant peer-reviewed publications for the duration of the outbreak. However, there is, of course, no guarantee of this occurring on the context of future crises. There is thus a need for reform of the commercial publishing system if science is to respond effectively to future crises.

In response to calls from the science community, the major commercial publishers have developed an open-access publication system, whereby authors, rather than readers, pay through the means of article publishing charges (APCs). In 2019, 31% of all academic peer-reviewed publications were published open-access – and 52% of article views were to open-access articles (link). However, APCs are often excessive, and effectively exclude scientists from many countries, especially in the Global South, from participation in a publishing system dominated by the developed world. In 2018, the European Commission launched "cOAlition S" – an international consortium, which sought an agreement from national funding bodies that they would require all their grantees to publish in open-access journals by 2021 (link). It has received little support from the Global South, and hence search for a globally equitable business model for open access publishing remains a high priority for science.

Modern research increasingly relies on large volumes of diverse data that often cannot be contained within a conventional scientific paper. Data, models, and computer codes that provide evidence for scientific claims must be concurrently accessible for scrutiny and reproducibility. A suitable framework for that is a FAIR format (Findable-Accessible-Interoperable-Reusable; link). Data should be deposited in open well-managed repositories and it should be the responsibility of the journals to ensure that the data and models are concurrently and openly available as a condition of publication. Computer code utilised in manipulating data or in models should be openly available; in some cases, characteristics of the machine that undertook the computation will be required. Open source software should be used in these operations as much as possible.

- **Cooperation between public science and private sector**: As many solutions rely on public-private research partnerships and on private sector technology platforms, mechanisms to enhance cooperation between public science and the private sector should be identified. Incentives for the public and private sector to share data and knowledge must be developed.

The private sector is responding to COVID-19 by creating new solutions to halt the spread of the virus innovating and producing new products and services, including ventilators, diagnostic tools, and, most significantly, vaccines.[1] Technology platforms developed in the private sector, most notably in ICT, are critical to many COVID-19 related initiatives.

In many areas, businesses are engaged in partnerships with the public sector. This is particularly evident in vaccines – there are more than three dozen COVID-19 vaccines currently under development, of which several are in partnership with scientists in the public sector. In terms of technology platforms, track and trace systems and digital health technologies used by the governments rely on ICT systems developed by business.

[1] For a recent listing on business sector innovations related to COVID-19 see: Coronavirus Business Tracker: How The Private Sector Is Fighting The Covid-19 Pandemic. Forbes April 1, 2020 (link).

Public-private partnerships to develop innovative solutions to the COVID-19 pandemic are most advanced in relation to medicine. As one example, the National Institute for Health (NIH) in the US has launched a major public-private partnership for vaccine development and COVID-19 treatment options which brings together public health agencies and private companies.[2] The WHO has sought the support of technology companies to develop its response to COVID-19. Digital technologies are critical in developing solutions such as population screening, tracking the infection and designing targeted responses. "We need your commitment… We can only tackle this global threat - and get our economy back on track - by working together." – said WHO Director-General, Dr. Tedros Adhanom Ghebreyesus addressing digital technology companies (link).

An outstanding example of international scientific collaboration in both the public and private sector was the sharing of the full genome data of the virus. Less than 24 hours from when it was first sequenced by Chinese public health laboratories, the full genome data was shared on GISAID1 EpiCoV™ database, a public-private-partnership. This allowed scientists to immediately begin working on a vaccine.

Reflecting on the Lessons for International Research Collaboration and Information Exchange from the experiences from the COVID-19 pandemic, the International Chamber of Commerce recently concluded that "The COVID-19 pandemic has demonstrated the importance of cross-border scientific collaborations within and between the public and private sector, and the effective and timely global exchange of scientific information, samples and materials. International cross-border scientific collaboration including between public and private researchers should be supported, and policies and regulations that could hinder this international collaboration and exchange avoided." (link)

Agility and quality

- **Research on risk and systems resilience**: Critical risks and the resilience of socio-economic-environmental systems should be a key focus of future research. Attention should be given to the decision-making contexts, policy implementation, and societal responses.

The COVID-19 crisis emphasized the need to enhance our preparedness to address exogenous shocks of various kinds and to increase our understanding of the vulnerabilities of critical systems both natural and human (link, link and link). Analyzing possible future risks, how such risks could be prevented, and how communities and societies could prepare and respond to those risks, should be an important part of the research portfolio for any nation, region and the global community. Stress-testing of key systems enabling our well-being, notably, livelihood systems and governance systems, to a broad range of shocks should similarly be undertaken at national, regional and global levels. "Glocalization" (link) is a term that highlights two facets that many critical risks possess. On the one hand, due to the high interconnectivity of the modern world, the contagion of many critical risks reaches continental and global scales. On the other hand, the same risk manifests itself very differently depending on the local conditions; this diversity is observed in how a risk originates, how it begins to spread, and how the response occurs. When addressing risk and resilience, future research should therefore recognize historical, cultural, and social heterogeneities. Social science and behavioral science should be an integral part of any policy-oriented research, more particularly in making policy trade-offs explicit and in overcoming vulnerabilities and ensuring resilience.

To improve the agility of the science system so as to provide early research inputs, reusable and general-purpose modeling must be prioritized as far as possible. Equivalent standards for data and models would allow for these models to be mobilized on demand. To further enhance trust in models, inter-model comparison – a practice that has been most advanced in climate and impact assessment and that has moved modeling in these areas to a much higher level of confidence – must be developed in other areas. The science community is not only is expected to do research into issues of relevance to current policy challenges – science is expected also to look beyond the immediate horizon and set the future agenda for politicians. Despite the urgency of dealing

[2] NIH to launch public-private partnership to speed COVID-19 vaccine and treatment options. NIH News Release, April 17, 2020 (link).

with the COVID-19 research related to the pandemic and its consequences should not displace the centrality of research on sustainability, including climate change. Other exogenous crises will emerge and, as with COVID-19, their origins are very likely to lie in the environmental degradation caused by human interference in natural systems.

- **Nimble re-direction of research efforts:** Mechanisms must be put in place to allow researchers to move rapidly into new areas of public policy concern. This entails funding, performance evaluations for career development and leadership.

At the onset of a crisis resources must be readily available to be employed. Funding will be required to support incentives that are designed to encourage researchers to shift their research to the challenges posed by the emerging crisis. Rapid and easy-to-access grants would be very useful. Easy-to-access grants could support efforts to mobilize, interpret, and communicate already existing research and insights. These grants would be especially useful when the crisis is developing very rapidly and there is no time to conduct new research. Funders, science managers, and research institutions should apply standard performance assessments with a high degree of flexibility during times of crisis times in order to create spaces and incentivize scientists to provide the requisite research response. Performance evaluation system should be adjusted so as to fully recognize the contribution that scientists make to inform decisions around an exogenous crisis. Special attention needs to be paid to young researchers who are often dependent on short fixed-term insecure contracts and at the same are under high pressure to demonstrate "high productivity" (link). Career track and traditional performance requirements make it difficult and disadvantageous for young researchers to quickly re-orient their research. Putting aside ongoing research creates risks for researchers, especially if they are reliant on third-party funding, more especially for early- and mid-career scientists. Performance evaluation system of different career stages should recognize the contribution of scientists in undertaking research which addresses issues posed by crises even if this research does not result in a publication in a peer-reviewed journal or another traditionally recognized output. As for leadership, senior scientists should be expected to lead by example and at the same time encourage and empower young scientists to contribute to research addressed to the issues posed by crises.

- **Easy access to existing research**: Mechanisms to facilitate utilizing already existing and emerging research results and insights to an exogenous crisis should be enhanced.

Global scientific output measured by the number of academic publications growing by 3% per year. As the COVID-19 crisis demonstrated, there is a very significant body of existent research that can be readily utilized to understand and address any exogenous crisis (link). The ease of navigation of already published research results and insights on issues that are relevant to a crisis of concern is accordingly a critical factor for the agility of the science system. In addition to improvements to the publication process, it is important to provide researchers and other stakeholders with far easier access to the existing body of research literature. Academic search engines and customizable AI-based aggregators are useful. However, the capacities of researchers are still required in order to understand, contextualize, and summarize already existing results and insights. Review and perspective articles should feature more prominently in academic journals; funding incentives should be put in place to encourage researchers to engage in such synthesis work. Machine reading can substantially improve how we undertake knowledge synthesis, and this will complement human intelligence in information harvesting and information interpretation to support scientific assessments. Likewise, machines can help disseminate new findings effectively by applying individual-targeting algorithms. It will be important to develop governance protocols for these emerging machines enabled science production processes and science-society interactions.

- **Scientific cooperation at the regional and global scale**: Traditional mechanisms for building and maintaining global research networks are breaking down. Attention should be paid to the development of new mechanisms to encourage scientific cooperation at the regional and global scale, and particularly, to developing networks centered in the South.

Many productive global research networks have traditionally been formed when students, particularly postgraduate students, study abroad and establish personal connections with research leaders in their field as well as with other foreign students. The US, UK and European universities have been the principal loci for these research networks. However, following COVID-19, a combination of health, financial and safety fears – in addition to official restrictions – are severely restricting the numbers of students studying abroad. Diplomatic tensions are increasingly a factor[3].

While estimates vary, Western universities are expecting a very significant drop in international student enrollment as a result of the COVID pandemic (link). Declining revenues from foreign students combined with a difficult economic climate will result in very significant declines in revenues for universities. Major employment losses are already evident (link). Declining revenues will curtail programmes and research activity, reducing the attraction for foreign students of enrolling in the research-intensive universities in the developing countries that have previously been the main locus for the development of research networks and the hub of international research collaboration.

Attention should be paid to the development of new mechanisms, including funding, to encourage international scientific cooperation and the development of global research networks. There appears to be considerable potential to reinforce such regional research networks. Since much of the decline in foreign students studying in the universities of the developed countries will be composed of students from developing countries, particular attention needs to be paid to developing research networks that are centered in the South[4] (link).

Public, policy, and science

- **Public awareness of science**: The awareness of the general public should be significantly enhanced as to how science operates; in particular the role of the scientific debate and disagreement should be made more widely known.

While public trust in science generally remains high, there is an observable lack of public understanding of how science functions and what science can and cannot do (link). This lack of public understanding is most evident in developing countries but is widespread also in the developed world. While the diversity of views and contestation are integral to the scientific endeavor, it is often difficult for individuals outside of the science community to distinguish a healthy scientific debate from an ill-founded contestation (link). In order to support trust in science, a richer understanding is needed of the context in which science operates. The public and policy makers should be educated so as to understand that science does not speak with one voice and that there is no one way in which science undertakes research or derives answers. A diversity of approaches employed to develop a vaccine, for example, is required because one cannot know *ex ante* which process will yield the desired result. With respect to "wicked" (link) problems of public policy planning science often cannot give a single definitive answer– as demonstrated by the differing scientific advice offered in response to COVID-19.

The public should be able to recognize situations when the pursuit of self-interested objectives is camouflaged by the pretense of scientific scrutiny. Stakeholders should be more realistic regarding the limits of what science

[3] For example, the Chinese government has warned its students not to apply for visas to study in the US (link). The US has recently announced severe visa restrictions that will be a significant deterrent to foreign students studying in the US.
[4] In Africa for example, a number of research networks have recently been established at continental and subcontinental levels. These networks strengthen local research capacities and provide a source of evidence for policy (link).

has to offer when it comes to science advice to policy and society. For its part, science has a responsibility to maintain scientific integrity, which in particular includes being clear as to the limitations of the advice it submits.

The communication challenge is further complicated because scientists are committed to precision and rigor whereas the public would prefer unambiguous statements. In this context, there may be a need for 'science translators.' This need has been recognized earlier, but COVID-19 has propelled this challenge to a much higher level of importance. Active participation of lay people in scientific work, for example, through citizen science and other engagement tools, is another promising avenue that can help advance the public's understanding of science.

- **Trust in science**: Measures of combating opposition to and distrust of science, as well as mechanisms for maintaining and increasing trust in science are required.

COVID-19 has highlighted the vital role of science in providing necessary information to combat the crisis and cope with its aftermath. Science and scientists found themselves at the center of public attention. High trust in science appears to have a positive effect on the willingness of the society to comply with quarantine measures (link). In the developed countries, science has been seen as trusted and valued, and in some countries trust in science has even risen (link). However, trust in science is far lower in many other parts of the world. In general, low-income countries have a higher percentage of people who have 'low' trust in science, compared to high-income countries (link).

Even in developed countries, there are large sections of society that are highly sceptical of the value of science. Moreover, science denial and misinformation have been increasing rapidly. Claims are being widely disseminated that science has created or exaggerated the crisis and is responsible for the economic recession resulted from lockdown policies. Public scepticism and distrust of science has been encouraged and facilitated by powerful political forces (link and link).

It is critical that science denial and misinformation be countered. Science communicators and scientists themselves have an important role to play in this regard. Science and scientists need to capitalise on the increasing centrality of science that has resulted from COVID-19. There is considerable potential in utilising automatic systems for filtering fake news – for informing authorities and citizens. Reliable sources of information could be created whereby the general public would be informed about COVID-19 and other issues where science is pertinent.

Scientists need to be careful about making extravagant claims about their own research and/or belittling the research of others. Retractions and qualifications raise questions about the quality of scientific research. Scientific debate is seen by many as scientists unable to make up their minds.

How science is communicated is critical to trust in science. The media often hype up and exaggerate scientific findings which then do not meet expectations and so further erode trust in science. Often, the views of celebrities – and not scientists – are given prominence and are widely disseminated. The media should ensure that the "experts" that they engage to provide scientific advice are indeed substantial and reputable scientists.

- **Strong institutions for science advice**: Strong institutions for science advice to policy ensuring interdisciplinarity, transparency and a capacity to draw on global science should be built.

The COVID-19 pandemic has demonstrated the critical importance, but also the limitations, in current science-to-policy advisory system, and the interface of this system with society. Countries differ widely in the way in which science-to-policy advice is institutionalised[5]. There is no one best institutional model. Developing countries tend to have major weaknesses at the science-to-policy interface. A first requirement is to ensure that science policy is institutionalised and located in robust institutions.

[5] For a partial list of government, professional networks, NGOs and international bodies working at the science-policy interface see (link).

But, even in wealthy countries where the science-policy interface is strongly institutionalised, the COVID-19 pandemic has made it apparent that there is considerable room for improvement (link). Policy responses to COVID-19 have entailed difficult trade-offs. This requires that policy assessments need to engage social scientists who can assess and present the impacts of policy and the responses to policy across the different communities and interest groups. Policy advice that draws widely from different disciplines and that assesses the systemic impacts of any policy will be both far more effective and ultimately enjoy greater legitimacy.

In so far as is possible, the advice of scientists to policy makers should be made open and transparent. Openness and transparency, and the freedom to discuss and debate scientific advice, is critical to trust and legitimacy. Trust and legitimacy, in turn, will render policies far more effective.

Advice will need to be timely. Evidence-based advice delivered rapidly, has been key to the success of some countries in combatting the pandemic. Open science allows countries immediate access to accumulated global knowledge, which is of particular importance to developing countries that are constrained in undertaking their own scientific research. Furthermore, international collaboration allows for sharing of evidence and the emergence of a scientific consensus which can then be communicated to policy makers. Scientific consensus, based on international global scientific collaboration, is especially critical for forecasting future global challenges and threats, and so allow for policy makers to take pre-emptive action.

Ten recommendations: A systems perspective

Figure 1 demonstrates how the proposed ten draft recommendations collectively advance on all three axes of improvement – *increased agility, enhanced reliability* and *a more effective science-policy-society interface* – and thus lift the science system to a new frontier. This Figure builds on a more detailed systems map that analyzed key factors relevant for the three axes prepared earlier (link).

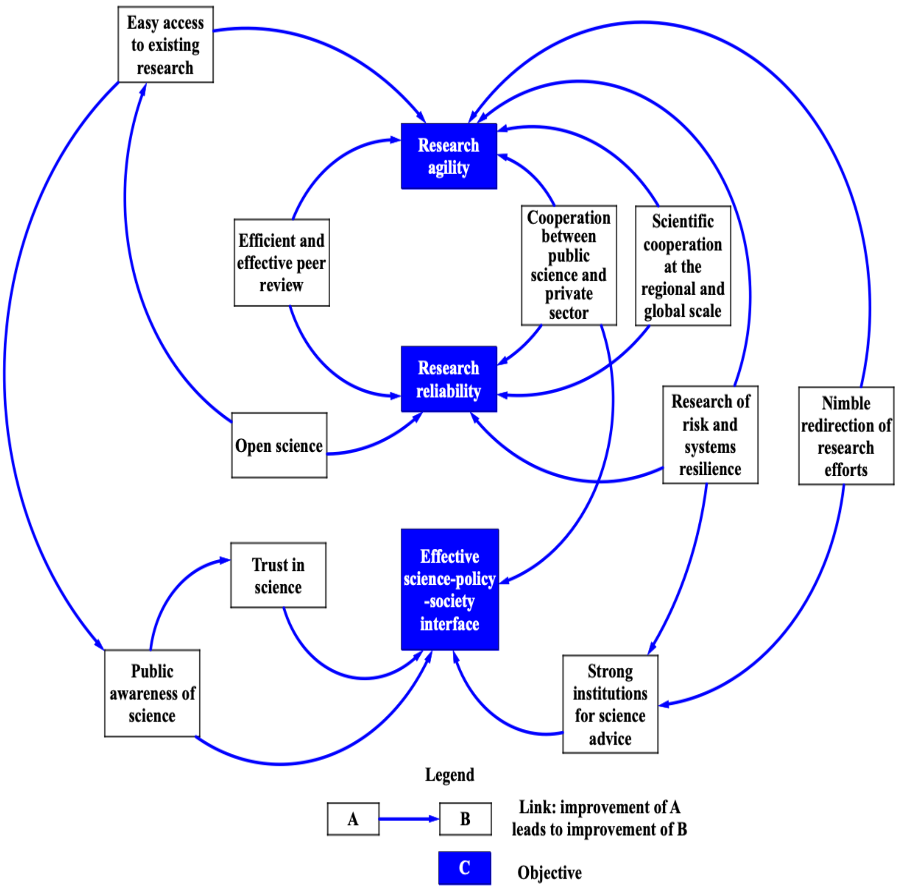

Figure 1: Causal interlinkages among ten draft recommendations and their effect for the three axes of improvement.