THE CONTEXTUALIZATION DEFICIT

Reframing Trust in Science for Multilateral Policy

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Preface

In 2022, two surveys raised worries among the scientific and policy communities. The Pew Research Center survey of confidence in groups and institutions showed a significant ten percentage drop in the share of the American population with a great deal of confidence in scientists to act in the public's best interests (from 39 to 29 percent) since 2020.[1] This decrease could be largely attributed to the specific uncertainties created by the enduring COVID-19 pandemic. Yet many scientific commentators believed that the observed decline among American society reflected broader trends and that similar declines in trust could be observed in most parts of the world. That other surveys suggested a more complex picture about the level of decline lent an urgency to the conversation.

A global survey of several thousands of scientists by the Economist Impact published a couple of months later showed over two-thirds of respondents worried about the levels of misinformation about science in their own society in the context of COVID-19.[2] Again, there seemed to be a general agreement that the trends revealed by the pandemic were more than circumstantial and not limited to certain world regions.

Concerns about the combined impact of declining levels of trust in science and increasing misinformation about science have become among the most discussed topics in science and policy circles. The multilateral system is alarmed by what is perceived as significant threats to its capacity to address global challenges.

In a world of growing geopolitical tensions, science remains one common language for developing coordinated international action. When trust in science is compromised, the capacity for cohesive global policy action is further diminished. The question is how can the multilateral policy interface engage effectively with science, in ways trusted by populations?

This working paper addresses this crucial problem by reviewing what research and practice in a range of fields from journalism to regulation have learned about trust in science in recent years, and the implications of that body of knowledge for policy-makers. The research suggests that the expectation that 'trust in science' should lead naturally to universal public compliance, although often criticized, still prevails among policy (and scientific) circles. The working paper proposes a different, more meaningful form of engagement of the multilateral system with science, organized around the notion of contextualization – in other words, the recognition that values, history, socio-economic factors and identities shape how people will respond to the science–policy interface in specific locations. It also considers the implications for action of the different engagement model for the science–policy interface.

This working paper on trust in science seeks to help clarify the issues, synthesize the knowledge base and outline directions for action. Far from being the final word on the matter, it is an opportunity for further exchanges and engagement with the science–policy interface on this critical problem.

MATHIEU DENIS

Head of the Centre for Science Futures

1 https://www.pewresearch.org/science/2022/02/15/americans-trust-in-scientists-other-groups-declines/

2 https://impact.economist.com/projects/confidence-in-research/

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Summary: New engagement model needed at the multilateral science–policy–society interface

If progress is to be made in achieving the United Nations' Sustainable Development Goals, those involved in multilateral policy need to engage more deeply with the scientific, social, historical and political contexts of their task.

Current engagement at the science–policy–society interface is stuck in a linear model intended to increase broad public trust in messages based on the current scientific consensus. If there is no public compliance, the assumption is that there is a deficit of appreciation by 'the public'. This focus means that engagement efforts have relied on overcoming misinformation and disinformation to better educate 'the public,' especially through burgeoning social media platforms powered by the growth of artificial intelligence (AI).

Global surveys indicate that trust in science can be understood and expressed in various ways by different members of society, and can vary depending on the specific issue. Individual perceptions of science are subject to a range of influences, many of which have little to do with the quality of the science. Responses to science are shaped by individuals' experience and identity, which requires understanding of contexts.

Trust in the practice of science and accuracy of scientific messages are important. However, if science is not mindful of contexts then there is a risk it may be rejected or prove ineffective. To avoid this, science has to be socialized with policy and its constituent publics (recognizing there is not one general 'public' but many). Socialization of science requires more deliberative engagement, which is multidirectional and multifunctional, allowing for mutual understanding.

We propose a new model of engagement in which science is more effectively socialized with policy. This will involve understanding the four drivers that shape any context in which science can be applied to policy: scientific uncertainty, different publics' value systems, historical relationships between policy institutions and their publics and relationships between organized science and political power.

Understanding and negotiating these drivers requires all forms of engagement, from framing the policy problem, disseminating science-based messages and maintaining dialogue between stakeholders, through to deliberatively producing and assessing evidence for decision-making.

The focus of such multimodal engagement should be on achieving trustworthiness, rather than blanket trust. Trustworthiness results from developing ongoing transparency and accountability where the contexts of science's application to policy are collaboratively researched and understood.

Our new model of engagement at the science–policy–society interface builds on developments in science communication, which now recognizes the need for all forms of engagement including dissemination, dialogue and participation. These varied modes of engagement enable the production of 'serviceable truths' that consider the different perspectives, disciplines and contexts of all actors.

Science communicators can play a role in implementing the new engagement model by helping scientists and technology developers to understand policy and societal contexts and how these might affect responses to their work.

Scientific and multilateral policy institutions can encourage the new engagement model by the following:

- Building partnerships that incorporate diverse scientific disciplines and forms of knowledge, use advice from reflexive science communication and set up open and transparent arrangements directed at gaining trustworthiness;
- Developing their organizations to embed a culture of responsive deliberation, apply trust markers for transparency, increase understanding of contexts and invest in narrative listening of actual and virtual publics;
- Supporting deliberative processes that create opportunities for public participation, and use adaptive science-policy decision-making; and
- Providing technical support for communication strategies, including supporting efforts to develop interpersonal trust, creating spaces for participatory development of policy and addressing key questions, which can lead to the increased socialization of science at global, regional and local levels.

Glossary

CONTEXTUALIZATION Considering the interplay of values, socio-economic history and community identities that shape the science–policy interface and responses to it in specific locations.

DISINFORMATION The deliberate circulation of information known to be false with strategic and malicious intent, often for political purposes and in support of vested interests, whether economic or social.

DISTRUST An entrenched position of negative regard for specific individuals, organizations and systems associated with scientific practice.

INFODEMIC Coined by the World Health Organization in 2009 with reference to the H1N1 influenza pandemic, an infodemic is an overabundance of information – including both accurate and inaccurate content – regarding a particular topic, such as a disease outbreak or a public-health issue. It is characterized by the rapid spread and amplification of information through various channels, including social media, news outlets and online platforms.

INFODEMIOLOGY A field of study, first named in 2006 (Eysenbach, 2006), that focuses on the research and analysis of information dissemination and consumption patterns in digital environments, particularly during epidemics or health crises.

MALINFORMATION Information that is based on reality but is used to inflict harm on a person, organization or country.

MISINFORMATION Selective interpretations of evidence which may mislead and unintentionally cause harm. Some instances may also be a normal part of inference from science.

MISTRUST A contingent position of scepticism about the trustworthiness of specific areas of scientific practice, open to change depending on new experiences and new information.

ORGANIZED SCIENCE Research organizations that contribute to policy interactions such as federations of universities, representative groups of scientific disciplines, research funding agencies and similar organizations.

SOCIALIZATION OF SCIENCE 'The processes involved in the production, use and circulation of scientific research and its products' (Bijker and d'Andrea, 2009).

TRUST Assumptions concerning the reliability, competence and integrity of individuals, organizations or systems, based on experience and a variety of social factors.

1.0. Introducing the contextualization-deficit problem

In this chapter we explore the attributes required of the science–policy interface to tackle global challenges. We describe how outmoded ideas of science engagement and concerns about trust in science at this interface create a problem for multilateral institutions seeking to tackle global issues. We outline how the paper explores and addresses this problem.

1.1. Science is crucial for the Sustainable Development Goals

Science is critical to the multilateral vision of promoting socially inclusive and environmentally sustainable forms of development. The United Nations (UN) 2030 Agenda aims to transform the world, using the 17 Sustainable Development Goals (SDGs) as a roadmap for policy-making and implementation. Policy-makers, leaders of organized science and research funders expect science to play a significant role in supporting the ability of the multilateral system to achieve these goals (ISC, 2021).

The challenges facing our world make achieving the SDGs an imperative rather than an aspiration. Most of these challenges are complicated by their multidimensional nature and in some case, as with artificial intelligence (AI), by the fact they are still emerging. These complications suggest that the partnership required between science and policy must be multidimensional and versatile, possessing a 'social robustness' to respond to various real-world contexts (Nature, 2023).

1.2. Sustainability requires appropriate socialization of the science interface

A successful partnership between science, policy and society requires influential actors to understand and appreciate the contexts they are seeking to transform, and open up space to renegotiate established ways of doing things. In this way, science becomes 'socialized' with policy-making institutions and their constituent publics.

A successful partnership between science, policy and society requires influential actors to understand and appreciate the contexts they are seeking to transform.

The socialization of science refers to 'the processes involved in the production, use and circulation of scientific research and its products' (Bijker and d'Andrea, 2009). To work well, these processes need much more than a one-way transfer of knowledge from science to policy or to publics. Instead, socialization demands close attention to the contextual realities that shape how science is produced, used, circulated, governed and, sometimes, rejected or ignored. It requires scientists and multilateral policy-makers to invest in learning how publics and other local institutions relate to the problems posed by shared challenges, such as the SDGs, and proposed solutions to them.

Failures of socialization at the science–policy interface are typically seen as a problem relating to lack of trust in the global scientific consensus. In this paper, we critically assess this assumption. We explore how a lack of trust is often an expression of resistance from policy

and publics, which arises from issues adjacent to science. These adjacent issues, in turn, are typically rooted in the historical relationship between policy and scientific institutions, and in the community identities or socio-economic dependencies that shape the policy-making process. In other cases, problems characterized as a lack of public trust may in fact be linked to uncertainties in science that arise in specific contexts.

The example of the eradication of polio in India demonstrates the need to consider all the contexts at the science–policy–society interface. Such considerations are necessary if global knowledge is to deliver public good at local and regional scales.

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Eradicating polio in India required understanding local contexts

In 1988, the World Health Assembly resolved to eradicate polio by the year 2000. With the help of immunization efforts supported by the Pan American Health Organization, the Americas became the first region to be declared polio free in 1994. By contrast, it took over 20 years before India achieved polio-free status, with the last case of wild polio virus transmission reported in 2011. Since 2011, India has also successfully grappled with the challenge of vaccine-derived polio virus.

The story of polio in India illustrates the limits of a one-size-fits-all strategy focused on a standardized technology (the two-drop or the later three-drop OPV or oral polio vaccine) and disseminating messages through mass campaigns to secure public acceptance. Global health experts (e.g. Taylor et al., 1997) had long warned against such a top-down multilateral approach. From technology design to community engagement to partnerships for dealing with new challenges, polio eradication had to be tailored to the infrastructural and socio-cultural realities of specific regions of India.

First, health experts **tailored vaccination protocols** in response to poor sanitary conditions in parts of the country that lowered the efficacy of the standard OPV. Early on, they developed a novel technique of 'cluster' or 'pulse' immunization in which large groups of children were vaccinated over a short period of time in the local district of Vellore (John et al., 1980). This became the basis for a national mass polio vaccination strategy in 1995, the Pulse Polio Programme. This involved door-to-door campaigns, efforts seeking out migrant families at key sites such as railway stations, as well as dispensing at fixed booths. In some cases, the programme also involved increasing the number of doses above the norm of three.

In the next phase, experts demonstrated the subsequent need to **redesign the vaccine** itself since polio remained persistent in two populous states, Uttar Pradesh and Bihar, even after it had been largely eliminated in the rest of the country (John and Vashishta, 2013; John, 2016). Their research showed that while the standard trivalent Sabin vaccine (consisting of three live or attenuated virus types, 1, 2 and 3) had helped eradicate wild virus type 2 by 1999, but that new vaccine-derived cases were re-emerging in the community especially in conditions of poor sanitation and low levels of routine immunization. This led to a worldwide switch in 2016 to a bivalent variant (consisting only of live and attenuated types 1 and 3 wild viruses) and an inactivated polio vaccine used to retain immunity to type 2 virus without adding to the risk of community transmission.

None of these achievements would have been possible without the efforts of **community mobilizers** working on the ground in settings where families refused the vaccine (Perry et al., 2019; Solomon, 2021). Refusal was often for entirely understandable reasons: suspicion and resentment of a singular focus on polio vaccination when basic health services were lacking; lack of trust in the vaccine given the dark history of forced sterilization initiatives in the 1970s; outbreaks of polio in the previously vaccinated; and other more immediate priorities such as loss of livelihoods. The incentive to refuse vaccines was exacerbated by wariness of the shifting vaccine protocols. Polio was eradicated more quickly in southern India where health services were provided as an entitlement (Solomon, 2021). Vaccine resistance in pockets of northern India was eventually overcome through a combination of empathic communication, provision of health and other key services including food and engagement with religious and civil society leaders (Closser et al., 2016; Solomon, 2021). There was also increasing investment by state and federal governments, which came under increasing international scrutiny, particularly from the United States. The local chapter of Rotary International, key partners in the campaign, was also a well-connected social network.

Ultimately the polio eradication campaign succeeded through a combination of technical and expert advice, community engagement and multiactor partnerships, all tailored to local realities.

Polio eradication in India is a textbook case of key actors turning failure to success, but other examples in which those at the science–policy interface have failed to approach the issue of socialization effectively can be cited across the 60-year history of international development. The COVID pandemic provided several examples where high-profile political resistance to scientific advice made headlines and featured on social media threads around the world. Some researchers argue that the failures during the pandemic reflect entrenched failures to accommodate socio-political contexts in the knowledge used to inform policy (Leach et al., 2021). The last 15 years have seen a growing body of research focused on multilateral programme failures across Africa. The critique typically focuses on the political, cultural or technical inappropriateness of the programme design (Ika, 2012).

1.3. Socialization of science with policy requires contextualization

The Indian polio example demonstrates socialization at the science–policy–society interface at work. Leaders of the eradication effort invested time to understand the *local contexts of disease transmission* and specific failures to interrupt transmission. This knowledge was then used to shape key decisions on vaccine protocols and on knowledge sharing in local and multilateral

partnerships. Equally important were efforts of community workers to understand the *local contexts of public resistance* to vaccination among underserved publics. This informed the shaping of local partnerships for broader service delivery and the design of communication activities.

The socialization of science at the policy interface requires understanding the specific contexts affecting the application of science in that situation. We refer to this understanding of the drivers affecting the development and implementation of science-informed policy as *contextualization*.

Typically, four drivers shape contextualization at the science–policy interface:

1. Scientific enquiry seeks to diminish **uncertainty**, and achieves this on some questions and under certain conditions, but new uncertainties can emerge as science comes to be applied to new situations. This happens because controlled scientific studies are based on specific assumptions about physical and social worlds. These artificial situations may not precisely match the realities of actual environments. For ethical and other reasons, sometimes it is not possible to use real test subjects in the real world. This means science advisers need to exercise judgement and draw broader inferences from individual studies to inform public decision-making. In other instances, closer attention to real-world contexts may be exactly what is needed.

2. Different **value systems** shape how different actors frame and investigate problems or conceive solutions in specific contexts. In using science to inform policy, policy-makers must contextualize knowledge by engaging with different values within and between sciences, publics and other stakeholders. An example is organized religion, which can determine what is considered permissible in relation to technological interventions. In addition, values-based differences may be reflected in judgements about preferring false negatives to false positives in statistical tests, privileging current versus future generations or established versus alternative pathways for societal transformation.

3. Public responses to policy problems can be shaped by their **relationships with institutions** rather than by the content of science. This issue is not necessarily limited to institutions of governance and organized science but can extend to any institution involved in the delivery of Science, Engineering, Technology and Innovation (SETI). This is especially true when specific communities have a history of being marginalized or abused. These histories of power and access are a crucial part of narratives of identity. Scientists and policy-makers need to contextualize their work by engaging with publics in their settings and by understanding the legacy of past relationships.

4. Existing **relationships between science, political power and publics** in specific contexts affect how local groups respond to the science presented by multilateral institutions. Some national policy-makers might ignore recommendations of expertise, including the scientific consensus, depending on the net benefits for their constituency, however that constituency is conceived. Political institutions may be drawn to research that supports their manifesto. The work of the Research and Policy in Development programme at the Overseas Development Institute which has tracked decision-making in policy spheres over 12 years proves this point (Ramalingam, 2013). However, the constituent publics of political institutions may seek to mobilize science to challenge local political arrangements and forms of injustice. The crucial point here is that local or national systems of patronage for political leadership will influence how science-policy is regarded and developed at national and regional levels.

Contextualization means considering the interplay of uncertainties, values, socio-economic history and community identities that shape the character of and the responses to the science–policy interface in specific locations. Often this contextualization, which drives how meaning is made of science, can be misread as the public's lack of education or awareness about consensus science. In recent years, this has also been associated increasingly with a lack of public trust in science.

We refer to this understanding of the drivers affecting the development and implementation of science-informed policy as contextualization.

1.4. The socialization problem is a deficit of contextualization

The paper outlines a vision of socializing science-policy by considering the specific drivers that shape the contexts in which science is being applied. However, this vision is hindered by an influential, but outdated, understanding of how science is supposed to contribute to policy and society. High-level SETI agendas are often framed in linear terms, in which the dissemination of trusted scientific knowledge and associated technological innovations is assumed to transform societies for the better. In this top-down model, the instinct is to first work out the global scientific consensus and then educate policy-makers and their publics in the expectation that they will act on the basis of this trusted information. When publics do not react as expected, their lack of compliance is diagnosed as a problem of lack of trust in science. This deficit of trust is often associated with a failure of scientific education or with a belief in 'pseudoscience' or other forms of irrational behaviour driven by a general 'information disorder' in public communication (Wardle and Derakhshan, 2017).

This outdated linear model of socialization (see Figure 1) relies on one-way engagement between organized science and policy institutions. Within such engagements, the drivers of context are ignored at the policy interface as problems are framed, decisions are made and messages disseminated.

This outdated linear model of socialization relies on one-way engagement between organized science and policy institutions.

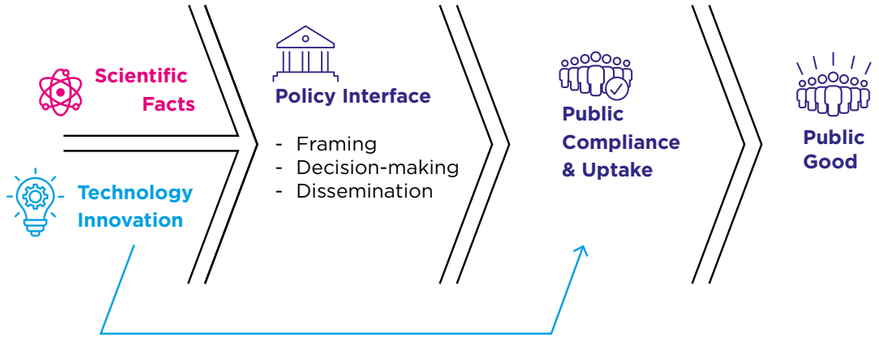

Figure 1. *In the standard model, scientific facts and technological innovation are presented to policy in a linear fashion, with no context and no reciprocal relationship with publics. The only role imagined for the public is to comply with science and take up technological outputs and so realize public good.*

There is also an assumption by some actors at the science–policy interface that technological innovation will outpace regulatory environments and that this is a good thing. This assumes that innovation serves a broad collective agenda for the general public. For instance, neo-liberal economics supports innovation as a marker of efficiency and as a driver of growth. Business studies championed this, particularly the value of 'disruptive' innovation (Brusoni et al., 2006). (We will explore the opportunity regulation can present for socialization of the interface in Chapter 5.)

This linear conceptualization of science–policy–society engagement shapes the ways in which public reactions to the new information landscape are analysed with respect to science and policy problems, as shown in Figure 2. This diagram illustrates the simplistic assumption that misinformation sabotages the links between high levels of trust in science and high levels of public acceptance to policies involving scientific content. In this framing, the problem to be fixed is the proliferation of bad information.

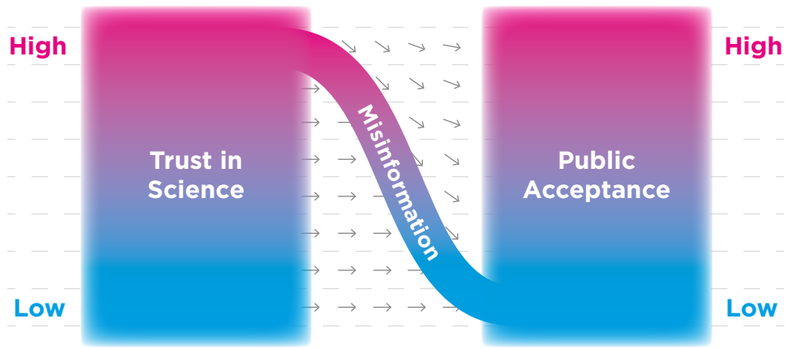

Figure 2. *In the standard model, level of trust in science is correlated with public acceptance of policy decisions. This relationship is assumed to be disrupted by misinformation, which is taken to be the cause of low levels of acceptance.*

This focus on generic levels of public trust in science for policy traction ignores the contextualization of science. The task of socializing science to achieve multilateral goals will need more than top-down information management strategies focused on disseminating trusted messages based on consensus science. Contextual realities at the science–policy–society interface cannot be trumped by messaging alone.

The burgeoning social media communication now taking place through commercial platforms largely ignores the uncertainty that marks good science and the role of value judgements at the interface with policy. Social media platforms often foster a simplified format of two opposite policy positions, where each side claims to speak on behalf of science. Framing science engagement for multilateral policy as a matter of only disseminating the correct science-based messages reinforces this dynamic.

The current analysis of resistance to science, or lack of public trust in it, is also too often linked with individual deficits of knowledge or dysfunction in rational decision-making. This is consistent with approaches that focus simply on behavioural outcomes, which are typically concerned with the quantity of inaccurate information consumed.

Accuracy of information in the public domain is, of course, critical. But the challenges at the science–policy–society interface cannot be addressed with generic efforts to improve informational accuracy. Instead, stakeholders from government, science, advisory and research funding systems need to support scientists in the important job of putting their knowledge into specific contexts. This contextualization is essential if science is to contribute to the SDGs and related multilateral agendas.

Contextual realities at the science–policy–society interface cannot be trumped by messaging alone.

This contextualization will require reframing how organized science and policy-makers at the multilateral level value diverse forms of knowledge. It will also require more deliberative engagement between diverse national policy-makers, their constituent publics and scientists.

1.5. Objectives for multilateral policy, organized science and publics

This paper draws on research and practice from a range of disciplines investigating the science–policy and science–society relationship to achieve the following:

- Assess the concerns about public distrust and misinformation, and the solutions commonly offered in response;
- Describe the contexts to consider in the socialization of science-policy and society;
- Explore a more responsive mode of engagement at the science–policy–society interface; and
- Outline the implications and possible future remedial actions.

The paper focuses on multilateral policy agencies given their global role as agents for social and economic growth. The mission of these agencies is central to the science–policy interface across a range of sectors, networks and institutional contexts. For example, the UN is the custodian

of the SDG framework. Furthermore, multilateral institutions, across the UN and beyond, are typically key technical resource partners for line ministries and industry around the world. Our focus on multilateral agencies also recognizes the enduring importance of science as a truly global language for diplomacy. It is vital that the scientific community not be undermined by national, sub-national or digital bloc interest groups that challenge the integrity of science for the public good. The response to such blocs is to build an evidenced understanding of the drivers of this resistance.

Our focus on multilateral agencies recognizes the enduring importance of science as a truly global language for diplomacy

These interest groups have contributed to explicit politicization of science and left scientists politically exposed. A 2022 study by the Economist in collaboration with the Elsevier Foundation surveyed over 3,100 researchers from 100 countries. A third of respondents reported that they or a colleague had been harassed in the last year because of their work. So the threats to the global scientific consensus may also become threats to the multilateral rights frameworks that enshrine freedom of expression and scientific freedoms.

In response to these challenges to multilateralism, the paper provides framing for a more constructive interface between science-policy at the multilateral level and the national and transnational communities that multilateral policy needs to engage.

We use the term 'science-policy' to refer to both science-for-policy (the contribution of scientific knowledge to policy-making and implementation) and policy-for-science (policies that shape the production of scientific research including for new technologies). In practice, the two domains are interconnected. Policy-for-science often relies on science-for-policy, for example in the contribution of risk assessments to policy decisions about new technologies. While science-for-policy may likewise engage with policy-for-science, for example in assessments of potential technological solutions to policy problems. We use the term 'science' to include both the physical and the social sciences. The ISC defines scientific enquiry as the pursuit and application of knowledge of the natural and social world following a systematic methodology.

Organized science also contributes to multilateral policy organizations through their scientific or technical divisions and through their chief scientists, as well as through formal mechanisms of independent advice. Platforms such as the Intergovernmental Panel on Climate Change, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and the International Resource Panel exemplify these organized links between science and multilateral policy.

In this paper we refer to the constituents of multilateral science-policy as various and diverse *publics*. Their exact composition depends on the issues being addressed in a specific case. Publics are an important part of the science–policy interface and the socialization of science. Our use of the word 'publics' signals that the general public consists of communities and that the identities of these communities play a significant factor in the quality and meaning of trust in science.

We recognize that science can also influence public attitudes, policy debates and decisions in other ways, for example when individual scientists who become visible in specific episodes such as the COVID-19 pandemic (Joubert et al., 2023). In some instances, individual scientists may also be marginalized, despite having something to contribute to the policy issue in question. Given these variations, we focus mainly on the role of organized science.

In this paper, we draw on empirical evidence to consider how engagement in science and with publics can support policy-making, in a role reversal of the usual focus on how policy-making can support and fund science. We reframe this engagement in terms of how engagement might improve the relationship between science, policy and society at the multilateral interface to achieve greater socialization.

KEY TAKEAWAYS:

1. **Socialization of Science with Policy:** A successful partnership between science, policy and society requires an appreciation of the values and contexts that influence decision-making. This process of socialization involves more than just one-way knowledge transfer.

2. **Evidencing the Value of Contextualization:** The example of polio eradication in northern India demonstrates the various ways in which science and policy needed to consider and adapt to local contexts to be successful, including public responses to vaccines. The COVID-19 pandemic provides high-profile examples of failures that ensued from persistent lack of contextualization. Several researchers have observed that the history of global development is characterized by similarly repeated failures of decontextualized research knowledge to deliver desired political and social outcomes.

3. **Importance of Contextualization:** Bridging the gap between science and policy requires consideration of the specific contextual factors affecting the application of scientific knowledge. This process, which we call contextualization, takes into account scientific uncertainties, value systems, historical relationships and local power dynamics.

4. **Trust in Linear Models:** The traditional linear model of disseminating scientific knowledge to policy-makers and the public is outdated. It ignores the contexts affecting the science–policy–society interface and assumes that trust in science is solely a matter of educating the public and addressing misinformation.

5. **The Paper's Objectives**: The paper aims to assess concerns about public distrust in science, articulate the importance of contextualization, explore responsive modes of engagement and outline implications and remedial actions for science–policy–society interactions at the multilateral level.

2.0. Rethinking common approaches to trust in science

In this chapter, we critically assess the dominant concerns at the science–policy interface about trust and disinformation, and the responses, which are typically centred on information and communication management.

Leading scientists and policy-makers have expressed concern that mistrust and distrust in science are affecting our collective ability to tackle global challenges. The presumption is that scientific and technological innovation hold the key to developing policy solutions, but their ability to do so is being compromised by publics, and sometimes policy-makers, failing to trust scientific consensus and the promise of new technologies (STI Forum, 2023).

The dissemination of messages – misinformation and disinformation – that contradict scientific consensus is feared as a further threat to the ability of science to engage with policy issues. Yet, in some fields, notably the health and biomedical sciences, there are significant concerns that the published record may itself be misleading, with negative results remaining unpublished and researchers overstating their findings in a context that favours hype (West and Bergstrom, 2021).

2.1. Trust in science advances societal goals

Trust is widely acknowledged to be indispensable for coordinating social interaction across multiple sectors. In the context of science, it has been described as 'the relational glue that binds science and society in advancing social goals' (Goldenberg, 2022, p. 3). Most policy issues demand far more complex information than any individual, scientist or layperson, can possibly gather and analyse. For the science–policy interface to work well, some measure of trust in what key actors are bringing to the table is essential. A lack of trust is a serious drawback to constructive engagement between science, policy and society.

'The perceived trustworthiness of organized science and policy institutions is the most important measure of trust at the science–policy interface'

Researchers usually distinguish between trust that is warranted by the behaviour of institutions including the way they engage with issues of public importance, which translates to how *trustworthy* they are perceived to be; and trust that may simply be an expression of faith. 'The perceived *trustworthiness* of organized science and policy institutions is the most important measure of trust at the science–policy interface' (Goldenberg, 2022; Wynne, 2006). Trustworthiness is linked to how institutions provide reasons to account for their messaging in specific instances such as a crisis, and to the more established patterns over time of how they engage, or fail to engage, with publics. Here, their approach to transparency and accountability is especially important. In this context, the distinction made between mistrust and distrust is helpful.

Mistrust is typically seen as a contingent position of doubt or scepticism about the trustworthiness of institutions, and which is open to change depending on new experiences and new information (Jennings et al., 2021). Mistrust can be beneficial for scientific enquiry, which is meant to be based on 'organized scepticism' of authority – prompting the testing of knowledge claims (Merton, 1938). Likewise, some level of scepticism from publics is critical for democracy and ensuring that scientific claims are subject to critical scrutiny, especially where they connect with matters of public and policy interest.

Distrust is typically characterized by a deeper level of intrinsic suspicion or contempt for institutions such as governments (Jennings et al., 2021). Distrust often stems from a deep-seated belief that individuals, organizations or systems are inherently untrustworthy or corrupt, and this perception is difficult to overcome. It can be driven by a range of factors, including experience of these institutions or loyalty to opposition groups. When applied to science and its relationship with policy decisions, distrust is a more serious problem. It is a factor, for example, in antivaccination movements and climate change denial.

2.2. Trustworthiness is more important than trust in messages

In current discussions of promoting trust in scientific messages for global challenges, trustworthiness has been marginalized in favour of promoting public trust in science. The common assumptions seem to be as follows:

- The ability to respond to problems such as climate change, disease transmission or biodiversity loss rests on the public trusting scientific *assessments* of these challenges; and
- The ability to create science-based solutions or deploy technological solutions also rests on the public trusting science-based solutions to *alleviate* these problems.

It is true that some trust in the scientific consensus is required if it is to respond to our global challenges. However, it would be more useful to focus on establishing trustworthiness in scientific organizations and their processes, rather than on assessing public trust in messages.

As COVID-19 unfolded, such concerns about public trust, or lack of trust, in scientific assessments and science-derived solutions reverberated across multilateral settings (e.g. Calleja et al., 2021). We often heard publics, and sometimes policy-makers, being urged to 'just listen to the science.' Some researchers asserted that the public are more likely to comply with pharmaceutical (e.g. vaccines) and nonpharmaceutical (e.g. mask-wearing) interventions if they listened to and trusted the scientific enterprise (e.g. Algan et al., 2021; Plohl and Musil, 2021; Sulik et al., 2021). Others went so far as to suggest that trust is the most important tool for healthcare (Farrar, 2019).

However, in these discussions, the focus was on securing trust in headline messages from science. They were less concerned with testing the trustworthiness of science and policy institutions, which depends upon their understanding of the conditionality of scientific knowledge and of differing public values (or any other drivers of contextualization which can shape the response to policy targets). In her assessment of errors of science communication around COVID-19, Intemann (2023) suggests that more attention to communicating how science works and why certain expert judgements were made – despite conflicting interpretations of the evidence by some scientists – might have helped foster trustworthiness. We will return in Chapter 5 to how these considerations around transparency and openness, which can increase trustworthiness, can affect efforts to support the socialization of science.

Most of the strategies used by organized science to build trust seek ways to express the expertise of scientists and policy-makers, not their trustworthiness. As Bryden and Gezelius (2017) put it, it will be critical to develop '*innovation as if people mattered*' in order to be judged as trustworthy.

Clearly, there is value in considering the trustworthiness of science as part of a complex interaction of norms, histories, relationships and, of course, technologies. Unfortunately, this is not often reflected in how key actors interpret results of the surveys designed to measure trust in science.

2.3. Beyond quantitative measures of trust in science

Recognizing that trust in science is important is not the same as advocating blanket trust of science. This 'trust fallacy' (Krause et al., 2021) is problematic, especially when scientists try to fix an assumed problem of trust with more science. Even when they try to communicate scientific content to non-experts in simple, jargon-free language, the risk of ignoring its context remains. This points to the importance of distinguishing between learning to talk about science as an enterprise as opposed to disseminating its findings. It also points to the problem of seeking a silver bullet to achieve universally equal levels of trust in science as a global enterprise.

Research on science–publics relationships and on the factors that shape public trust illuminate important contextual issues. This field of study consists of large-scale public-attitude surveys as well as in-depth enquiries into how publics make sense of specific science- or technology-related issues.

These surveys repeatedly show that scientists are one of the most highly trusted groups in society – a finding that persisted throughout COVID-19. Surveys of global public attitudes towards science and scientists in general show that trust remains high in most countries (Funk et al., 2020). The Wellcome Trust (2021) reported an increase overall in expressions of trust in science (80 percent) and in scientists (77 percent) since the start of COVID-19.

Levels of trust do, however, vary within and across countries. For example, the Wellcome Trust (2021) reported low levels of trust in scientists in sub-Saharan Africa (19 percent) compared to Australia and New Zealand where trust is highest (62 percent). We can assume this variation would continue among specific communities at national and sub-national levels, as seen in the example of polio eradication in India.

Recognizing that trust in science is important is not the same as advocating blanket trust of science.

The most important results emerging from both survey-based and in-depth qualitative research are less about average levels of trust, and more about what trust statements mean. Public responses to science and science-based technologies are multifaceted. Trust in science also varies from issue to issue. Positions on trust vary depending on the issue and the proposed solution, for COVID vaccines and climate change (Richardson et al., 2022).

Trust in AI

Measuring how trust is expressed around AI is particularly instructive. The Council of Canadian Academies notes that trust in AI is marked by two features. First, it is very context specific. Some members of the public may be happy with AI recommending music but uneasy with it recommending medical treatment. Also, they find that trust is derived from two things: intention and quality- or accuracy. These appear to be linked. An experiment by Dietvorst suggests that the public is less forgiving of algorithmic mistakes than of mistakes made by human professionals, even when the human errors are larger and the public could see that AI consistently outperforms human counterparts. The Canadian report suggest that accuracy alone is not enough to build trust. Transparency and 'explainability' of AI results maybe more critical as trust markers. (CCA, 2022; Dietvorst et al., 2015)

Science is heterogeneous, and invites questions such as trust in which science? Under what conditions? (Ankeny, 2020; Krause et al., 2021). While the public may have high degrees of trust in areas such as astronomy or 'impact science' such as environmental impact assessments, they can simultaneously have more negative views on 'production science' including technological solutions such as genetic modification or AI (McCright et al., 2013).

Acknowledging that trust in science means different things to different communities explains why there is a growing sense of crisis, even as polls suggest there is no clear and sustained aggregate deterioration in public trust. During the COVID pandemic we observed some vocal, high-profile instances of resistance to medical advice. These instances of resistance share features of concern to organized science. Resistance was typically directed at the broad arena of scientific expertise, even if the issue was very specific, like the mask mandate. The resistance may not reflect an objectively measurable majority but, in some instances, it was championed by individuals with real power and so had a material impact on outcomes, including excess deaths.

Acknowledging that trust in science means different things to different communities explains why there is a growing sense of crisis.

Given the importance of understanding the quality of trust, we need to know more about how trust changes between contexts. Measuring aggregate levels of trust is probably less important than developing meaningful and even personal relationships at the science–policy interface (Sofranko et al., 1988) to help build meaningful partnerships.

An awareness of heterogeneity both in science and societies allows us to update the conceptualization of public responses in the information landscape presented in Figure 2. In Figure 3 we recognize

An awareness of heterogeneity both in science and societies allows us to update the conceptualization of public responses.

that where an individual's trust in science is placed is determined by a myriad of factors around their 'position' in society. The resulting acceptance of expertise on a specific issue by a community is determined by further considerations like the accuracy of any information they access, the policy framing and how it relates to their experience or identity and, crucially, how they perceive the net benefit to them of science-policy prescriptions.

Figure 3. *Public acceptance of science-policy initiatives is related to a mosaic of different factors, not just trust in science.*

There are two other factors that challenge conventional efforts to manage the lack of trust in science: the communication of scientific uncertainty confounded by misinformation and disinformation; and pervasive assumptions about the role of social media.

2.4. Uncertainty in science confounded by misinformation and disinformation

Disinformation is defined as the deliberate circulation of information known to be false, often for political purposes. Misinformation, by contrast, is defined as selective or misleading interpretation of evidence without necessarily intending to cause harm. In some cases, it may be difficult to detect intention, but the distinction is useful for signalling the fact that misinformation is more complicated than an obviously false statement. Misinformation and disinformation can be circulated through interpersonal channels or traditional media (Tsfati et al., 2020), but the capacity of digital media to foster rapid spread across continents has been of particular concern.

The WHO's Director-General famously described having to deal with an 'infodemic' as well as the virus, as the challenge of the COVID-19 pandemic. The WHO (2020) defines an infodemic as 'too much information including false or misleading information in digital and physical environments during a disease outbreak,' which causes confusion and undermines the public-health response.

The concern is that publics and policy-makers are increasingly exposed to science, and other forms of knowledge, via online platforms that foster the decentralized exchange of opinions. Here, there is little professional vetting of public information by comparison to the editorial processes of traditional media.

Scientists and scientific claims are involved in these infodemics, and this complicates efforts to restore trust in science by simple appeals to scientific consensus. Such appeals ignore the need to communicate in ways that recognize the uncertainties involved in scientific knowledge. For example, the circulation of claims about the purported effectiveness of chloroquine and hydroxychloroquine as COVID-19 treatments is commonly cited as an example of the spread of misinformation that goes against the grain of scientific consensus. Many prominent science-policy actors including journal editors, clinicians and especially politicians contributed to the hype by talking up the promise of these treatments (Intemann, 2023). Yet, some scientists also contributed to the problem by publishing studies – later retracted – without adequately verifying key data (Singh and Ravinetto, 2020).

This episode demonstrates the uncertainties involved in communicating public messages based on a complex and rapidly evolving base of scientific evidence. Misinformation is therefore more ambiguous than disinformation. There is inevitably some judgement involved in distinguishing the 'best available evidence' or from selective and misleading use of science for policy and determining the intent when the information is repeated or circulated.

There is a difficult balance to strike here. Some scientists may be inclined to be overly cautious while policy-makers need to make clear, actionable decisions based on how evidence interacts with other public policy considerations. This contrast between the incremental nature of systematic scientific enquiry and the proclamation of truth encouraged by 'clickbait' headlines in the media is a fraught one.

This situation presents a number of tactical opportunities for misrepresentation. It also emphasizes the difference between mistrust and distrust. The former can be an informed querying that is part of scientific literacy while the latter can lead to a misrepresentation of the scientific consensus. This has important implications for action around transparency as well as for the categorization of narratives of distrust.

There is no simple technological fix or algorithm that will resolve decision-making or eliminate opportunities for manipulation or misunderstanding between communities. Instead, it is more sustainable and constructive to be mindful of the factors which are likely to drive such manipulation and seek to address them directly.

2.5. Social media platforms complicate trust in science

The rise of social media over the past two decades has created new challenges for debates about public trust in science. Social media are perceived by many to have become breeding grounds for the creation and rapid dissemination of false or misleading information (Wardle, 2018).

It is feared that the 'platformization of communication' through social media platforms such as Facebook, Instagram and Twitter (Alinejad and Van Dijck, 2023; Cotter et al., 2022) is creating echo chambers and filter bubbles that promote the rapid spread of misinformation and disinformation. These concerns came to a head in the COVID-19 pandemic, reinforcing longstanding anxieties about a major decline or lack of public trust in science. Strategies to disseminate more accurate scientific messages have been proposed to tackle this problem.

We acknowledge that the platformization of communications in the digital age has exacerbated problems related to the transmission of disinformation. Policy-makers will need to respond appropriately to improve their regulation. Information and communication professionals (notably journalists) are already exploring ways to foster the trustworthiness of publicly disseminated information. Internet governance initiatives have made progress in describing analytical frameworks for healthy information ecosystems and the role that regulators and other actors can play.

Communicating more nuanced judgements around science is a challenge in the face of social media platforms, which can control the dissemination of public information and whose business models may reshape the information landscape. Social media platforms are thought to present information through obscure algorithms that personalize information feeds to a user with in-built biases (Courtland, 2018; Howard and Borenstein, 2017; Stahl et al., 2023). Algorithm design is driven by commercial goals, where information is valued not so much for its content or truth-value, but for its ability to circulate rapidly and widely (Marres, 2018) and sustain the attention of a digital audience.

Platformization has also increased opportunities for polarization around political topics. This presents challenges for policy development (Kubin and von Sikorski, 2021). There are significant concerns that as people increasingly access news online, the delivery of information via social media platforms encourages 'echo chambers' based on differing ideologies. Rather than presenting readers with a range of diverse opinions, platforms appear to lock publics into information bubbles that reinforce existing biases and presumptions. There is some empirical evidence from studies of climate communication on social media to suggest that there is significant polarization and formation of echo chambers around climate science (Pearce et al., 2019).

The rapid emergence of AI in the past year has sparked new anxieties that disinformation campaigns will be easier to mobilize, sowing distrust in science among publics and policy-makers. Fundamental to these concerns is the power of AI to imitate reliable sources. It might generate credible looking 'research findings' for nefarious purposes and crowd out 'real' users on platforms intended to curate quality content. Generative AI is based on the ability of large language models (LLMs) to scan and synthesize data and produce novel content in response to a prompt (Bell et al., 2023). Some scientists fear that AI might create a 'paradigm shift' in the way patients access health information, or even in how publics understand ethical issues to do with new medical technologies (Doshi et al., 2023; Hopkins et al., 2023). Internet governance activists will need to tackle the development of these models (LLMs or generative AI), which could be used to subvert social discourse and dialogue in democratic systems (Bell et al., 2023).

However, these debates often assume that the predicted outcomes will inevitably emerge, simply by the inherent nature of technological change. Scholars in technology studies counter this assumption, highlighting that professional and regulatory interventions introduced sufficiently early are capable of redesigning algorithms and LLMs to ensure they meet social and policy goals in the public interest. For example, they have offered frameworks to leverage opportunities for 'responsible AI' (Nabavi and Brown, 2023) and build in equity and respect for diversity into LLMs (Davis, 2023). Given that LLMs are trained on existing or outdated datasets, policy-makers will need to recognize their limitations for handling rapidly changing crisis environments or the expectations created by new scientific knowledge or social movements.

Recent empirical research by Zheng et al. (2022) analysed a large-scale (31,000 households) United States dataset to determine individuals' online news consumption patterns and test the dominance of echo chambers. They found (a) a notable difference between what news consumers choose to read and what they choose to spread or share and (b) that 'fake news' or polarizing opinion pieces are typically not read at the exclusion of other news. This research may indicate that echo chambers are permeable, and function not as boundaries for information consumption but as markers of identity or belonging in social networks.

In summary, generative AI needs to be assessed in a measured way, with societal goals and opportunities for steering such technologies kept upfront. Commercial platformization of information also requires effort to improve the veracity of information circulating in public. However, such efforts also need to consider notions of contextualization and trustworthiness that we have already discussed. The impact of the technology and of its regulation cannot be predicted without analysis of the broader context.

2.6. Information management solutions alone are not enough

In the media and journalism sector, tools such as explainers and fact-checkers aiming to convey accurate content are increasingly featured in established outlets. However, in many instances, platforms have delegated responsibility for discerning the accuracy of information to their users. A study of the response of Facebook, YouTube and Twitter to the COVID-19 infodemic illustrates this contrast (Cotter et al., 2022). In response, social media companies are being urged to take responsibility and design their algorithms to remove claims known to be false, while increasing the prominence of claims coming from reputable sources (Krishnan et al., 2021).

Public information management alone cannot solve the challenge at the science–policy interface.

We acknowledge the importance of efforts to regulate the dissemination of information to serve the public interest. However, public information management alone cannot solve the challenge at the science–policy interface. This involves negotiating the conditionality of knowledge and understanding the context of differing value judgements. Some knowledge creation for policy must happen through public engagement (Marres, 2018).

In addition, the efforts of multilateral agencies to focus on strategies for information management have faced their own problems. For example, the WHO brought together researchers and public-health practitioners to explore solutions to the infodemic at their infodemiology conferences in the context of COVID-19 (Gruzd et al., 2020). However, these aspirations for an infodemiology are proving difficult, as reports from a subsequent WHO 2021 conference show (Wilhelm et al., 2023). Defining what counts as misinformation, distinguishing misinformation from disinformation, agreeing on a way of quantifying infodemics and measuring the impacts of mitigating strategies have proven to be significant hurdles.

Some science and multilateral agencies have looked to communication strategies based on behavioural-science interventions to combat disinformation. These interventions rely on experimental methods to determine efficacy. However, these judgements of what does or does not work are made in controlled environments with a sample of people (Gruzd et al., 2020) and translating them to work in the real world is a much harder job.

For example, 'prebunking' is one proposed novel strategy to counter disinformation in the digital landscape by inoculating against it (Lewandowsky and van der Linden, 2021). The idea is to forewarn people about disinformation they are likely to encounter, and to offer a rebuttal in advance before people encounter it.

Information and communication strategies based on correcting disinformation and the more egregious cases of misinformation may work under certain conditions. Some are warranted in response to systematic campaigns to distort facts. However, as we explore further in Chapter 3, such solutions still miss underlying socialization challenges related to the contexts of science and its interfaces with society and policy.

In the current model of science socialization, there is no meaningful conceptualization of 'publics' in the science–policy–society interface. Indeed, there is only a 'general public,' which is homogenous and lacking in knowledge or judgement. Communities that shape the contextualization of policy are typically seen as interfering with or resisting change. Given the rise of social media platforms, such communities are prone to be bundled under 'mistrust' or 'misinformation' by institutions of policy and science.

KEY TAKEAWAYS:

1. **Mistrust and Distrust in Science:** There are growing concerns among scientists and policy-makers that mistrust and distrust in science are hindering our ability to address global challenges. Public scepticism about scientific consensus and new technologies is seen as a major obstacle.

2. **Trust in Science as a Foundation:** Trust is considered crucial in bridging the gap between science and society for addressing social goals. Trust is based on institutions' behaviour and perceptions of their trustworthiness. Mistrust can be beneficial for scientific inquiry, while distrust is more profound and can lead to significant problems.

3. **Focus on Trustworthiness:** Rather than solely focusing on promoting blanket public trust in scientific messages, it is argued here that efforts should prioritize building trustworthiness in scientific organizations and processes. Transparency and accountability are essential elements in establishing trustworthiness.

4. **Contextual Factors in Trust:** Trust in science is not uniform and varies depending on the issue and its proposed solutions. Different communities have varying levels of trust, and trust in specific areas of science, technology and engineering may differ significantly.

5. **Impact of Misinformation and Disinformation:** The spread of misinformation and disinformation, particularly through social media platforms, complicates efforts to restore trust in science. To combat misinformation, scientists need to address uncertainty in scientific knowledge when communicating with the public.

6. **Challenges of Social Media:** Social media platforms have exacerbated the problem of misinformation and echo chambers, making it harder to foster trust in science. There are concerns that the rapid development of AI technologies can further complicate the information landscape.

3.0. Updating the contextualization model of science-policy

In this chapter, we look more constructively at how to conceive the science–policy interface and amend the model of socialization to build in contextualization. We describe the main drivers that shape contextualization and therefore contribute to expressions of trust or distrust. We also explain the application of this new model.

In the multilateral context, the contextualization of science is critical to how global challenges are recognized, understood and acted upon.

For example, the UN Framework Convention on Climate Change (UNFCCC) is a product not just of climate science but of a set of processes through which climate research is socialized or made meaningful in public and policy contexts (Hollin and Pearce, 2015). In this case, socialization happens most notably through activities organized under the auspices of the Intergovernmental Panel on Climate Change (IPCC) where scientists, economists and more recently, social scientists, are brought together to frame the problems, take stock of published evidence and advise on potential solutions. Science is further socialized with communication through the media, public and private organizations, expert and research groups, civil society and interpersonal networks.

While these forms of socialization inevitably happen when science is mobilized to inform policy debates, we are interested in how socialization can work better. The process of socialization we outlined in Chapter 1 is predicated on social science's understanding of socialization as a process of mutual influence between science and society (Wyatt, 2009). However, modifications are needed to this model to better reflect the need to contextualize science in the policy space.

First, it is worth examining what we understand about the opportunities for science and multilateral policy to engage with one another about a specific issue or problem.

3.1. How science and policy engage with one another

Organized science tends to engage deliberatively with multilateral policy in four ways[3]:

1. **Framing** the policy problem;
2. Designing and **disseminating** science-based messages to policy-makers and their constituent publics;
3. Contributing to spaces for **dialogue** between different scientists, policy-makers and key stakeholders; and
4. Assessing and producing evidence to maintain an underlying basis for **decision-making** in public policy and implementation.

3 From interviews held with multilateral policy-makers January–March 2023

When scientists and policy-makers perceive an issue that needs addressing, one of the first steps may be to agree on how the problem should be **framed**, which can clarify the nominal mandate for science and policy to collaborate. This can be an important step for scientists to present synthesis activity and provides a space to demonstrate how academic freedom and scientific responsibility can combine for the good of the public. It is also a useful point of entry for scientists to the policy landscape. A current example is the issue of AI. In the face of broad and sometimes fantastical speculation about dystopian futures, it is important that science and technology works with policy spheres to establish where the real risks are and what should be the targets and parameters of uncertainty for effective regulation.

Science and multilateral policy-making often share a common interest in **disseminating** accurate, accessible and relevant messages for stakeholders, intended to affect their decision-making and behaviour. This form of science–policy engagement currently dominates science–policy connections. Research institutions and multilateral agencies often have communication divisions, which are responsible for advising on and designing such messages.

Science also engages through **dialogue** opportunities, where scientists, policy-makers and interest groups such as industry and advocacy bodies are brought together to discuss an issue of concern. These multistakeholder forums and workshops can frame how problems are defined, and how research results are interpreted, to inform conclusions on possible actions. This type of interface is consistent with newer ideas about deliberative processes.

Scientists may also work with each other and with other stakeholders to assess the state of scientific knowledge and its implications for policy. In such activities, scientists are generally concerned with maintaining an underlying scientific basis for informing **decision-making**. Intergovernmental platforms for science advice and internal science-focused divisions within policy agencies exemplify these activities.

These existing forms of engagement between science and policy are expected to serve the public good, but there needs to be an awareness of how the perspective of various publics are reflected in these deliberations if there is to be sustained benefit. Organized science and policy institutions often think that the complexity of scientific and global challenges necessitates a division of labour between experts and society. Here the public must be willing to trust science and the contributions it makes to collective problem-solving (Wintterlin et al., 2022). Such perceptions fail to recognize that contextualization at the science–policy interface involves recognizing other types of expertise and worldviews.

There is an opportunity to use these modes of engagement to support contextualization.

There is now an opportunity to use these modes of engagement to support contextualization. To do this requires us to be alert to the drivers of contextualization, in order to determine who is engaged and what should be explored in this engagement.

3.2. Contextualization driver 1: Uncertainty in science

The scientific evidence base is complex, multidisciplinary and open to different interpretations. For example, experts disagreed in public over key questions about COVID-19: when to come out of lockdown and the efficacy of specific interventions such as school closures or the use of masks. Such disagreements cannot all be explained by differing political ideology or bias.

Scientists believe that the approach they take to investigating issues produces the best possible results in an imperfect world. Peer review, the public examination of research through publication, and the scientific method of rigorously testing research conclusions are the basis of this belief. However, many scientists also recognize the shortcomings of these existing practices. Peer review can be subject to bias; the pressure to publish has also been criticized. Commercial interests and prepublication of work yet to be peer reviewed can distort the system. Recognizing this, scientific claims are sometimes qualified as representing the 'best expert evidence available at the time' (Vraga and Bode, 2020, p. 338). These appeals to the scientific basis for policy communicate the core scientific content that is deemed to be the most reliable for the policy issue in question. For example, such content may refer to the safety of vaccines or novel biotechnologies, or the lack of evidence for popular but 'pseudoscientific' interventions.

However, even the best expert scientific knowledge developed in controlled research or laboratory conditions makes certain assumptions about physical and social worlds. Claims for such scientific evidence can become controversial when they move into more open-ended real-world contexts, where study conditions may not hold. Different disciplines may also approach the same phenomenon differently.

The conditionality of science – and failure to take on-ground realities into account

The System of Rice Intensification (SRI) was designed to help resource-poor rice farmers. The aim was to improve yields and reduce the levels of water consumption required by traditional methods of flood irrigation. However, the prescribed SRI methods of weed management were difficult to follow in rural South Asian settings. For example, the methods required mechanical weeders in a context where women traditionally carried out manual weeding. A machine-based regime disrupted gender roles. Existing machines for weeding were also ill-suited for following the SRI principle of tailoring the distance between rice plants to suit local conditions (Glover, 2022).

Issues of disputed or uncertain science can be exacerbated during emergencies or when the stakes are high (Weingart, 1999). We saw this regarding the question of how COVID-19 is transmitted (Greenhalgh et al., 2022). Early in the pandemic, scientists representing WHO indicated there was no evidence to suggest mask-wearing by healthy individuals would be beneficial unless they were caring for the sick. They also put out a fact-check in March 2020 highlighting that COVID-19 is *not* airborne and that the virus is mainly transmitted through droplets. In 2021, these claims were updated to acknowledge airborne transmission and, in 2022, the departing WHO Chief Scientist expressed regret for the earlier error (Kupferschmidt, 2022).

This case underlines the limitations of relying on simple policy appeals to current scientific consensus on complex issues. As it turned out, the original WHO assessment had relied on their standard toolkit of infection control science, which did not show evidence of airborne transmission. This understanding was contested by experts in building physics and ventilation who had applied a different scientific toolkit and revealed evidence that supported the counter conclusion.

Issues of disputed or uncertain science can be exacerbated during emergencies or when the stakes are high.

This is also an example of an emergency where there is pressure to make decisions, even if scientists cannot agree.

In another COVID example, evidence on the efficacy of wearing masks is still contested. Experts and lay members of the public continue to draw different interpretations from the body of scientific studies on physical interventions designed to inhibit viral transmission, including masks. The Cochrane Collaboration's systematic review (Jefferson et al., 2023) reported that results were 'inconclusive.' This was variously interpreted: some asserted that the study showed 'masks don't work' and others disagreed.

When there is a public emergency (as compared to a crisis like climate change), disputes focusing only on what the evidence says or does not say can create publicly damaging controversies (van Eeten, 1999). Experts on different sides of a scientific dispute get locked into the idea that science will provide a conclusive answer: masks either work or they do not work. In reality, the phenomena are too complex to be framed in this way. Recognizing this problem, Greenhalgh et al. (2020) argued early on that 'the search for perfect evidence may be the enemy of good policy' and that a case for mask-wearing should be made on broader grounds including the precautionary principle.

In sum, simple appeals to scientific evidence ignore the uncertainty within science and the need to cultivate judgement through dialogue with different perspectives. This applies especially during an emergency or when the policy issues are complex. Rather than 'following the science,' we need to recognize the need for 'serviceable truths' (Jasanoff, 2014) that may be less than perfect renditions of a single body of evidence but which are better adapted to policy-making through paying attention to diverse knowledges and values.

3.3. Contextualization driver 2: Diverse public values

Discussions of trust and misinformation within science and policy tend to focus on the development of science-based messages, which are supposed to be designed and delivered by policy-makers and their science advisers. These messages use language which confidently asserts 'this is what the science says,' but they ignore the reality of differing contexts in which science and multilateral policy intersect with multiple publics with different values. They also ignore the point that policy-makers and publics will make decisions on science-based issues by considering many factors, not just any scientific justification. The views of publics are influenced by economics, politics, the impacts of decisions on their personal lives and cultural factors, not just the facts presented by science.

Framing differences in values as a clash between the rational promotion of technology and irrational resistance to it, is unproductive.

The differing values of publics and stakeholders involved in multilateral problems and policy-making need to be recognized and addressed. For example, developers of new technologies make assumptions about how the technology will solve social problems, which may not match public expectations (Marris, 2015). Likewise, publics may have their own visions of how global challenges such as climate change should be addressed on the ground, visions that clash with dominant policy frameworks. Framing differences in values as a clash between the rational promotion of technology and irrational resistance to it is unproductive and works against the socialization of science.

Science by itself can never solve a social problem, and solving a technical problem always requires social investment. Leaders at the science–policy interface will need to recognize that although science 'has given us deep knowledge of ourselves and our place in the universe' (ISC, 2021, p. 7), for many it will only be taken as a tool, rather than being a silver bullet for solving a problem.

Engaging with public values and needs to develop technologies that work for publics

Greater success has been seen in technology adoption when publics and their varying needs are considered right from the start of the design process. This has been seen on the ground in sub-Saharan African countries. Here, multilateral actors have long been promoting improved cookstoves to reduce the health and environmental impacts of cooking with fuelwood and other solid fuels. A Nigerian programme that deployed an expert-led rollout of these cookstoves saw far less success than a Kenyan programme that took account of the contexts of those receiving the new technologies. The Kenyan programme involved women and youth groups in devising and developing the solution – more efficient ceramic wood-burning stoves (Sesan, 2014).

The need for more varied reasoning about science-policy (Raman and Pearce, 2020) is apparent when it comes to assessing and debating the case for new technologies. Messages drawn from risk assessments and designed to reassure publics about the safety of new technology fail to realize that publics may have their own priorities and values about how to respond to crises.

In cases involving novel technologies such as synthetic biology, publics may raise legitimate questions beyond merely safety. Some questions may be sceptical, for example asking whether the promised benefits of new technologies can materialize (Marris, 2015), or about the potential for knock-on ecosystem effects. An example is the use of engineered gene-drive techniques to eliminate mosquitoes that spread malaria (Hartley et al., 2021). Scientists often work with certain social assumptions, for example, that islands used for field trials of gene-drive technologies are relatively uninhabited and therefore risks are minimal. A public constituency may call them out with lessons from history where such claims turned out to be wrong (Taitingfong, 2020).

In the same way, visions of future pathways to climate stability or food security held by different people may reasonably differ. While climate science provides factual information about the expected impacts of anthropogenic global warming and the need to stop burning fossil fuels, we can expect disagreement on what this means for action on the ground. Some advocate for a radical decline in consumption while others see the potential for mainstream energy-transition initiatives. In the same way, the future of agricultural biotechnology is not only a matter of 'persuading' people to accept new technologies. Some local publics have concerns about the impact of monocultures and corporate control that may be part of the bargain with biotechnology. In other cases, local communities produce grassroots innovations aimed at achieving food security, for example through local food sovereignty or agro-ecological practices (Levidow et al., 2013). Messages about 'the safety of genetic modification' or of genome editing do not align neatly with such diverse concerns and values (Glover et al., 2021).

We have also seen a growing body of research on social media, where the public expression of values can be an important strategy for status, protection and livelihood. This means that the emerging digital information environment is driven less by breakthroughs in programming and engineering and more by social constructions like business models and identities.

3.4. Contextualization driver 3: Relationships with institutions

The concern of policy-makers and scientists about low scientific literacy among the public may completely miss contextual realities on the ground. What is perceived to be distrust in science is often a lack of trust related to publics' experience with dominant governance institutions (Attwell et al., 2022; Goldenberg, 2022; MacGregor and Leach, 2022). Historical relations between publics and institutions can affect how publics accept or reject science-policy, rather than concerns about the quality of the science itself.

The concern of policy-makers and scientists about low scientific literacy among the public may completely miss contextual realities on the ground.

Anxiety about COVID 19 vaccines in Uganda related to actions by other governments

In Uganda, anxieties about the COVID-19 vaccine were shaped by decisions made elsewhere around supply – for example, the United States 'donating' (dumping) AstraZeneca vaccines in African countries, and the United Kingdom deciding to withhold the vaccine for under-25s (MacGregor and Leach, 2022).

Public rejection of science and technology can be especially evident where publics are marginalized by the way governance institutions work. This phenomenon has been repeatedly observed in low- and high-income countries, especially among marginalized or vulnerable groups. For example, Smallman (2023) found that in the UK, expert judgements about the state of the future were radically at odds with groups of people who did not feel part of the apparent scientific and social progress that was being reported. Likewise in the health sector, multilateral frameworks to tackle disease may ignore local realities that shape people's experience with the health system (Bardosh, 2014). Rather than treating this as irrational behaviour, science for multilateral policy needs to find ways to recognize and incorporate these realities into policy recommendations.

Mistrust during Ebola epidemic resulted from past poor relationships with health authorities

In the West African Ebola epidemic, anthropologists found that researchers' and policy-makers' concerns about misinformation and knowledge deficits were often at odds with reality (Rascouët-Paz, 2020). Rather than public ignorance and the irrational spread of misinformation, anthropologists saw an information environment that was genuinely confusing. This mistrust was exacerbated because people did not have good relations with health authorities, and institutional reporting systems were inadequate. The researchers also found examples of publics demonstrating leadership in their efforts to respond to the disease outbreak.

Public dialogue initiatives aimed at promoting trust in new technologies may fall into the trap of assuming that the purpose of engaging publics is to secure support for interventions whose remit has already been decided by governance institutions (Delborne et al., 2020; Wynne, 2006).

History of poor treatment affects African American views on value of biomedical science

In the United States, the legacy of historical episodes in biomedical science research, such as the 1930s Tuskegee study of untreated syphilis in African Americans, is an important influence on current expectations among African Americans. Funk (2022) reports that 75% of Americans identifying as Black were familiar with the Tuskegee study and many were sceptical of the ability of medical research procedures to prevent further cases of misconduct. This was despite their reporting generally positive beliefs about the value of biomedical science. Encouragingly, many leaders in organized science recognized this legacy and called for scientists to rebuild trust by fostering community engagement and knowledge-sharing (Parikh, 2020).

3.5. Contextualization driver 4: Science's relationships with power

Science–policy–society relationships are shaped by history and political power. These affect how scientists are perceived in national, regional and local contexts, and the ways in which science can be used by different actors. Key decision-makers in policy may use science as an extension of their political platform, to demonstrate loyalty, to leverage partnerships or to diminish opposition. Actors in the science–policy interface cannot assume that political leadership is motivated by a patronage system that is based straightforwardly on democratic majorities.

Conversely, publics do not always resist science. In situations where they are marginalized by political systems, they may well use and stand up for science. Reflecting on the United States, medical researchers writing about uncertainty in science communication observe that 'in our current regulatory system, debate over science has become a substitute for debate over policy' reflecting the ways in which science has become politicized and a proxy for other political action in broader discourse (Michaels and Monforton, 2005).

Publics do not always resist science. In situations where they are marginalized by political systems, they may well use and stand up for science.

There are many instances where social movements have mobilized scientific knowledge to challenge political arrangements that render them vulnerable (Moore and Strasser, 2022). This approach is termed 'counter-expertise.' In environmental justice campaigns, publics in many parts of the world have tried to challenge structures that render them disproportionately exposed to environmental hazards. In recent years, some of these struggles for environmental justice have converged with concerns about data sovereignty in the face of expanding social media platforms (Vera et al., 2019). Such examples show that scientists often engage productively with publics and, in many cases, assist them in their attempts to challenge entrenched power.

Where science appears to be aligned with dominant political institutions, its position in society may be weakened. Where scientists have made little effort over the years to articulate their work in ways that connect with public concerns, populist rejection by reigning governments of all forms of expertise may go unchecked (Monteiro, 2020). In such cases, claims about the value of science or the importance of technological innovation ignore public disaffection with institutions, which can affect attitudes to science. Political leaders can often take a position on science in response to their constituencies or relationships of patronage. Here science becomes an extension of a political platform. This is how political leadership can reject the scientific consensus as part of a narrative to resist globalization or as an expression of contemporary nationalism.

3.6. Socialization of science always matters in policy

The challenge of contextualization for the socialization of science at the policy interface is most evident during situations of crisis or emergency, when the stakes are highest or time is short. However, the drivers that shape the contextualization of the policy interface apply whenever science engages with policy.

The actors involved in the science–policy interface always need to consider the contexts involved. They would also do well to consider that it is easier to engage with communities and publics before they become polarized and oppositional positions become entrenched.

The point of contextualization is that what might pass as wholly accepted 'settled science' (following the outdated model of socialization) in one situation might be disputed or resisted in another. It is only by careful deliberative attention to contextualization that this could be anticipated or understood.

The point of contextualization is that what might pass as wholly accepted 'settled science' in one situation might be disputed or resisted in another.

Those involved in policy-making cover a spectrum of expertise and activity, from research synthesis to drafting and ratification. Socialization needs to be considered across this spectrum through a process that is ideally cyclical. Such a process recognizes that the responses of publics, the societal impacts and the science all shape the science–policy interface in a virtuous loop.

3.7. A new model of science socialization incorporating contextualization

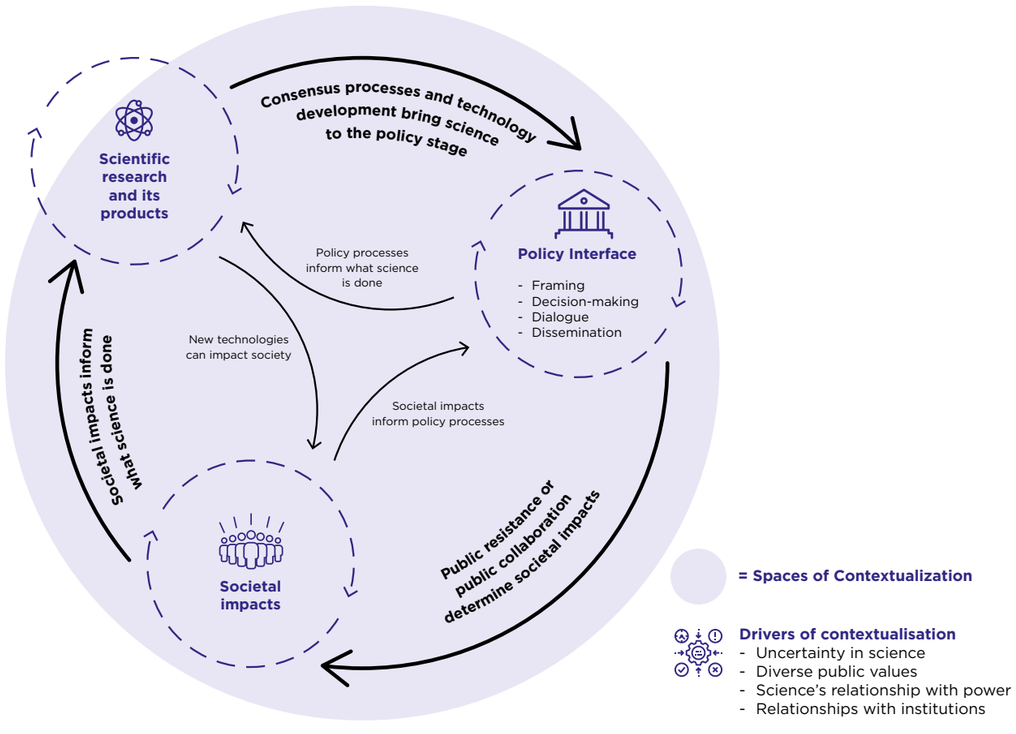

Figure 4. *Revised model of the socialization of science-policy, incorporating drivers of contextualization. In this model, scientific research and its products (such as technology) are non-linearly related to both the policy interface and societal impacts. This is a more nuanced view of the interplay between the four ways that science and policy engage (at the outer and inner rings of the policy interface, respectively).*

In Figure 4 we present a visualization of the non-linear relationship between science, policy and societal impact that contributes to the socialization of a given science-policy issue. Here each part of the cycle relates to each other, and they are all underpinned by the four drivers of contextualization: uncertainties, values, institutional relationships and relationships to power.

As in the standard model (Figure 1), science and its outputs such as technology can flow to the policy interface and then on to having societal impacts, but this is not the only way these elements interact.
We see too that societal impacts feed back to the policy discussions through dialogue processes, and back into the science and research system, helping to shape what research is done and what direction technology takes. In this way, technology development can bring about societal impacts directly, and policy can contribute to scientific research. The nature of each element for a given issue, such as whether the societal impacts are beneficial or not, depends on understanding the four drivers of contextualization, as well as the relationship between these elements.

Each of these four drivers contributes to how collaboration or resistance is expressed and how trustworthiness in the actors at the science–policy interface is derived.

KEY TAKEAWAYS:

1. **Contextualization of Science and Multilateral Policy:** The contextualization of science is crucial in addressing global challenges within multilateral policy-making, as with the example of the UNFCCC.

2. **Socialization of Science:** Science can be socialized more constructively by identifying ways for it to engage with and monitor the actors and dynamics that drive contextualization.

3. **Science-Policy Engagement:** Organized science engages with multilateral policy in four ways: framing policy problems, designing science-based messages, fostering dialogue between scientists and stakeholder groups and synthesizing evidence for decision-making.

4. **Challenges in Public Engagement:** Existing science-policy engagement often doesn't adequately consider the public's role and its diverse perspectives, relying on trust in science rather than acknowledging other types of expertise and worldviews.

5. **Drivers of Contextualization:** There are four drivers of contextualization: uncertainty in science, diverse public values, publics' relationships with institutions and science's relationships with power.

6. **A New Model of Science Socialization:** A revised view of the socialization of science-policy highlights the dynamic, non-linear relationships between science, policy, societal impact and the four drivers of contextualization.

4.0. Deepening responsive engagement between science and policy

In this chapter we explore the role of debates on the scholarship and practice of science communication, particularly as it relates to the science–policy interface. Reflexive science communication supports responsive and deliberative engagement practices, which can be applied to science-policy socialization to better consider the drivers of contextualization.

4.1. More responsive engagement needed at the science–policy interface

The previous chapters have shown that attempts to socialize science through the dissemination of evidence-based scientific messages have not worked. One-way engagement at the science–policy–society interface fails to consider the scientific, social, political and cultural contexts within which these messages are being delivered.

Instead, the onus is on policy-makers and organized science, as those in positions of power in relation to their constituent publics, to engage with the concerns and perspectives of publics and scientists on the ground. Such engagement needs to consider the contexts of policy-making, from the framing of a policy problem to the implementation of jointly constructed decisions and solutions.

This new style of responsive engagement relies on collaboration between scientists, policy-makers and publics through an intertwining of dissemination, dialogue and participation.

4.2. A new style of dialogue stimulates socialization

Science communication has already progressed beyond a focus on the dissemination of science messages and content through products such as websites, infographics, videos and publications.

Around the turn of the century, science-communication scholars (Callon, 1999; Höppner, 2009; Irwin, 2008; Miller, 2001) argued for dialogue-style communication developed in the 1990s to replace one-way communication, known pejoratively as 'deficit communication.' Dialogue was perceived as a means of helping scientists and their institutions regain trust, which had decreased in the light of public controversies about HIV/AIDS, new reproductive technologies, pollution, environmental change and food safety (Benneworth, 2009; Irwin and Wynne, 1996; Jackson et al., 2005).

As a result of this perceived loss of trust, organized science and policy institutions in many Western countries began to emphasize the need for greater openness and consultation with the public. This was exemplified by the UK House of Lords Select Committee on Science and Technology (2000) report, which recommended direct dialogue with the public as integral rather than optional to science-based policy-making.

However, the policy-makers and scientists who responded to this perceived loss of trust in science by opting for dialogue-type communications methods did so with the view that such controversies arose because the public had an inadequate understanding of the operation of science (Irwin, 2001). In many ways, these methods assumed that at some point in the past, the public understood and respected science, but had then stopped doing so (Nisbet and Scheufele, 2009).

Early engagement labelled as dialogue sought to fill a perceived deficit of public trust rather than to increase understanding of the context.

Much of the early engagement labelled as dialogue sought to fill a perceived deficit of public trust rather than to increase understanding of the context for the socialization of science. These early dialogue activities focused on better understanding publics' concerns and misperceptions about science so that these could be addressed through improved public education and public relations. In response, many scholars thought that the deficit model of science communication was being reinvented (Kahan et al., 2012; Pearce et al., 2015; Ritson, 2016; Trench, 2012).

Irwin (2008) theorized dialogue as a more deliberative and responsive form of communication between scientists, policy-makers and publics about the nature of risk, especially on controversial topics, and where:

- Science and decision-making about science issues are open and transparent;
- Uncertainties in science are made more apparent through two-way communication about the nature of risk;
- The public is trusted to respond rationally to openness; and
- Some publics are seen to bring some useful knowledge and resources to science and policy-making.

This change in the science-communication zeitgeist involves a shift from an emphasis of telling (i.e. dissemination) to recognizing the importance of listening, which makes dialogue most effective.

Story listening increases understanding of context

Recent work by Craig and Dillon (2023) presents the concept of 'story listening' – an approach to understanding how cultural and social narratives inform and shape the way publics conceptualize science. This has implications for the science–policy interface and science engagement. They show that cultural narratives – news media, film and television – influence public perception of particular sciences or technologies. For example, films with AI as a dominant theme can prime public attitudes to real technological advances years or decades before that point of development is reached.

However, even 'dialogue' may need to be interpreted differently in different contexts. The standard Western model of dialogue may not be appropriate where resources are limited or where there are differing cultural contexts or processes. For example, with remote Australian Indigenous communities, a 'yarning circle,' which is an informal conversation usually held in a shady place in the outdoors, is likely to be more appropriate than a more formal dialogue activity.

4.3. Collaboratively framing and deliberating on policy problems

Criticism of the dialogue model of science communication resulted in a move by some research organizations and policy agencies towards science communication that engaged the public upstream rather than downstream. In this refinement, the public (including policy-makers) were engaged from the start of research rather than once it was finished and peer reviewed. For example, Joly and Kaufmann (2008) reported on a UK Government ten-year strategy for science and innovation, which committed to enabling upstream public debate before scientific and technological developments had already produced results or products that publics might not even want. Such policies encouraged science communication where publics can participate on a more equal basis with scientists, and have some power in directing and shaping science according to societal needs.

The lesson for our task of socializing science for multilateral policy is the importance of developing an initial collaboration between science, policy and publics to frame a policy problem. Then comes the ongoing sharing of various forms of knowledge, including from different disciplines, to inform joint decision-making and the development of shared solutions.

Undertaking deliberative processes generates novel publics-engaged policy

An example of this was seen in Aotearoa New Zealand, where a research project by Koi Tū and Watercare explored their alignment with Te Tiriti o Waitangi and addressed the future water source for Auckland. Through a two-stage process, 40 diverse Auckland residents engaged in learning, deliberation and collaboration with experts. Incorporating Māori customs and knowledge, the assembly recommended recycled water as Auckland's future source. The recommendations were delivered to Watercare, and feasibility assessments were underway by February 2023.

Science-communication scholars and practitioners (e.g. Brossard and Lewenstein, 2010; Bucchi, 2008; Hetland, 2014; Jensen and Holliman, 2016; Metcalfe, 2019) now recognize the need for all forms of science engagement, often working in tandem, and encompassing the following:

- Collaboration for framing problems and finding and implementing solutions;
- Dissemination, often in response to a demand for information (as seen during the pandemic);
- Dialogue, with an open and respectful sharing of information; and
- Participation opportunities in science for various publics (including policy-makers), which has the potential to improve joint decision-making and the development of shared solutions.

The rhetoric in the science-communication community now focuses on 'reflexive science communication.' This approach to science communication requires more nuanced and dynamic interactions at the interface between scientific knowledge and other domains of society. Reflexive science communication considers scientific knowledge in its social, political, economic and historical contexts. The point is that scientific facts should be questioned in the contexts in which they are received. This awareness helps science and policy to shape more effective science messages as well as more effective policies.

The richness of reflexive science communication lies in its differing contexts, disciplines, complexities and characteristics. Science communication happens in a multitude of directions, and in differing social, political and cultural motivations and contexts (Irwin, 2014). Reflexive or evolved communication is not about more truthful content per se, but about understanding processes of science, policy and science communication and coming up with workable ways to balance the connections between science and policy to elicit contextual evidence or 'serviceable truths' (Jasanoff, 2014). As we saw above, solutions in specific cases might involve one or more of collaboration, dissemination, dialogue and joint deliberation.

Reflexive or evolved communication is not about more truthful content per se, but about understanding processes of science, policy and science communication.

There are significant opportunities for science-communication scholars and practitioners to take a lead in ensuring appropriate engagement at the science–policy–society interface.

4.4. Mapping the opportunities for science communication

Recent discussions[4] between science-communication scholars have reflected the move to emphasize the role of reflexive science communication at the science–policy interface, identifying seven main opportunities and their relative usefulness for policy-makers (see Figure 5)

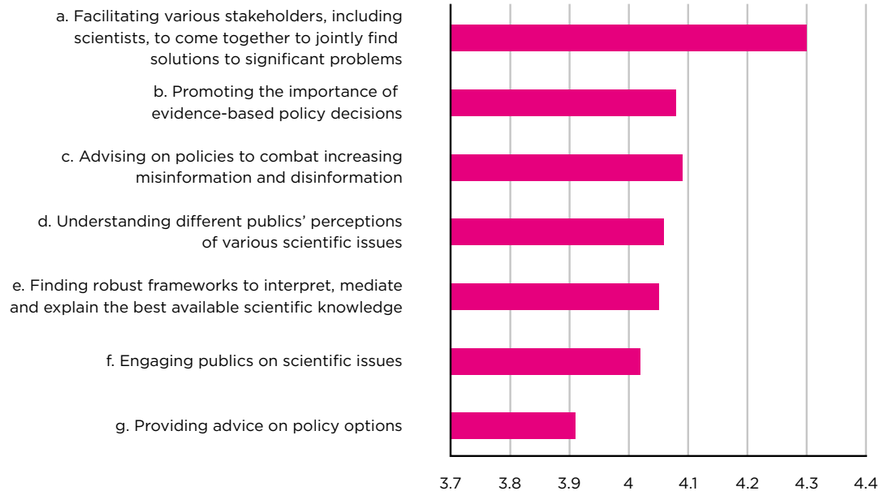

Figure 5. *Ratings of the usefulness of science communication for policy-makers, where 1 is the least important and 5 the most important (weighted averages from 141 responses).*

4 In 2022, 21 experts in science-communication scholarship and practice held wide-ranging discussions at the Rockefeller Foundation's Bellagio Center. The outputs of these discussions were tested in an international survey of the Public Communication of Science and Technology Network community, with 158 respondents.

These results reflect in more depth the four ways that science and policy connect:

- **Framing** the policy problem (opportunity categories a, d and f)
- Designing and **disseminating** science-based messages to policy-makers and their constituents (opportunity categories d, e and g);
- Creating space for **dialogue** between scientists and policy-makers (opportunity categories a, d and f); and
- Jointly producing and assessing evidence to maintain an underlying scientific basis for **decision-making**, while recognizing other social, economic and cultural drivers (opportunity categories b, c, e and f).

The facilitation or boundary-spanning role for science communicators offers leadership opportunities for this community to use its insights from science communication to shape discussions, convene appropriate meetings and influence agendas in the multilateral policy space.

Smallman et al. (2020, p. 947) argue that in the current era of widespread public debate about emerging technologies, the role of the science communicator has potentially shifted 'from one who explains science to the public, to one who helps scientists and technology developers understand society.'

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The potential to connect science and policy (set out in the opportunities in Figure 5) will be realized when science-communication scholars and practitioners are supported to engage with the opportunities presented by the four ways that science and policy connect.

KEY TAKEAWAYS:

1. **Responsive Engagement Needed:** Much of the dialogue-style communication of the past sought to fill a perceived deficit of public trust in science rather than to increase understanding of the drivers affecting its contextualization.

2. **Dialogue-based Listening:** Science communication has evolved from one-way communication to a dialogue-style approach. This shift aims to rebuild trust in science by engaging scientists, policy-makers and the public in open and transparent conversations, especially on controversial topics and issues involving risk.

3. **Upstream Engagement:** Rather than engaging the public after research is complete, there is a growing emphasis on upstream engagement, involving the public from the beginning of research to shape scientific and policy decisions collaboratively. This approach seeks to empower the public and policy-makers to direct and shape science according to societal needs.

4. **Reflexive Science Communication:** Reflexive science communication acknowledges the complexity and contextual nature of scientific facts. It involves dynamic interactions between scientific knowledge and societal contexts and aims to produce 'serviceable truths' that consider a range of perspectives, disciplines and contexts.

5. **Opportunities for Science Communication:** There are seven key opportunities for science communication at the science–policy interface, which can be rated in terms of their usefulness for policy-makers. These opportunities include framing policy problems, designing and disseminating science-based messages, creating spaces for dialogue and jointly producing and assessing evidence.

6. **Role of Science Communicators:** Science communicators have a vital role to play in shaping discussions, convening meetings and influencing multilateral policy agendas. Their role has evolved from explaining science to the public to helping scientists and technology developers understand societal contexts.

5.0. Considering implications for action

In this chapter, we point towards a systemic approach that would support the socialization of science-policy and mitigate the risk of resistance to collaboration. There are also tools to facilitate constructive socialization at any scale.

For science to be socialized with policy and its constituent publics, it is critical that policy-makers and organized science take the lead to consider context throughout their engagement (Bijker and d'Andrea, 2009; Urama et al., 2010). This will require a more responsive mode of engagement that employs all four ways in which science connects with policy: collaboration in framing the problem, dissemination of messages, dialogue to fully understand the context and deliberative participation in joint decision-making. For example, in the African context, socialization necessitates:

'Connecting the agenda of African STI [Science, Technology, Innovation] to the needs of the African people, to recognizing the relevance of different African knowledge and technology systems, via developing African styles of research and scientific production, to African forms of stimulation, regulation and evaluation of STI (Urama et al., 2010).'

In contrast, engagement at the science–policy–society interface that focuses on conveying discrete facts from 'settled science' (Pearce et al., 2019) overemphasizes the crafting of science-based messages at the expense of fostering the capacity for civil discussion between scientists, publics and policy-makers around a complex evidence base.

For the socialization of science-policy to work for more effective collaboration, action is needed in these four areas:

1. **Partnership building** to convene different expertise to understand context and support a healthy knowledge ecosystem;
2. **Organizational development** in multilateral spheres reflecting greater capacity to support contextualization;
3. **Supporting opportunities for deliberative processes**; and
4. **Technical support for communication strategies** that reflect awareness of the drivers of contextualization.

5.1. Partnership building

5.1.1. Support transdisciplinary and diverse knowledge ecology projects

For science to be socialized with policy-making, both scientists and policy-makers need to consider the full complexity of the scientific evidence base. They should also understand the competing contexts at the interface with policy. To handle this complexity, we need transdisciplinary spaces where different forms of evidence, contexts and priorities can be recognized and discussed. Scientists and policy-makers must expect to be able to engage with different perspectives and be open about the limits of what they know.

For organized science, this means supporting projects that bring together diverse knowledge ecologies and disciplines. It also means ensuring that new mechanisms for Open Science engage these different forms of knowledge, as opposed to focusing only on opening up scientific datasets. For policy-makers, it means investing in transdisciplinary science that enables a greater range of problem-solving approaches to be applied in the face of complex challenges, both from within science and in collaborations with other forms of expertise.

Creating spaces and organizations for dialogue

Strengthening the global community of people at the science–policy interface enables lessons in science-policy engagement to be consolidated, reflected upon and shared worldwide. This can improve engagement and build trust about complex science between scientists and policy-makers through a network of practitioners who are able to address contextualization challenges. This was the driving force behind setting up the International Network for Government Science Advice (INGSA) in 2014. The network arises from an acknowledgement of core issues at the science–policy interface: that science is complex and multidisciplinary, that evidence does not speak for itself and that different interpretations and ways of framing policy problems are the norm and not the exception.

INGSA's work has helped create awareness of the myth of science-based policy, highlighting the role of values and multiple priorities for policy-making. They have advocated instead for evidence-*informed* policy and for two key mechanisms in its support (ISC and INGSA, 2022). One is evidence synthesis, which requires effort to establish what is known across multiple disciplines relevant to a policy issue, but also acknowledging the limits, uncertainties and contextual conditions of this knowledge. The second is knowledge brokerage, which is oriented towards supporting policy-makers in making sense of this evidence and drawing appropriate inferences for decision-making and implementation.

To deliver on these requirements, appropriate institutional structures and capacities for communicating across boundaries must be fostered. INGSA highlights the difference between science policy in times of crisis as witnessed during COVID-19 and the need for longer-term capabilities and transdisciplinary interactions for other challenges we face. Policy-makers' trust in scientific inferences and the advisory mechanism emerges from this type of sustained, constructive engagement.

5.1.2. Gain advice and support from reflexive science communication

Given the 30+ year history of research and practice in science engagement with publics and policy-makers, and the development of reflexive science communication, there are real opportunities for this community to support responsive engagement between science, multilateral policy and constituent publics.

This could include establishing an international science communication advisory body tasked with the following:

- Synthesizing current empirical research on identifying engagement modes and mechanisms that foster the socialization of science in different scientific, social, cultural and political contexts;
- Researching any identified gaps in current research;
- Researching contexts for specific multilateral policy problems; and
- Advising on processes and people ('boundary spanners') that could assist with facilitating and mediating an exchange of views, ideas and knowledge through dialogue and participation between science, policy and constituent publics.

5.1.3. Earn trustworthiness with transparency and healthy ecosystems

The focus on demonstrating trustworthiness is fundamental to engaging contexts around science-policy because it acknowledges that the institutions of science are not ahistorical or asocial, as discussed in Chapter 3. Where they are located, who participates and how they operate will all shape how these institutions are regarded by various constituencies.

The implication of demonstrated trustworthiness places responsibility on organized science to engage with context, as opposed to expecting stakeholders to accept their scientific outcomes as universal truths.

The Transparency and Accountability Initiative (Radsch, 2023) provides a useful overview of a healthy information ecosystem. The key factors influencing the health of this ecosystem are grouped under three themes: 'Access to Information,' 'People & Communities' and 'Norms'. None of these factors can be unilaterally created or managed by a multilateral agency. Yet they underscore the need for long-term systemic thinking about how to support the socialization of science-policy. These factors remind us that this ecosystem is not limited to the online world, and interpersonal trust matters. For socializing science with policy-making, this means creating spaces and processes for interpersonal interaction and relationship-building.

Demonstrating trustworthiness is fundamental to engaging contexts around science-policy because it acknowledges that the institutions of science are not ahistorical or asocial.

In this regard, the increasing focus on responsible scientific practice is welcome. The ISC Report, A Contemporary Perspective on Free and Responsible Practice of Science in the 21st Century (ISC, 2021b), sets out several measures that benchmark responsible scientific practice for research institutions committed to the new social contract for science in the 21st century. Research funders have an important role here, as do academic publishers given their proximity to the science–policy–society interface and because publishers tend to be more politically agnostic (profit margins notwithstanding). In this regard, the Transparency and Openness Promotion Guidelines (COS, 2015) developed by the Open Science Foundation present a useful framework. Clearly these measures will not resolve alienated or vested interests, but they mitigate the risks of growing contextualization deficits and contribute to the infrastructure for the socialization of science.

At the heart of healthy information ecosystems (Radsch, 2023) is the shared emphasis on diversity and transparency – this is a significant opportunity for socialization. The science–policy interface should be active allies in supporting a healthy information ecosystem, which will help deliver better outcomes. This approach also broadens the partnerships for science. The principles of Open Science align clearly with this agenda (see OECD Open Science portal). More directly, a healthy information ecosystem also offers functional support to the socialization process by offering a range of means for engagement with diverse stakeholder groups.

5.2. Organizational development

5.2.1. Embed a culture of responsive deliberation and learning

It is inevitable that multilateral institutions will have operational cultures and mental models of what constitutes expertise or good practice. This happens in every organization and is a mark of any professional class. However, as Ramalingam (2013) notes, this is problematic for the goals of global development. Without consistent and meaningful 'feedback from the end-user, high-level narratives can easily turn to imposed dogma' (p. 22), which is to say that technical advice is not contextualized effectively.

The challenge of trust in science is a systemic issue for multilateral organizations that should be tackled with a culture of responsive deliberation embedded across operations and mandated to support institutional change management where appropriate. This requires a tricky balance between efficiency and cost-effectiveness. Uniformity is easy in comparison. However, national or regional resistance to collaboration with the global scientific consensus, because of ineffective contextualization, has an unconscionably high cost.

Ramalingam (2013) maintains that the central problem of multilateral agencies has been a focus on the wrong kind of learning – learning for efficiency as opposed to the 'double loop' reflection he associates with learning for effectiveness. (Double loop learning can be understood as reflecting on your objective as opposed to how to achieve it.) Such learning, he argues, challenges the mental models embedded in the hierarchies of large institutions. Of course, there have been some high-level examples of change over the last 15 years (the World Food Programme's move from 'food aid' to 'food assistance' is one). The point is that institutional change is hard, but remains possible.

5.2.2. Monitor equity and inclusion at the science–policy interface

The relationship between publics and institutions at the interface of science and policy is the result of history combined with current systems of governance and science. We have seen several examples of how these relationships regularly exclude and alienate specific groups.

This increases the risks of resistance to science-informed policy and may give rise to political platforms, which could shape national policy. It would be helpful therefore to consider how the configuration of institutions and practices can help avoid perpetuating discrimination and marginalization of individuals and groups.

Consider how the configuration of institutions and practices can help avoid perpetuating discrimination and marginalization of individuals and groups.

To do this means institutionalizing the mantra of leaving no one behind, broadly associated with the SDG project. Here are some concrete measures that can be explored.

Policy impact
Monitoring the rollout of policy to ensure that it is not reproducing existing inequalities or creating new communities of vulnerability.

Training and participation
The more diverse and inclusive the team, the less likely are biases in evidence analysis and synthesis. Even the framing of problems and the development of SETI solutions is informed by social conditioning and lived experience. Instances of gender and racial biases are well-documented, particularly in response to initiatives like GenderLinks and movements like Black Lives Matter. Data gathering is typically uneven among less privileged publics such as the chronically poor or indigenous communities. Such communities should participate in testing and the contexts in which they engage science and technology must inform all four modalities of science-policy engagement: framing, decision-making, dialogue and messaging.

Data provenance
This refers to 'documenting the history and process of a dataset's selection [and] construction,' (CCA, 2022). Data are critical to managing equity and inclusion in the science–policy interface, particularly with the increasing ubiquity of AI and LLMs. Documentation of the institutional context around datasets, as well as their content, would support calls for openness and transparency. Ensuring data managers reflect on data context might also act as a counter to any unconscious biases and assumptions. Datasheets used to document provenance would cover things such as 'the motivation for their creation, their composition, their collection process, the preprocessing and labelling process, their recommended uses (including distribution and maintenance) and any other relevant features' (Gebru et al., 2021).

5.2.3. Develop trust markers for research institutions

The media, like science, relies on institutions and conventions that are meant to foster trust from society. Trustworthiness is as central to the quality of journalism, as it is to the value of science. As the ALL European Academies observed, the practical and ethical guidelines that journalists observe are familiar to research integrity – 'both professions rely on a system of institutional checks and balances' (ALLEA, 2019). It is instructive to reflect on how journalism has been tackling the challenges of a changing communication landscape.

Lessons about trustworthiness from journalism

Campaigns for the integrity of journalism have become more sophisticated about identifying 'trust markers.' They are less concerned than in the past with analysing individual pieces of information, and more focused on process indicators about how work is produced and in what institutional context in order to establish trustworthiness. Such markers include safeguards for editorial independence and managing conflicts of interests.

The Journalism Trust Initiative is an example that follows what it describes as a holistic approach. The rationale is that this independently verifiable audit process incentivizes outlets to enhance their editorial processes, ethical conduct and standards of transparency. Crucially, it is done so that key groups from consumers to regulators and donors can assess and compare the scores. The goal is a self-regulatory mechanism, which manages to engage with the dominant forces, like funding models, that shape the institution.

Similar markers could be developed and applied by policy-makers to research institutions in the public and private sectors, reflecting where funding is coming from and what controls exist on publishing. This transparency would help policy to distinguish between studies and reveal the links between vested interests and some scientific efforts.

5.2.4. Increase understanding of contexts

Organized science and policy-making both need to deliberatively research the four drivers of context for multilateral policy: uncertainty of the science, differing values of stakeholders, relationships between publics and governance institutions, and relationships between organized science and political power.

We need a more comprehensive understanding of the underlying issues and contexts if we want to build organizational trustworthiness. As discussed above, trust in science is not just a matter of communicating facts, especially in a transforming world of 'Uncertain Times, Unsettled Lives' (UNDP, 2022). The trustworthiness of science and policy institutions must be negotiated, shared and learned.

Trustworthy interventions require processes at the global and local level which engage with the following:

- A deep understanding of the concerns of different publics in relation to science and new technologies, their values, expectations and priorities;
- A new appreciation of the limitations and uncertainties of science in the policy-making world; and
- A frank recognition of the crises people face, the solutions they see and their different visions of the future.

Multilateral policy action needs to coexist with local initiatives and conversations.

Multilateral policy action needs to coexist with local initiatives and conversations. These may include researching and understanding the cultural reasons why people may sometimes reject science-based conclusions. Some of this listening will need to happen directly within communities, including digital communities where listening to narratives unfolding online is critical. Structures, processes and partnerships that support this analysis, both online and offline, will be a priority for investment.

One way for the science–policy interface to better understand contexts is to use a decision tableau, like that in Figure 6, to identify critical stakeholders and platforms. It can apply across a range of settings from global to sub-national.

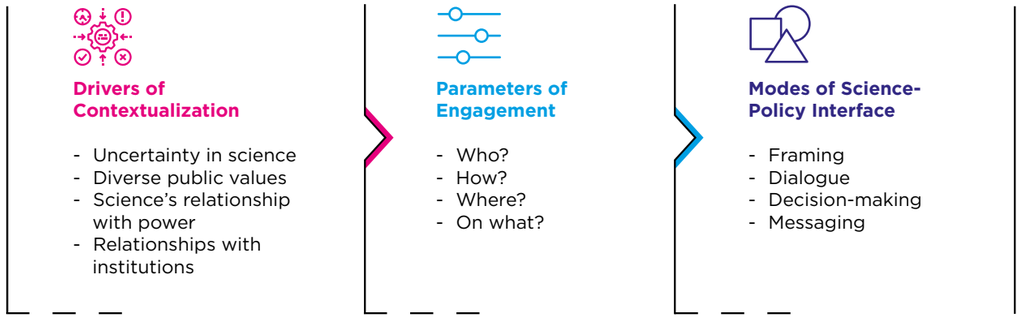

Figure 6. *The drivers of contextualization feed into the parameters of engagement for the four modes in which organized science engages with multilateral policy.*

5.2.5. Invest in science of narrative listening to understand publics

Given that people likely share misinformation and disinformation online as part of a wider narrative (Wardle, 2023), researchers and policy-makers should pay more attention to those narratives and networks if they want to understand the publics that they wish to influence. They must 'seek out and listen to the public's questions and concerns' (Wardle, 2023) and their aspirations, as these emerge through conversations on social media platforms. This could involve scouring 'sources depending on context and understand which narratives are taking hold on different platforms including disinformation and using innovative techniques from computational social science' (Alvi, 2023). The 'story listening' approach described in Chapter 4 is already being explored as an instrument of policy-making.

It would be useful to start a taxonomy for these narratives that distinguishes not only misinformation from disinformation, and which can collect data on the following:

- How the problem with the science–policy interface is framed by the dissenting voices. Is it the target or the objective of the policy, the enforcement, the ratifying actors or the synthesis of evidence?
- Who has power or responsibility and what are their motivations?
- The political orientation of the narrative.

5.3. Support opportunities for deliberative processes

Organized science and policy-making need to understand the contexts of the policy problem, and then create spaces and processes for dialogue and deliberation. The value of such thinking is that it keeps the focus on a broad enabling environment to support socialization, instead of anticipating a new high-tech communications solution.

5.3.1. Embed deliberative processes for public participation

There are opportunities for institutionalization, embedding deliberative processes in the policy-making cycle. The OECD report on 'The Deliberative Wave' (OECD, 2020) applies this recommendation to innovations in citizen engagement. Standards for the socialization of science-policy could be a useful guide for line ministries and multilateral institutions as well as a benchmark for nations and research institutions.

Keep the focus on a broad enabling environment to support socialization, instead of anticipating a new high-tech communications solution.

There is a growing array of modalities on deliberative policy, which could be co-created with stakeholder institutions and adapted for processes to engage publics as part of the science–policy interface. The OECD database (2021) outlined in the box below is a good place to start.

Lessons from citizen participation

There is a trend in public policy for innovative citizen participation, which lends itself to contextualization mechanisms for science-policy. The OECD now has a database of 537 such initiatives, which cover a range of case studies reflecting diverse objectives (from restorative justice to infrastructure planning). This is worth reflecting on because, as we have seen, the socialization of science is fundamentally a challenge of governance and reflects a fundamental mandate for inclusion.

5.3.2. Use adaptive science-policy decision-making

This builds on the concept and practice of adaptive regulation in the wider policy domain. Regulation is typically seen as a one-off activity involving long-term commitment. Supporting regulation as a continuous process responding to an evolving situation is more effective. Adaptive regulation is 'a structured regulatory process that enables learning and modification of policy over time via adjustments informed by data collection and analysis' (Bennear and Wiener, 2019). The value of this process in the socialization of science-policy is that it allows for meaningful engagement, through dialogue and participation, with the drivers of contextualization without sacrificing the need to commit to a policy decision framework.

Of particular interest is the decision-making tree (Figure 7) set out by Bennear and Wiener (2019), which helps to determine when 'adaptive regulation' is appropriate. Some key factors in

these decisions support our analysis of the drivers of contextualization. 'Discretionary' adaptive regulation, for instance, means the regulating body can determine process indicators for when regulation is reviewed.

Decision tree for adaptive regulation

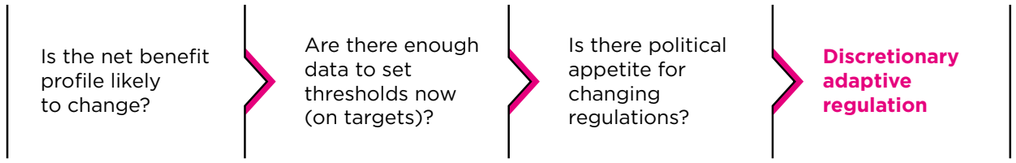

Figure 7. *Decision tree for adaptive regulation.*

The answers to the three questions in the decision tree that determine the appropriateness of adaptive regulation, will reveal factors that can shape the response of various publics to the science–policy interface on a given issue. For instance, how groups perceive the net benefit of any policy is crucial for how they approach collaboration. If the science–policy interface expects that there may be considerations in the broader environment that shift the profile of net benefit, planning for a review and dialogue would be appropriate.

The uncertainty of scientific predictions in specific contexts can make it difficult to commit to reasonable targets for the future. As the uncertainty diminishes with data, multidisciplinary observation and analysis, a review of the regulatory targets might be appropriate.

Finally, and perhaps most crucially, is understanding the political appetite for ongoing review and deliberation. This appetite depends on how the contested issue relates to the platform of political leadership and the broader legislative agenda, two key considerations for the contextualization of the science–policy–society interface.

5.4. Technical support for communication strategies

5.4.1. Design for trustworthiness and social cohesion

Trust is not a commodity that can be injected into an information flow, but rather a dynamic and volatile quality associated with tactical expressions of identity, support, resistance and leverage. Trustworthiness is achieved as the outcome of relationships. It is earned through extending, deepening and combining different modes of engagement at the interface between the sciences, publics and policy to achieve greater socialization of science-policy decisions and their implementation.

The example of Parque Explora reflects what is possible with this approach. Ensuring trustworthiness as an outcome of relationship-building requires a shift in thinking. It is less about producing trust and more about developing interpersonal trust. This is about investing in a process.

Trustworthiness is achieved as the outcome of relationships.

Parque Explora in Medellin, Colombia, provides a safe and trusted place for the community

This is an example of the value of science communication spaces for social cohesion. It also illustrates how an organized and trusted science entity can become a refuge. The Parque Explora building houses a science museum. It was seen as safe when disenfranchised communities mobilized on the street in the 2019–21 Colombia uprising. The building was left unaffected, underscoring its value within the community as a space through which to 'develop diverse scientific communication activities where different actors from the community are involved, such as scientists, educators, mediators, students of primary and secondary education, parents and vulnerable populations' (Ayure and Triana, 2022).

5.4.2. Build on dialogue to create serviceable truths

Framing policy challenges as battles between facts on the one side and mere opinion on the other is unproductive. We challenge an overemphasis on disseminating clearer or better messages about authoritative science as the critical response to perceived science–policy–society issues. While clarity is essential for making and communicating key decisions, it needs to come after scientists are confident that a diversity of actors have been engaged around the science–policy interface through dialogue and there is understanding of the contexts in which they are framing the policy problem and seeking a solution.

This means creating spaces for the participatory development of 'serviceable truths' (Jasanoff, 2014) where the expectation of scientific rigour and the need to respect the varying contexts where knowledge is applied can be jointly managed.

Multilateral science-policy groups can connect with publics to produce serviceable truths

Like the IPCC, the IPBES synthesizes the scientific basis for multilateral policy. The IPBES shows how science-policy models can evolve to better navigate the boundary between global science and essential knowledge from local contexts (Pearce et al., 2018). The IBBES aims to incorporate different indigenous and local knowledge systems alongside science. However, this novel model needs to consider how best to balance the authority of science with the authority of contextual cultural meanings (Montana, 2020).

Creating serviceable truths will mean addressing the following needs:

- Reframe complex issues to focus more explicitly on questions such as *how much evidence is good enough* and *in what context*, as opposed to evidence in isolation (e.g. Greenhalgh et al., 2020);
- Emphasize scientific uncertainty and the limitations of knowledge;
- Incorporate transdisciplinary sciences into policy development;
- Understand risk and uncertainty, and what they mean for policy timelines; and
- Develop methods and tools to help policy-makers differentiate between evidence-based, reliable knowledge about the natural world, and other types of knowledge.

5.4.3. Questions framing the increased socialization of science-policy

These are questions that can be used by in the actors at the policy–science interface to identify what might be required systemically at global, regional or local levels.

- Where has the mandate come from for science and policy to address this problem?
- What are the stakeholder institutions?
- What are the different disciplines and knowledge ecologies involved?
- How do these institutions facilitate trustworthiness? Specifically, transparency, openness and effectiveness?
- How have you identified and segmented the publics affected by the problem?
- What are the perceptions, concerns and needs for each segment?
- Who are the potential winners and losers in the way the problem is framed?
- What are the relationships to and perceptions of stakeholder institutions about each segment?
- What are the dominant cultures operating among the stakeholder institutions and public segments?
- Who are the opinion-shapers in the different cultures?
- What is the system of political patronage operating in the space? (Who are the political leaderships actively accountable to?)
- What are the opportunities for collaboration and participation?
- What are the opportunities for dialogue?
- How are you monitoring narratives about the issue, the framing of the problem, the benefits and any regulation (including regulators)?
- What processes have you been using or are you planning to use to engage with the issue? Over what time frame?
- What advice and support do you need from the reflexive science communication community, and how can you access this?

5.4.4. Approach national policy partners as advocacy partners

Multilateral policy-making happens with the support and partnership of national policy-making institutions. This means that to be successful, the contexts for national policy-making and the individuals who shape it also need to be understood.

Build institutional awareness of national partners

Advocacy campaigns analyse the policy spheres recognizing that the individuals who constitute these spheres are themselves part of systems. They have with their own communities, values and information-seeking behaviour. This analysis allows multilateral institutions to be better placed to co-create acceptable solutions by anticipating the affinities of partners, and to map the power points in the science–policy–society interface that are likely to leverage the most influence (see Figure 6).

Supporting national partners to monitor narratives and drivers, and to build a shared vocabulary around trust, is critical.

Invest in the capacity of national partners

It is useful to have a shared understanding of the inevitability of the socialization of science-policy and the associated risks with not managing this contextualization adequately. Supporting national partners to monitor narratives and drivers, and to build a shared vocabulary around trust and knowledge, is critical. This capacity support should identify and develop contextually appropriate opportunities for knowledge brokerage. This includes building a repository of 'trust markers' for research institutions (see 5.2.3). The model of the European Union's Joint Research Centre's Competency Frameworks for Policymakers and Researchers is a good example of capacity support strategy[5].

Incentivize deliberative processes

The OECD report (The Deliberative Wave) recommends consolidating evidence on the value of deliberative processes. Among the outcomes typically presented are increased capability among the people. This makes for more scientifically interested populations, which in turn, is good for sustainable growth. It is important for organized science and its allies to research examples of increased social cohesion to strengthen the case for dialogue and deliberation with those who see scientific consensus as oppositional or problematic to national agendas.

KEY TAKEAWAYS:

1. **Responsive Engagement is Crucial:** Effective socialization of science with policy and the public requires a responsive mode of engagement that considers context. Both policy-makers and organized science must lead in this effort.
2. **Balancing Messages and Dialogue:** Overemphasizing science-based messages at the expense of dialogue can hinder productive discussions between scientists, policy-makers and the public. Engagement should prioritize fostering civil discussion around complex evidence.
3. **Action Areas for Socializing Science and Policy:** To enhance collaboration, there are four critical action areas: building partnerships, organizational development, supporting deliberative processes and providing technical support for communication strategies.
4. **Trustworthiness and Contextualization are Key:** Trust in science and policy institutions relies on demonstrating their trustworthiness by addressing context rather than expecting universal acceptance of scientific outcomes. Understanding and addressing contextual factors at international and national levels are crucial for building trust.
5. **Importance of Serviceable Truths:** Instead of framing policy challenges as battles between facts and opinions, it is essential to develop 'serviceable truths' through joint engagement and collaboration between science, policy and the public. This approach prioritizes the application of scientific knowledge in specific contexts.

5 See Knowledge for Policy reference

6.0. Conclusion: What is possible?

Trust is a complex quality, difficult to define and even more challenging to measure, but its impact can be tragically material.

There is no simple technical solution to restoring trust in science across the world. Indeed, it is in the interest of scientific disciplines to be faced with healthy scepticism, allowing public policy to ask the right questions around the intention and assumptions of research and the brokerage of research. It is also essential to consider the impact of any solutions on all constituent publics.

Also, as we have seen, attitudes to science are based on a range of issues, which are in many ways bigger than any piece of research. Thus the research is effectively co-opted into other agendas.

When we consider some of the most prominent instances of resistance to scientific consensus or innovation, it is difficult to determine the extent to which a more considered and deliberative process of socialization could have avoided the emergence of problems.

The point though is that socialization is happening anyway. Everyone makes choices about how they make meaning out of scientific discovery and how they engage with technological advances. Given the nature of the crises we are facing, the stakes around this socialization are high, arguably existential. However, our understanding of how science interacts with societies and the ideas that shapes them is limited at best. Our technology for information sharing has far outstripped this area of knowledge.

The very least our conscience can allow is that we put sustained and collective effort into understanding these dynamics and that the science–policy interface reflects greater awareness of this process. A tactical place to start is by using the mandate and capital of multilateral institutions to concentrate resources so that we can learn from efforts to make the interface more constructive.

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