Deliverable

D4.4 Governance framework report, recommendations, process descriptions and chart

Project	S4D4C – Using science for/in diplomacy for addressing global challenges
Project Acronym	S4D4C
Project Number	770342
Deliverable	D4.4
Submission Date	14.12.2020
Responsible Author(s)	Ewert Aukes (UT), Gonzalo Ordóñez-Matamoros (UT), Stefan Kuhlmann (UT), Sanaz Honarmand Ebrahimi (UT)
Quote as	Aukes, Ewert, Gonzalo Ordóñez-Matamoros, Stefan Kuhlmann and Sanaz Honarmand Ebrahimi (2020): Governance framework report, recommendations, process descriptions and chart, Deliverable 4.4, Vienna: S4D4C.

ABSTRACT

This deliverable (D4.4) outlines the development of the S4D4C science diplomacy governance framework. We propose using meta-governance as a procedural lens and describe the understanding of the governance area of science diplomacy that underlies the meta-governance framework. Furthermore, the governance practices recommended for science diplomacy and the meta-principles for effective science diplomacy, which are made available also online in an interactive tool, are described.

Document Control Sheet

Work Package Number	WP4
Work Package Title	Science diplomacy governance framework (processes and interfaces)
Task Number	T4.2
Task Title	Co-creation and validation of a science diplomacy governance framework
Deliverable Number	D4.4
Deliverable Title	Governance framework report, recommendations, process descriptions and chart
File name	S4D4C_WP4_D4.4_Governance framework report.docx
Number of pages	46
Dissemination level	Public
Main author	Ewert Aukes (UT)
Contributors	Gonzalo Ordóñez-Matamoros (UT), Stefan Kuhlmann (UT), Sanaz Honarmand Ebrahimi (UT)
Quality Assurance	Tim Flink (DZHW), Helen B. Woods (USFD)

Versioning and Contribution History

Version	Date	Author/Editor	Collaborators	Description
_v0.1	19.07.2019	Ewert Aukes	Gonzalo Ordóñez-Matamoros, Stefan Kuhlmann	Working paper Meta-Governance for Science Diplomacy - towards a European framework, building on D4.1 and D4.2
_v0.2	01.05.2020	Ewert Aukes	Gonzalo Ordóñez-Matamoros, Stefan Kuhlmann	Draft structure for D4.4
_v0.3	27.10.2020	Ewert Aukes	Laure-Anne Plumhans, Elke Dall	Exchange with team, input from ZSI on online presentation
_v0.4	29.11.2020	Ewert Aukes	Gonzalo Ordóñez-Matamoros, Stefan Kuhlmann, Sanaz Honarmand Ebrahimi	Version for QA
_v0.5	03.12.2020	Tim Flink		Quality Assurance
_v0.6	11.12.2020	Ewert Aukes	Gonzalo Ordóñez-Matamoros, Stefan Kuhlmann	Version for submission
Final	14.12.2020	Elke Dall	Helen B. Woods	Final version for submission

Executive Summary

Science Diplomacy has emerged as a popular theme in foreign policy and science policy discourses. With its roots as a soft power mechanism, what can arguably be called a second wave of science diplomacy coincides with the observation that grand societal challenges have become increasingly complex, requiring specialised knowledge and technologies, and that these challenges are less and less likely to be tackled by traditional policies or tools. So, it makes sense to consider whether and how science diplomacy, an umbrella concept describing the interconnection between the world of science and the world of diplomacy, can be positioned, both conceptually and operationally, to **improve the collaboration between international actors to address the challenges** they face.

In this report, we posit that addressing global challenges requires systemic changes involving a transformed science-diplomacy interface, resulting in new policies informed by science, new modes of science informed by diplomacy, and new modes of diplomacy informed by science. With this goal in mind, we present a **meta-governance framework** developed specifically to guide stakeholders in the organization of productive and constructive science diplomacy activities.

Meta-governance is a notion from policy studies describing the observation that traditional governance modes – e.g. hierarchy, network, market – are incapable of solving societal challenges, as long as they are not mixed and continuously re-balanced and evaluated. This means that governance frameworks constructed with meta-governance in mind do not prescribe specific actors or mechanisms that constitute the 'perfect' science diplomacy. Rather, a meta-governance framework presents the enabling conditions that need to be met for stakeholders to be able to work together substantively on developing science diplomacy activities.

This does not preclude the meta-governance framework to be 'prescriptive', however. It is a **normative** framework that is developed with the political goal of addressing transboundary societal challenges in mind. Hence, this meta-governance framework presents **science diplomacy as a governance mode** in itself that will enable stakeholders to continuously recalibrate the governance of specific policy issues and tensions occurring at the intersection of foreign policy and science. The governance framework will also not be able to bridge all tensions conceivable between actors in the international context. Value systems, interests, and worldviews may simply be too divergent to come together and commit to common interests. Thus, the governance framework presupposes the transcendence of national interest towards what has been called a cosmopolitan worldview (Ulrich Beck). Our Protocol is only usable in situations that are potentially collaborative and not competitive.

The meta-governance framework - **"A new Science Diplomacy Protocol"** - consists of nine procedural and three infrastructural principles meant to guide smooth transboundary knowledge flow by means of illustrating ways to cope with

potential tensions occurring at different stages, levels of decision making and arenas of practice in the science diplomacy enterprise evolving in the international politico-scientific context. The nine procedural principles are: sensitivity, inclusiveness, transparency, deliberation, reciprocity, complementarity & manoeuvrability, legitimacy, alignment and evaluation. The three infrastructural principles are: capacities, capabilities and trust. All of these principles were derived from lessons learned from the empirical programme of the S4D4C project, and from the authors' knowledge and expertise on science policy and governance studies. They are defined and described in greater detail including examples from the other products of S4D4C, notably the empirical case studies and the transversal case analysis.

As such, the new Science Diplomacy Protocol is geared towards creating what we term the Science Diplomacy Interaction Space at the intersection of the scientific knowledge production arena, the problem deliberation & reflection arena, and the politics & powering arena. These arenas represent specific practices that altogether shape those activities that can be labelled as science diplomacy. We deliberately refrain from a specific actor perspective, as the notion of social practices allows for a more nuanced picture. To mention just one example, universities, of course known primarily to figure in the scientific knowledge production arena, also engage in agenda-setting, which would also fit the problem deliberation & reflection arena.

We conclude that meta-governance thinking is particularly fit to interact with the substantive elusiveness of science diplomacy as a concept. The procedural and infrastructural principles are shaped so that science diplomacy activities do not only figure traditional diplomatic stakeholders and mechanisms. Rather, they represent the move towards international governance beyond national governments and including lower policy levels, NGOs, business and other civil society organizations.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

CERN	Conseil Européen pour la Recherche Nucléaire
COVID-19	COrona VIrus Disease 2019
ERA	European Research Area
EU	European Union
FAO	Food and Agriculture Organization
FECYT	Fundación Española para la Ciencia y Tecnología
FET	Future and Emerging Technologies
H2020	Horizon 2020
MS	Member State
NGO	Non-Governmental Organization
OECD	Organisation for Economic Co-operation and Development
RRI	Responsible Research and Innovation
S4D4C	Using science for / in diplomacy for addressing global challenges
SDGs	Sustainable Development Goals
SESAME	Synchrotron-light for Experimental Science and Applications in the Middle East
STEM	Science, Technology, Engineering, and Mathematics
SSH	Social Sciences and Humanities
STI	Science, Technology and Innovation
USA	United States of America
WHO	World Health Organization
WP	Work Package

1 Introduction

In a globalizing world, contemporary grand societal challenges, such as the UN Sustainable Development Goals, have been observed to be **increasingly difficult to address by traditional means** (Haas 2016; Kuhlmann and Rip 2018; U. Beck 2009). Among others, foreign policy and governing in general have seen shifts from centralized, top-down modes to more networked forms with new actors both multi- and sub-national pushing onto the scene (Hocking 2016; Rhodes 2007). Such developments increase the complexity and, in turn, the difficulty of policymaking on all levels. Additionally, national and international policy initiatives linked to, for example, reducing poverty, crime, health threats, greenhouse gas emission or biodiversity deterioration are losing out against national political, sometimes protectionist struggles, short-sighted businesses and self-centred interests. Indeed, the effective transformation of unsustainable socio-technological systems calls for targeted intergovernmental action and dedicated **diplomatic efforts for the mobilization of appropriate scientific knowledge**.

The **role of scientific knowledge in general and Science, Technology and Innovation (STI) in particular** in all this has been at the center of scientific scrutiny for decades. Science advice (Maasen and Weingart 2005), the science-policy interface (Hoppe 2010), and evidence-based policy/diplomacy (Wesselink, Colebatch, and Pearce 2014; Ruffini 2018) are but a few of the concepts and practices that have been positioned to describe what is going on at the intersection between science and policy. Unfortunately, the general thrust of these literatures may feel disenchanting for advocates of a strong role of 'objective' scientific knowledge for 'rational' decision-making. By now it becomes clearer and clearer that science and scientific knowledge carry power themselves and relying on them only in solving the knowledge controversies connected to societal challenges can turn out to be troublesome for scientists, policymakers, and society alike (Turnhout and Gieryn 2019). In times in which knowledge about societal and environmental problems is "inescapably political" (S. Beck et al. 2017), it is more evident than ever that STI often figure not only as the *sources* of potential resolution of many of the challenges global society faces – as techno-optimists want to assure us –, but also as the *causes* behind these challenges (Collingridge 1979). In other words, even with scientific knowledge related to societal challenges, it matters who defines what counts as a problem and what as a solution, who is included and who is excluded.

In recent years, and not least since the outbreak of the COVID-19 pandemic at the end of 2019, **'Science Diplomacy' has emerged** as a new way of thinking about the relations between foreign policy and scientific knowledge. Originally thought of as a tool of soft power (Nye 2008), science diplomacy experiences what could arguably be called a second wave in which it is portrayed as a 'panacea' to better face situations that threaten humanity, i.e. societal challenges (Flink 2020b; Young 2020). Regardless of such promise and fashionability, in many common understandings of the concept (The Royal Society 2010; Gluckman et al. 2017) it

partly overlaps with the afore-mentioned notions and partly represents a new mixture or highlights other aspects of importance in international relations. Such diversity and fluidity of the concerned activities, practices and mechanisms make it not only more difficult to clearly demarcate its conceptual and practical reach (cf. Rungius and Flink 2020), but also enables convergence of actors under a symbolic 'umbrella' notion (Kaltofen and Acuto 2018). In practice, this conceptual elusiveness is accompanied by the inaccessibility of much scientific knowledge due to language barriers, i.e. jargon, and lacking concreteness (Soler, Robinson, and Wang 2017).

Framing the two waves of science diplomacy as 'soft-power-oriented' and 'societal-challenge-oriented' resonates with its frequently mentioned task to function in competitive and collaborative circumstances, respectively (Ruffini 2020; Young et al. 2020). Prima facie, this is simply a matter of consecutive development or reinterpretation over time. However, it actually represents a profoundly different approach to the interactions of science and foreign policy that are difficult, if not impossible, to reconcile. As afore-mentioned, the nature of societal challenges renders an approach purely focused on protectionist interests unsuitable, perhaps undesirable. Rather, a societal-challenge-oriented science diplomacy, which to our understanding is inherently collaborative, will have a hard time flourishing in circumstances of strained or even dysfunctional international relations.[1] In other words, in situations in which the collaborative 'logic' (cf. Ruffini 2020) of science diplomacy is illogical, due to diverging value systems, interests and worldviews, societal challenges cannot be addressed through science diplomacy.

So, in the face of conceptual elusiveness, the inaccessibility of knowledge, and strained or dysfunctional international relations, what *can* science diplomacy 'do' to address societal challenges? The **'umbrella' notion** of science diplomacy allows for a better understanding of the processes modulating the flows of STI around the world, thereby improving the conditions for better knowledge-based decision-making around the world. Furthermore, when it adheres to a set of 'meta-principles', science diplomatic practice can act as a force "balancing social tensions" in transboundary knowledge flows (Dunsire 1993, 11; cf. Jessop 2002, 52f; see section 2 below). The interactions between actors in STI and diplomacy required for this, need to be constructive, productive and anticipatory at all levels (Kuhlmann and Rip 2018; Spaapen and Van Drooge 2009).

In this report, we present an understanding of a **societal-challenge-oriented science diplomacy** that occurs in what we call an "interaction space" at the intersection of three arenas of practice within the context of societal debates about

[1] Ulrich Beck, in his contribution on Power in the Global Age, states the following about the contradictions between the national and the cosmopolitical view: "…the horizon of globality, i.e. the experience of civilisational self-endangerment and planetary finiteness, which removes the pluralist rivalry of people and states and creates a closed action space with intersubjectively binding meaning, becomes the point of departure for everyone." (U. Beck 2009, 173; translation by the author)

what those challenges are and how they can be solved (section 4). Based on this understanding, this report proposes that **tensions occurring in various dimensions of transboundary knowledge flows can be addressed by appropriate overarching 'meta-principles' for science diplomatic practices**, i.e. those conditions setting the scene for science diplomacy governance to be arranged effectively (Jessop 2002), across the scope and diversity of science-diplomatic efforts. Thus, the set of meta-principles we present can be seen as a normative tool to be considered by actors willing to *collaborate on* addressing societal challenges instead of *competing for* knowledge and resources for national gain. This "New Science Diplomacy Protocol", as our proposal for an open science diplomacy is called, builds on what Ulrich Beck termed "methodological cosmopolitanism", i.e. a cosmopolitan critique of nation-state-centred foreign policy and science (U. Beck 2009, 53).

As the main objective of S4D4C's work package 4 (WP4), this report presents a science diplomacy governance framework based on 'meta-principles'.[2] The (meta-)governance framework integrates the findings from the tasks 4.1 and 4.2, i.e. exploring "Challenges and opportunities in European science diplomacy" and "Co-creation and validation of a science diplomacy governance framework", respectively. Building, among others, on two earlier deliverables by WP4 – a policy brief (Deliverable 4.1; Aukes et al. 2020) and a confidential deliverable describing the results of the two co-creation workshops organised by the work package (Deliverable 4.2) – this report ponders: Which governance practices could contribute to the resolution of tensions on transboundary knowledge flows in support of evidence-based decision making processes? In other words, what **overarching (meta-)governance framework** (see below) is necessary to shape effective science diplomacy interactions for addressing grand societal challenges?

First, we give a brief overview of the conceptual positioning of the notions of 'meta-governance' and of 'science diplomacy'. Second, the methods undergirding the governance framework presented here are described. Third, we sketch a basic conceptualization of the governance field of science diplomacy for addressing grand societal challenges from an innovation policy and governance studies perspective. Fourth, based on meta-governance thinking, we suggest a set of procedural and infrastructural principles. The report ends with conclusions and recommendations.

[2] The S4D4C governance framework "The new Science Diplomacy Protocol" is also available in an online format in the main menu of the S4D4C project website (www.s4d4c.eu).

2 Conceptual positioning

The objective of this report is the elaboration of a governance framework for a societal-challenge-oriented science diplomacy in Europe and its international politico-scientific context that is inspired by the scientific literature on 'meta-governance' put forward inter alia by Bob Jessop building on previous work by Andrew Dunsire, and by looking at the lessons learned from the de facto governance practices studied in the context of the empirical programme of the S4D4C project.

In the following we give some background on the emergence of the meta-governance concept in literature and how we use it for our purposes (section 2.1). Furthermore, we discuss what conceptual frameworks relating to science diplomacy have by now been presented (section 2.2). This section ends with a brief explainer about the nature of a 'governance framework' (section 2.3).

2.1 The procedural contribution of meta-governance

Here, 'governance' is understood as those processes by which stakeholders make decisions to which all can commit despite their conflicting interests (Kuhlmann 2001). In policy studies terms, this perspective is complementary to focusing on the analysis of the outcomes of a public policy process or the actors involved, as it focuses on how stakeholders work together to come to some kind of policy as a result of struggles, tensions, and push-and-pulls involved (cf. Colebatch, Hoppe, and Noordegraaf 2010). The 'governance arrangements' following from this include the formal organization of a governance domain, inter alia legal frameworks, rules, policy instruments, governmental strategies, official principles and prescribed actors. According to Jessop, governance arrangements may follow the logics of one or a mixture of *modes of coordination* including:

A. *Hierarchies* marked by a clear mandate from an authority;
B. *Networks* in which processes take place in the framework of a sort of 'epistemic community'; and
C. *Market*s with supply and demand of information and action originating from different and sporadic actors and emergent needs/opportunities (Jessop 2003, 102; cf. Jessop 2011, 114).

The concept of meta-governance emerged as a reaction to the observation of failure of those generic modes of coordination as a normal state in the complex, modern societies we live in. Meta-governance scholars noticed that the traditional governance modes – e.g. state, market, network – did not suffice anymore on their own and neither could their failures be solved definitively (Jessop 2002; Dunsire 1996). In other words, it became clearer and clearer that the complexity of societal contexts both on national and international levels prevented governments from making policy solving specific problems exactly in the way foreseen. Rather, policies are often partial solutions only fit for specific contexts under specific circumstances. Thus, meta-governance, that is, the governance of governance, or the overarching governance conditions necessary for *de facto*

governance arrangements to function in a productive and constructive way (Spaapen and Van Drooge 2009), was proposed as the primary process of coordination in modern societies. It implies the rearticulation and 'collibration' of the failing modes of governance (Dunsire 1993). For example, existing modes of governance in a certain policy domain need to be reflected by policy-relevant actors and collibrated – i.e. re-balanced, re-synchronized, re-aligned – frequently, if not constantly. In other words, meta-governance entails the "organisation of the *conditions* for governance and involves the judicious mixing of market, hierarchy, and networks logics to achieve the best possible outcomes from the viewpoint of those engaged in metagovernance" (Jessop 2003, 108; cf. Jessop 2015, emphasis added). Thus, it is these conditions, i.e. those mechanisms and aspects of governance that make content-oriented policy-making possible, that meta-governance approaches address.

This observation has consequences for all stakeholders in policy processes. From a meta-governance perspective, stakeholders must cultivate a different way of thinking about policy-making. The continuous process of collibrating the prevailing modes of coordination requires an iterative and reflective approach (Rein and Schön 1996) and benefits from a tentative attitude (Kuhlmann, Stegmaier, and Konrad 2019). In practice, meta-governance addresses uncertainty and complexity by (a) involving all policy-relevant stakeholders, (b) defining governance mechanisms that lead to outcomes that are acceptable to many, (c) developing a variety of possible responses, and, foremost, (d) accepting the possibility of (partial) failure (Jessop 2003, 110).

Besides a more flexible attitude towards governance, a meta-governance framework must enable interactions between policy-relevant actors that are *constructive* and *productive*. We follow Lindner et al. (2016, 51; drawing on Spaapen and van Drooge 2009) in defining interactions as **'constructive'** when they treat the issues at hand adequately. 'Adequacy', then, is not an externally defined, objective measure, but depends on the problem context and actors' perceptions of it. In turn, interactions are **'productive'** when they result in the transformation of actors' behaviour or at least of their attitude. The aim of productive interactions is "a higher level of shared understanding of [science diplomacy] or in responsive/reflexive improvement in the governance arrangement itself" (Lindner et al. 2016, 51).

2.2 Science Diplomacy: empirical observations and conceptual frameworks

While the activities subsumed under it have a long-standing history, science diplomacy is still relatively new not only as an object of study but also as a domain to be purposefully governed (Berkman 2019; Müller and Bona 2018; Rüffin 2020; Rungius and Flink 2020). Labelling activities aimed at facilitating transboundary knowledge flows as 'science diplomacy' also represents a performative, rhetorical act of agenda-setting for the foreign policy arena (Flink 2020b; Penca 2018;

Walker 2015). It summarizes formerly more disparate activities under one heading and foregrounds them as potentially valuable diplomatic activities in a globalizing, networked world, in which knowledge and knowledge creation become more and more important for political, economic, social and environmental success. Typical examples of the application of the concept in scientific and grey literature include EU integration (López de San Román and Schunz 2018; Rüffin 2020; Trobbiani and Hatenboer 2018), (historical) international relations (Millwood 2020; Wilder et al. 2020) as well as environmental issues (Özkaragöz Doğan, Uygun, and Akçomak 2020; Robinson 2020; Ruffini 2018).

In any case, science diplomacy involves collaboration between partially existing, partially new stakeholders working in the STI community, the diplomacy community and the policy community on different levels in the multi-level spectrum of decision making within an international politico-scientific context that can be characterised by activities ranging from competition to collaboration (Melchor 2020; Moomaw 2018). In the wake of a shift from the traditional shape of 'club diplomacy' to a more networked form (Cooper, Heine, and Thakur 2013; Hocking 2016), which runs parallel to the shift from government to governance (Rhodes 2007), science diplomacy often involves a broader range of stakeholders from sub-national or non-governmental organizations. This has already led to institutionalized, dedicated governmental science diplomacy networks in, for example, the United States, United Kingdom, France or Switzerland (Flink and Rüffin 2019; Flink and Schreiterer 2010). Other stakeholders, such as the EU with its dedicated European External Action Service or other EU member states, are also keen on using science diplomacy for foreign policy objectives (Rüffin 2020).

In some cases, variants are developed which focus more broadly on economic diplomacy or on innovation diplomacy which, in turn, can be located on the intersection of economic diplomacy and science diplomacy. At foreign mission posts these 'types' of diplomacy lead to a mix of diplomats from traditional international relations, economic and innovation diplomacy and other departmental 'niche' diplomacies (Van Genderen and Rood 2011). While niche diplomacies such as science diplomacy or innovation diplomacy are by no means clearly demarcated diplomatic domains, science diplomacy may ultimately function as an overarching diplomacy concept integrating many if not all conceivable niche diplomacies given their specialized knowledge component.

As said before, its timeliness and popularity has not yet led to a stable definition of the concept (cf. Flink and Rüffin 2019; Kaltofen and Acuto 2018). On the one hand, this leads to confusion and unclarity as to what it may mean and may make some actors question the use, convenience and necessity of the concept. On the other hand, an unstable container or 'boundary' concept may cater to the needs and interests of many actors stating to be involved in science diplomacy (Kaltofen and Acuto 2018). Depending on the issue and context at hand, actors can opt in or out of science diplomacy.

Nevertheless, over the years, several conceptual frameworks for science diplomacy have been suggested. In the following, we give a birds eye view of a few of these. Four views will be presented here owing to their relevance for the field and their diverging nature. First, and frequently heard from practitioners, is a definition proposed in 2010 by the Royal Society (The Royal Society 2010). It takes a *procedural orientation* and defines science diplomacy as three processes: science in diplomacy, diplomacy for science and science for diplomacy. As such, activities can be called 'science diplomacy', if they somehow improve the workings of diplomacy based on scientific evidence (i.e. "evidence-based diplomacy"); facilitate the collaboration or exchange of scientists across borders by supporting researcher mobility or by providing simple things such as meeting facilities; or influence the relations between countries through indirect processes of knowledge exchange or collaboration between scientists internationally, with relevant scientific outcomes as a result. These three categories resonate with practitioners' understanding of the concept to varying degrees. Second, another contribution defined "a more utilitarian framing of science diplomacy" as three *motivation orientations* (Gluckman et al. 2017). It differentiates between actions motivated by furthering (a) a single country's interests, (b) bilateral interests, and (c) global interests. Third, a new study reconstructed the concept as a materialization of actors' *interpretative schemas* and shared assumptions about the social world they constantly need to make sense of (Rungius and Flink 2020). This means that the actors need to collaborate in a regular manner, whereby science diplomacy is presented as a panacea against looming threats and grand challenges in a world facing deterioration. Fourth, Ruffini (2020) presents science diplomacy to function in the two *dialectical rationales* of collaboration and competition.

Conceptually speaking, an approach developed from a meta-governance perspective is not concerned with the substantive content of governance in a certain field as the above conceptual frameworks are - e.g. by listing specific actors, governance structures, institutions and outputs related to that field -, but with the problem of **how the processes of governing need to be designed to make the process and its outcome constructive and productive**. Of course, a basic understanding of what we talk about when we mention the term 'science diplomacy' is still required. For the time being, we follow Rungius and Flink (2020), who define it as all kinds of actions bridging science and foreign policy. Nevertheless, a governance framework as we are presenting should start with a view on *what* it is that needs to be governed. This includes considerations about the societal and (geo-)political contexts in which science diplomacy will need to operate. While we have detailed the basic 'ontological' elements of our view on science diplomacy elsewhere (Aukes et al. 2020), in section 4, we describe the governance domain of science diplomacy in more detail.

2.3 What is a 'governance framework'?

A governance framework is not the same as a conceptual framework. Conceptual frameworks by and large intend to define the essence of a certain topic from a

specific intellectual or disciplinary perspective. They can take various shapes including, for example, typologies, theoretical statements ('hypotheses'), or follow a grounded methodology. In general, these follow from descriptive and explanatory work and are also intended for these purposes, i.e. as a search frame ('heuristic') or causal explanation ('models'). A conceptual framework is a lens through which reality may be studied (Abbott 2004). While a governance framework ideally builds on a conceptual one, the two must by no means exclusively appear in tandem. Still, in our understanding, a governance framework is intended as a structure for a governance domain to carry out its activities effectively. In other words it is a practical framework that guides stakeholders in their tasks. A governance framework is often normative, as is ours, because it encourages constructive and productive interactions addressing global challenges. It is strategically inspired. It is also prescriptive, because it states that stakeholders interested in science diplomacy activities who aim to address grand societal challenges should behave in a specific way (see below).

While this report bears the words 'governance framework' in its title and we also use this term to refer to it, the ultimate framework itself will not use this terminology. Rather, the governance framework should be usable by practitioners and resonate with them. For that to happen, we will adapt the wording in section 5 below ('A new Science Diplomacy Protocol'); a 'governance framework' labelled with scientific jargon will likely remain in the scientific domain. We sometimes refer to it interchangeably as 'governance arrangements' or 'governance mechanisms' In the following section, we describe how we came to this framework.

3 Research process

In this section we describe the process by which we arrived at the governance framework principles. We begin with a description of the empirical sources and secondary literature consulted. At the end of the section, we describe the development process of the governance framework.

3.1 Empirical data and secondary literature

Nine qualitative case studies constitute the empirical corpus from which the building bricks of our science diplomacy governance framework were derived.[3] All of these case studies revolve around contemporary topics on the intersection of foreign policy and science/science policy that are perceived as or bear the potential of being characterized as science diplomatic fields of action. The contemporary nature of the case studies, as well as their transcendence of the traditional, restricted delimitation of what science diplomacy is, makes them a valuable corpus to assess its potential breadth and depth. The case selection in the overarching project consortium followed a theoretical sampling logic. Cases were selected from potentially relevant, ongoing governance processes in the fields of foreign policy, science and science instruments (Table 1). The diversity and contextual difference of the cases was chosen deliberately to ensure a widespread representation of de facto science diplomacy governance processes where the interface of science and foreign policy involving transboundary knowledge flows was found. As such, this is a case selection design that roughly follows the most-different-systems logic and allows conclusions as to the general patterns across these cases (Seawright and Gerring 2008).

Table 1 Case studies

Foreign policy	Science	Science instruments
Infectious Diseases and epidemic management	Societal Challenges in H2020 – Food	ERA Infrastructures
Export and transfer of water management expertise [a]	FET Flagships – Graphene	ERA Funding and Support – Europeanization and beyond
Cybersecurity	Open Science [a]	Support and advice instruments at the EU and MS

[a] At the beginning of the project, these case studies were called "Climate change including water" and "Responsible Research and Innovation (RRI)" respectively.

As the case studies were carried out by researchers from the whole S4D4C project consortium and their topics differed considerably, it was necessary to coordinate

[3] The empirical data for the nine case studies was generated in the context of an EU H2020 project called "S4D4C - Using science for/in diplomacy for addressing global challenges" (www.s4d4c.eu).

data generation. This was done by a common case study principle containing all questions that would be relevant to compare across cases. Hence, the principle consisted of three sections dealing with (a) the governance arrangement, (b) the stakeholder landscape and (c) de facto governance practices in the respective case. By governance arrangement the formal organization of the case topic is meant. This includes legal frameworks, rules, policy instruments, governmental strategies, official principles and prescribed actors. Furthermore, governance arrangements deal with the direction of implementation – i.e. top-down or bottom-up – and the structure of the arrangement, i.e. whether it resembles a hierarchical structure (where there is a clear mandate from an authority), a network structure (where processes take place in the framework of a sort of 'epistemic community') or rather a market structure (where supply/demand of information/action comes from different and sporadic actors and emergent needs/opportunities). The stakeholder landscape describes the actors involved in the case topic and their attributes (i.e. interests, roles, power to influence/facilitate/block, etc.). De facto governance practices are the actual workings of the case in practice. This involves the actual mix of all formal processes and procedures and those where actors deviate from the formal governance arrangement. In addition, under this section the problems actors are dealing with in practice were to be described, as well as possible rules and procedures in the case study and interfaces through which resources pertaining to the case topic are exchanged. Interfaces were thought of as loci of exchange or absorption, such as personal meetings or conferences, but also material/non-human elements like websites, portals, physical infrastructure, etc. They can be institutionalized in the form of programmes, positions, etc. They can be (a) permanent, (b) temporary, (c) formal, or (d) informal occasions, on which actors meet and interact (both nationally and internationally).

In an introductory text to the case researchers it was explicitly stated that each case study's situatedness and idiosyncrasies required a different selection of those questions to be answered. The principle was not supposed to serve as an interview topic list. Rather, the questions served as analytical guidance for the case study teams to sketch the governance situation in their case and to extract information for the transversal case analysis. This had two consequences. First, it may not have been necessary, nor applicable, to answer all questions for every case study. Second, generating all necessary knowledge from interviews was not imperative, especially, if some/many questions could already be answered by the case study teams themselves without reaching out to other experts (via internal dialogues or desk research, for example). Through this method of 'coordinated freedom' we were able to capture the empirical richness of the case studies. It enabled us to distinguish positive and negative examples of governance structures, actors and practices that pertain to science diplomacy. Qualitative, semi-structured interviews - executed between September 2018 and May 2019 - were used to generate the data. Interviews were recorded where possible and permitted. At the completion of the case study process, transversal analyses were performed by the case authors, where a selection of 'key matters' was possible, which led to some lessons

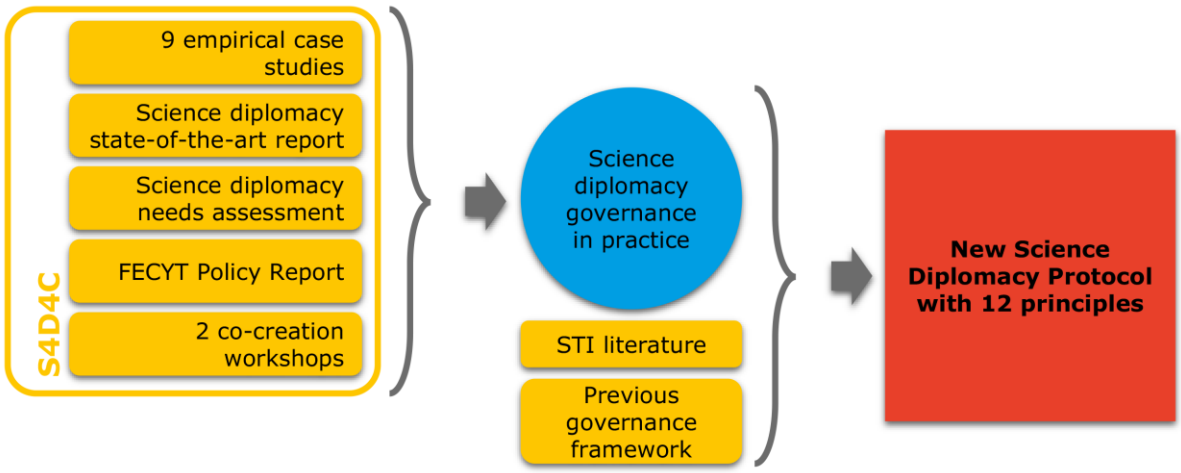

Figure 1 Governance framework development process (Source: author's illustration)

useful for the development of the science diplomacy governance framework (Young et al. 2020).

Besides the case studies, the work done in S4D4C provided four other sources of information, for example, the science diplomacy state-of-the-art-report (D2.2, Rungius, Flink, and Degelsegger-Márquez 2018), the needs assessment (D2.3, Degelsegger-Márquez, Flink, and Rungius 2019), and the FECYT Policy Report (Melchor, Elorza Moreno, and Lacunza 2020). The fourth data source were the two co-creation workshops carried out in Berlin and Vienna with high-level diplomats, scientists and actors on the boundary of science and diplomacy by S4D4C work package 4 (Task 4.2: "Co-creation and validation of a science diplomacy governance framework"). Together, these empirical sources provided an up-to-date view on the topic of science diplomacy governance in practice (see Figure 1). We combined this with scientific knowledge from the current debates in STI policy and governance literature as well as with experience with a previous meta-governance framework (Lindner et al. 2016). The process by which we generated the principles for the governance framework will be described in the following section.

3.2 Governance framework development process

Based on the afore-mentioned conceptual considerations and empirical sources, the governance framework was developed. As Figure 1 shows, the empirical results gathered within S4D4C were accompanied by insights from innovation policy and governance studies as well as experience with another governance framework - for Responsible Research and Innovation - based on meta-governance thinking. As such, by considering these various sources, it can be said that the science diplomacy governance framework is a result of interweaving 'top-down', i.e. relating to a priori knowledge, and 'bottom-up', i.e. relating to empirical knowledge, movements.

Before designing the governance framework, it is paramount to conceptualize overarching characteristics of the domain that the framework should be applied to. Of course, the meta-governance approach, with its procedural take, means that it does not make sense to be extremely specific in defining a governance field including specific stakeholders, mechanisms, policies etc. We tackled this complication by focusing on the notion of 'practices' and 'governance arenas'. This led us to an 'ontological' view on science diplomacy which was detailed in a policy brief by (Aukes et al. 2020). This worldview consisted of four premises underlying the domain of science diplomacy:

- **Premise #1**: Grand societal challenges require diplomatic efforts and science-based knowledge
- **Premise #2**: Science-based knowledge production is diverse and evolving
- **Premise #3**: Diplomacy means reconciling a variety of interests
- **Premise #4**: Science Diplomacy requires science and diplomacy literacy

Based on these premises, we sketch a governance domain of science diplomacy in section 4.

In the following development of the actual principles for the governance framework, the idea of 'tensions' helped our thinking. Intuitively defined as a somehow problematic situation arising from the interaction of specific forces following their own objectives, and therefore potentially blocking smooth transboundary knowledge flows, we distilled such tension situations from the results. Analysing the case reports, the matters analysis and policy reports published in the course of S4D4C then yielded a set of twelve principles that science diplomacy activities should heed (see section 5).

This process can be characterised as an abductive design process, rather than a deductive one in the naturalist tradition. Abductive research processes often entail "simultaneously puzzling over empirical materials and theoretical literatures" (Schwartz-Shea and Yanow 2012, 27). This leads to a back and forth of considering empirical realities and comparing them with prior knowledge and experiences (in this case of policy and innovation scientists) (Charmaz 2006). We applied this by co-developing the principles together with the analysis of the data and deliberating them in the co-creation workshops with practitioners. Plausible and useful solutions to the puzzles found in the data were sculpted into the definitive principles by means of an iterative-recursive trial-and-error process from the data to the principles-in-the-making and back. Hence, the principles came into being through what has been called "interpretive moments" - the immersion in the context of the puzzle at hand combined with personal (scientific) experience (cf. Torgerson 1986).

4 Governance practices for Science Diplomacy

As discussed above, we based part of our conceptualization around the Science Diplomacy Governance Framework on both a) the fact that constructive and productive science diplomacy involves the collibration of tensions taking place at the level of three interrelated arenas located in the international politico-scientific context (see below), and b) on the notion of 'tensions' themselves, where tensions are imbalances or critical situations or dilemmas that result from the interaction between stakeholders at different stages of the science diplomacy process, at different arenas and levels of the decision making process, locally or abroad, implicit in the science diplomacy process. Tensions block smooth transboundary knowledge flows, and their presence is what makes a governance framework necessary. They occur not only in the same arena, at the same level of decision making within one country, but even more at the overlaps between arenas, locally up to internationally, which then need to be governed by collibration in the science diplomacy processes. This is not to say that all tensions conceivable can be overcome with science diplomacy. Some tensions and the barriers deriving from them, especially when it comes to different value systems, interests and worldviews, are either practically insurmountable or it can be normatively undesirable to resolve them. Nevertheless, it is important to mention that these tensions represent the context in which science diplomacy activities need to be embedded and this means that such activities need to relate to these contexts in one way or another. For example, science diplomacy activities need to take into account diverse socio-economic circumstances of involved actors that may lead to frictions.

In this section, we sketch the governance field of science diplomacy as an interaction space with three connected governance arenas. Then, we zoom in on what we can assume to happen in the interaction space to identify which kinds of processes lead to transformative science diplomacy interfaces.

4.1 Science diplomacy in an interaction space

Based on the conceptual and empirical underpinnings, we think about the domain of science diplomacy as three partly overlapping arenas characterised by different kinds of practices in the international politico-scientific context. With Benz (2007, 5; see Figure 2), these arenas are shaped as "areas of collective actions" characterized by different sets of dominant practices and, thus also of partly diverging actors and rules of engagement. We follow Shove, Mika, and Watson (2012) who define 'practices' as the active integration of materials (such as things, technologies), meanings (including ideas, aspirations) and forms of competence (skill, know-how, techniques); practices are merely carried by actors willing and able to keep them alive, while they compete and support each other in different ways (Shove, Mika, and Watson 2012, 14).

The three arenas can be sketched as follows. First, in a *'problem deliberation/reflection' arena* motivations and drivers are aligned: actors engage

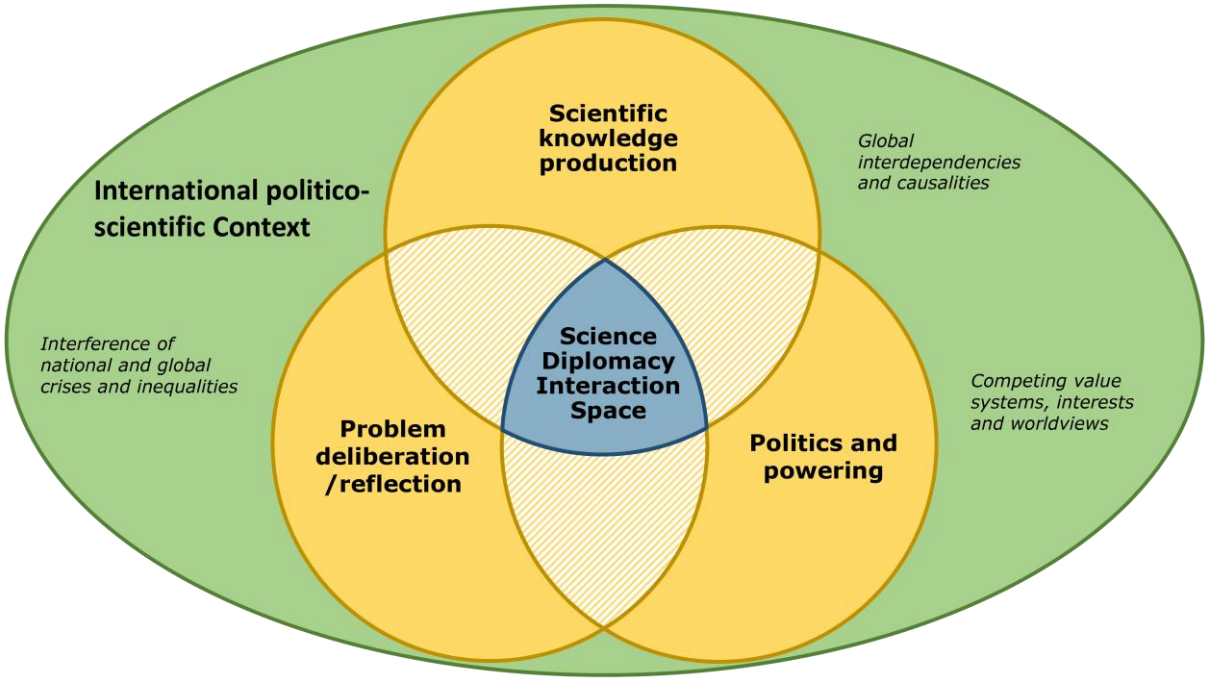

Figure 2 The Science Diplomacy Interaction Space at the core of three connected arenas of practice in its international politico-scientific context (Source: author's own illustration; cf. U. Beck 2009, 178)

through practices and mechanisms for co-reflection about issues calling for a science diplomacy process vis-à-vis SDGs. Typical actors in this arena are Civil Society Organization, NGOs, WHO, FAO. Second, in a *'scientific knowledge production' arena* actors discuss and decide on required scientific insights, technological innovation and related infrastructures. Typical actors in this arena are universities, research institutes, NGOs. Third, a '*politics and powering' arena* hosts decision-making on how a certain challenge should be governed, given specific knowledge needs. Typical actors in this arena are governments, international organisations, multinational companies.

The interaction space can also be conceptualized from the perspective proposed by John Kingdon's Multiple Streams Framework. According to Kingdon (2014), a 'window of opportunity' opens up when the 'policy stream', the 'problem stream' and the 'political stream' intersect. Sometimes, this occurs as a result of external events or due to 'policy entrepreneurs' working to bring the streams together. Indeed, on their own, these arenas ('streams') and related practices remain ineffective for science diplomacy. The intersection of the three arenas is the location at which productive and constructive governance happens and new practices may emerge: an interaction space (a 'window of opportunity') for science diplomacy opens up. From this perspective and abstractly, science diplomacy can be broadly defined as all those governance processes bringing together the problem, knowledge and power arenas to address transboundary knowledge flows towards addressing SDGs. In this context, 'policy entrepreneurs', including science diplomats, can play crucial roles. Science diplomacy is thus a governance mode in

itself that emphasizes the explicit inclusion of the scientific knowledge production arena into the efforts of solving challenges. Developing a science diplomacy process for a specific issue at hand, including certain actors, knowledge and governance mechanisms will lead to a new stage in a journey at which re-evaluation of and learning about the path is necessary (cf. Van de Ven et al. 2008).

The actor composition of each arena differs per issue, region, and knowledge domain. For example, addressing the SDG 6 "Clean water and sanitation" involves completely different challenges concerning which actors to consider or what technology to apply when discussed in a South American context vis-à-vis a Middle Eastern one. Thus, the particular, idiosyncratic character of the science diplomacy interaction space leads to context-specific outcomes in terms of which tensions are worth addressing and therefore which governance requirements or principles are suitable. Furthermore, because arenas do not describe a specific set of actors, but are delimited by the kind of practices involved, actors often do not belong exclusively to one arena. For example, organizations such as the WHO or OECD can be placed in the overlapping area between the scientific knowledge production arena and the problem deliberation/reflection arena. Finally, differences between actors interested in entering the science diplomacy interaction space may be so large that it is simply impossible to come together and define a common interest, such as societal challenges represent (U. Beck 2009; cf. footnote 1). Nevertheless, context is paramount for science diplomacy as it is for diplomacy in general. In the organization of science diplomacy activities the cosmopolitical reality of interferences between national and global crises and inequalities, global interdependencies and causalities, and competing value systems, interests, and worldviews need to be taken into account (U. Beck 2009, 178; Figure 2).

4.2 Transformative practice[4] within the interaction space

On its own, thinking of science diplomacy as an interaction space does not yield normative principles on a meta-level. For that we need to zoom in on the interaction space itself and identify, which processes actually lead to effective productive and constructive science diplomacy interfaces. From that we will be able to derive principles as to which conditions must be created for an interactive science diplomacy process to take place. Figure 3 represents a model of what goes on in an effective, transformative science diplomacy process occurring on the intersection of the three arenas. From a procedural meta-governance perspective, 'effectivity', 'transformativity', or 'success' of a science diplomacy activity cannot be pre-defined other than whether it turns out to be constructive and productive, from the perspective of the involved actors. So, as can be expected from a meta-governance viewpoint, these notions refer to a procedural outcome, and not to a substantive one. The stakeholders in the interaction space, who organize the

[4] Shove, Mika, and Watson (2012, 139) in their conceptual work on social practices also turn to the issue of how transitions can be achieved in and through social practices. Their terminology therefore parallels what we have in mind.

science diplomacy activity, are the ones who must gauge whether their activity is effective, transformative or successful in terms of substance.

System transformation involves profound and interrelated changes in all facets of society, including "skills, infrastructures, industry structures, products, regulations, user preferences and cultural predilections" (Schot and Steinmueller 2018, 9; Geels 2005). System transformations may be understood as resulting from either the 'problem perspective' or the 'solution perspective'. In both cases science diplomacy can play a key 'mediating' role. The former perspective implies that science diplomacy serves as the main connector between demand and supply (of solutions, in our case, STI), where 'problems advocates' or circumstances push issues into the foreign policy agendas, so that such problems are ultimately addressed. The latter perspective implies that 'solutions advocates' or circumstances frame problems in such a way that some 'preferred solutions' are implemented. Regardless of where the system transformation begins, science diplomacy typically deals with the need for a clearly agreed upon definition of the problem to be addressed, which implies deliberation and reflection practices by different stakeholders, who normally have differing goals, agendas, and understandings of the causal models behind. Such versions of 'the' problem to be addressed with science diplomacy practices inspire or shape to some extent scientific knowledge production and communication practices, whereby science diplomats play the role of intermediaries and translators for the different epistemic communities, sectors and stakeholders concerned. This process requires the facilitation of deliberation in discussion fora, and knowledge gathering processes, which are in turn determinant for setting the appropriate scene towards constructive and productive system transformation, considering incumbent politics and powering practices. These transformation processes involve the collibration of tensions spurring at different governmental and sectorial interfaces and at multilevel interactions.

In practice, the tensions occurring within and between different science diplomatic arenas of practice lead to the need of considering a single or a combination of principles to be implemented to relieve the tensions in question. The number of possible tensions is extremely large, and relates to the complexity of the issue, the respective arena and the links to the surrounding international politico-scientific context. Where the arenas overlap, and depending on the specific situations, some principles are more relevant than others. However, trying to connect tensions with principles one-to-one at the arena level or at the intersection between two or three arenas is not only impossible but pointless.

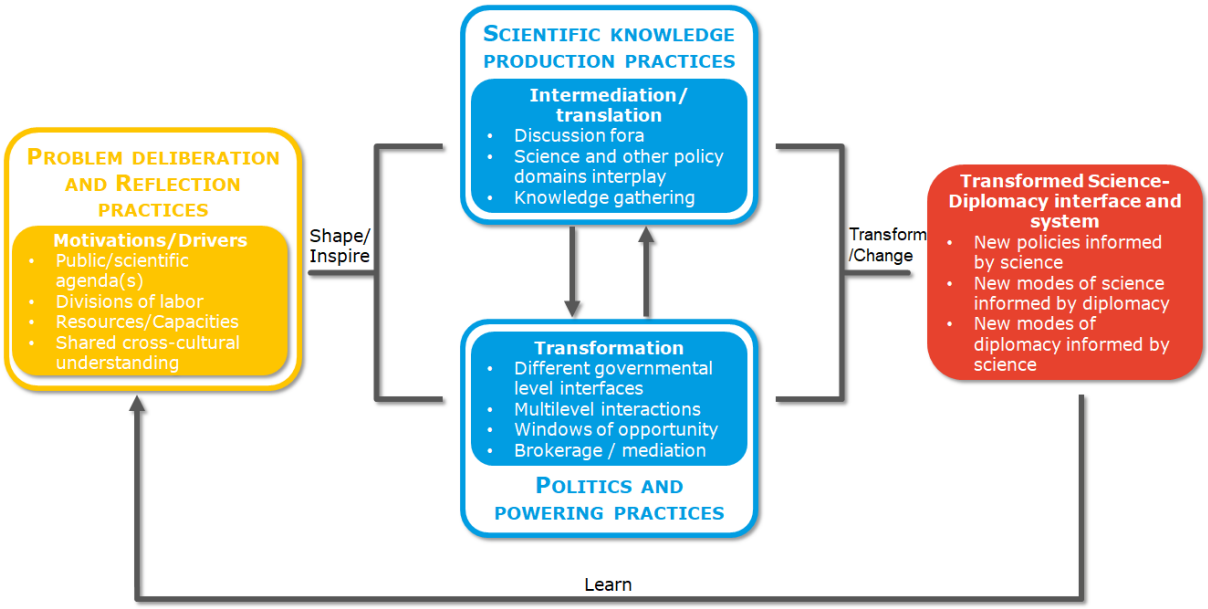

Figure 3 Overlapping practices within the Science Diplomacy Interaction Space: potential for transformative change (Source: authors' own illustration)

Still, following a set of basic principles for effective brokerage and mediation, allows for windows of opportunity to open up to facilitate systems' change. In this sense, systemic change involves a transformed science-diplomacy interface, resulting in new policies informed by science, new modes of science informed by diplomacy, and new modes of diplomacy informed by science. Learnings at the systemic level feed back into the whole socio-technological system both locally and globally, affecting the future productivity and constructivity of the next science diplomacy interaction space.

Actors from different practice arenas enter the interaction space if they have a relevant role and specific interest which is at least partly shared. Their respective practices (problem deliberation; scientific knowledge production; politics and powering) can feed interaction and joint work on the respective shared issue of interest; by means of collibration, i.e. the continuous rebalancing and recalibrating, of resulting tensions and active involvement of science diplomats as policy entrepreneurs, new practices can emerge and can be facilitated if appropriate principles are met, and such transformed practices can feed back into the three arenas as well.

5 Science Diplomacy meta-governance framework: A new Science Diplomacy Protocol[5]

This section presents the meta-governance framework including the set of twelve principles, which can be subdivided into two kinds. First, there are procedural principles explaining how science diplomacy needs to be organized to get a chance to be successful, that is, productive and constructive. The second kind are infrastructural principles related to what supportive resources and infrastructures in the broadest sense are required. The latter can include certain knowledge, regulations or capable individuals, but also more abstract resources such as trust. The **principles presented below constitute a new S4D4C science diplomacy "protocol"**, i.e. a compendium of principles fit for creating an interaction space that can generate transformed, constructive, and productive science diplomacy interfaces. The "Protocol" is applicable in situations where the science diplomacy activity can be expected to be collaborative, i.e. in societal-challenge-oriented situations. It is built on the understanding that national, protectionist interests do not contribute to solving the challenges global society faces.

We aim for the meta-governance framework we propose below to be understandable by practitioners. This means that it is formatted in familiar ways, too. The framework starts with a preamble, then gives a summarizing overview of the principles, including their definition ("description"), a set of guiding questions to be asked when considering the principle, and an example. Then, we describe each principle in more detail, explaining what kind of tension situations can emerge in science diplomacy activities that can be tackled by each principle.

5.1 Preamble

Science Diplomacy is an area on the interface between foreign policy, problem articulation (e.g. concerning SDGs) and science that is characterised by fluidity and multi-interpretability. Its definition, stakeholders and job descriptions are not fixed. As long as it is applied in collaborative situations and based on cosmopolitical interests, this Science Diplomacy Protocol capitalizes on these circumstances and proposes principles of interaction that are applicable to various configurations of stakeholders and topics pertaining to the challenges societies face today.

This Science Diplomacy Protocol outlines a set of twelve procedural and infrastructural principles that need to be considered to create transformative science diplomacy interactions. Not all are applicable to every situation, but it will be useful to consider combinations of principles in most. Depending on the specific situation, it can be possible that several of the principles need to be balanced with each other and that sometimes trade-offs between them are inevitable. This highlights the necessity of making the conditions which the principles address explicit among the stakeholders involved.

[5] The S4D4C governance framework "The new Science Diplomacy Protocol" is also available in an online format in the main menu of the S4D4C project website (www.s4d4c.eu).

5.2 Procedural principles

Before describing each procedural principle of the new Science Diplomacy Protocol in detail (section 5.2.1-5.2.9), Table 2 gives an overview of each principle, including their description, key questions and an example.

Table 2 Procedural principles

Principle	Description: "Science diplomatic activities should…"	Key questions	Example
SENSITIVITY	Respect the specific political, socio-economic and environmental context they are designed for and be able to adapt to changes in them.	• Who are the main stakeholders? • What is the specific (geo-)political, scientific and natural-environmental context?	Dutch water diplomacy
INCLUSIVENESS	Be aware of different degrees of inclusiveness vs. exclusiveness and that inclusion is a political choice and part of the diplomatic game, too. Where useful, involve a broadly representative portion of the relevant scientific and diplomatic communities.	• Who and what needs to be in/out of the envisioned activity? • How should inclusion and exclusion be balanced to ensure effectiveness of the activity?	SESAME Synchrotron
TRANSPARENCY	Be appropriately visible to enable monitoring and accountability activities by observing communities, thereby increasing the legitimacy of the activity.	• Which aspects of the activity should be openly accessible? To whom?	Decisions by opaque national ministries
DELIBERATION	Encourage mutual understanding of actors' perspectives and needs as well as of the problem definition, the disciplinary and interdisciplinary knowledge required (incl. probing for other relevant scientific disciplines) and common narratives for the support of science diplomacy processes.	• Which different perspectives exist concerning the planned activity? • How can consensus be achieved about the problem definition, scope and acceptability of solutions?	Consensual problem narratives simplify cooperation

Principle	Description: "Science diplomatic activities should…"	Key questions	Example
RECIPROCITY	Foster an attitude of understanding and cooperativeness leading stakeholders to trust that each actor participating in the activity contributes to addressing grand challenges in roughly equivalent ways according to their abilities, be it through knowledge or other resources.	• What are you willing to contribute and what do you expect your peers to contribute to the activity? • How do you achieve equivalent contributions?	The trade-off between competition and cooperation
COMPLEMENTARITY & MANOEUVRABILITY	Build on stakeholders' strengths to balance out others' weaknesses and embed them in governance arrangements that leave enough room to manoeuvre for these strengths to flourish.	• What are the relevant stakeholders for the planned activity? • What are they good at and which weaknesses can be complemented?	Soft power characteristics of Open Science
LEGITIMACY	Strive for the mutual acceptance of shared "rules of the game" in the interaction space, respecting participating stakeholders' expertise and framings. Science Diplomacy activities should enable 'democratic quality' of proposed and implemented mechanisms, processes and solutions.	• How does the planned activity contribute to or threaten stakeholders' core values? • Through which processes can the planned activity increase its legitimacy?	'Science Diplomacy' as a label
ALIGNMENT	Address problems on the lowest, i.e. most local and concrete, appropriate policy/instrumental level while coordinating all involved scales (temporal, spatial and administrative), governance dimensions (horizontal and vertical) and epistemic communities.	• On which level is the activity best suited to be implemented? • How can all influential stakeholders be aligned to maximize the activity's impact?	Crisis response time reduction
EVALUATION	Be reflective and facilitate learning throughout the process.	• What does the performance of the activity teach us?	Mutual Learning Exercise on Open Science

Principle	Description: "Science diplomatic activities should…"	Key questions	Example
		• Are we satisfied with the activity's performance?	

5.2.1 Sensitivity

Science Diplomacy is context-dependent. This means that what works in some contexts may not work in others. As a result, Science Diplomacy practices need to be adapted or redesigned to align with new situations to prevent them from becoming irrelevant, unresponsive or even counterproductive. Furthermore, contextual circumstances, such as expectations, goals or procedures may change rapidly due to developments outside of the initial scope, which can lead to misalignments or deadlocks, if not dealt with accordingly.

This leads to the following principle:

Sensitivity

Science diplomatic activities should respect the specific political, socio-economic and environmental context they are designed for and be able to adapt to changes in them.

To ensure this principle is considered, ask yourself:

- Who are the main stakeholders both at the national and international context? What are their main interests and goals?
- What do they expect (a) from their international interaction or peers and (b) from you as a science diplomat in the specific situation involved?
- What is the specific (geo-)political and scientific context in which the Science Diplomacy activity is being performed? What could enable/block it and why?
- Which specific circumstances in the natural environment does the activity need to take into account?

Example Science diplomacy in the field of water governance is a strong suit of the Netherlands. This country benefits from its longstanding experience with and traditional expertise on all aspects of water management. (Tomalová et al. 2020; Geography)

5.2.2 Inclusiveness

The choice of parties that are allowed to enter the interaction space is a crucial political act. Furthermore, restricted, exclusive science-diplomatic processes can reduce quality, legitimacy and system-transformative potential of the interactions (cf. Blomgren Bingham 2011). Dominant 'paradigms' and commonplace thinking resulting from broad generalizations may lead to exclusion of important views and stakeholders, and subsequently to potential conflict or incompatibilities among actors. Especially when addressing grand challenges, uncertainties stemming from excluded, but potentially influential actors can be fatal (cf. Kuhlmann, Stegmaier, and Konrad 2019). Instead, deliberation among a broad range of actors, domains, and science diplomacy arenas (see Figure 2), which covers all relevant topics, scientific disciplines and scientific approaches (e.g. STEM and SSH; inter-/ transdisciplinarity) will boost the quality and range of knowledge involved in the process as well as the credibility of the process itself (Ewert and Maggetti 2017).

Inclusive Science Diplomacy processes can lead to commitment to change on the part of stakeholders and increase the likelihood of transformative, systemic change when addressing global challenges (cf. Schot and Steinmueller 2018).

This leads to the following principle:

Inclusiveness

Science diplomatic activities should be aware of different degrees of inclusiveness vs. exclusiveness as well as that inclusion is a political choice and part of the diplomatic game, too. Where useful, involve a broadly representative portion of the relevant scientific and diplomatic communities.

To ensure this principle is considered, ask yourself:

- Which aspects, how many and which stakeholders should be included?
- How should inclusion of aspects and stakeholders take shape?
- Are there aspects and stakeholders that are purposefully or inadvertently excluded from the interaction space?
- Will the envisioned range of included aspects and stakeholders presumably lead to sufficient legitimacy and support of the science diplomacy interaction?
- How do inclusion and exclusion of aspects and stakeholders need to be balanced for the activity to be constructive and productive without risking the overarching goals in the short and the long term?

Example The SESAME synchrotron, by design, allowed for inclusive participation from various stakeholders, including people from opposing countries. (Rungius 2020; Explicitness/Implicitness, Interests)

5.2.3 Transparency

National-interest-based politics, the possibility of hidden agendas and the existence of transnational networks beyond democratic oversight can feed suspicion towards international policy processes, including those targeting grand challenges (Stone 2020). In some readings, transnational networks, in which national governments mingle with all kinds of interest groups jeopardise the former's autonomy (Fagerberg 2018). Besides, observing communities cannot evaluate a process's legitimacy, if they know neither about the functioning of the process nor about its outputs (French 2019; cf. Deliberation and Legitimacy; Ewert and Maggetti 2017; Van Assche et al. 2017). Thus, Science Diplomacy's reputation as a means of soft power positions it as a contender to mitigate that suspicion and prevents those stakeholders uninvolved in those networks to become democratically marginalized (Stone 2020). On the one hand, it builds on the effect of increasing transparency of diplomatic interactions through scientific exchange and technical cooperation. On the other hand, the emergence of Open Science promises the unfettered access of all stakeholders to scientific results, evidence and arguments. Besides access to relevant knowledge, transparent Science

Diplomacy activities should entail clear communication about mandates and missions with stakeholders within as well as outside the activity (cf. Deliberation); the availability and simple accessibility of appropriate communication and information channels – for communication among stakeholders as well as with third parties (cf. Capacities); or codes of conduct as a means of stating what can be expected of a process (Stone 2020).

Transparency is by no means a simple principle, but comes as a trade-off with others. First, extreme transparency may harm intellectual property (Picot and Hopf 2018). Second, the more inclusive a Science Diplomacy process becomes, the more complex relations, processes, and checks and balances revealed by transparency mechanisms become, as well (Van Assche et al. 2017). Hence, transparency mechanisms are crucial, but to be designed responsibly and conscientiously.

This leads to the following principle:

Transparency

Science diplomatic activities should be appropriately visible to enable monitoring and accountability activities by observing communities, thereby increasing the legitimacy of the activity.

To ensure this principle is considered, ask yourself:

- Which level of detail about aspects and stakeholders of the activity need to be visible and accessible? To whom should they be visible and accessible?
- What are the benefits and costs involved in not being transparent?
- How much are you willing to accept intransparency from your peers?
- Which aspects of the activity need to be accessible to enable monitoring and accountability by observing communities?
- How does transparency about aspects and stakeholders of the activity need to be designed for the activity to be constructive and productive without risking the overarching goals in the short and the long term?

Example National ministries have their own decision making processes which can obstruct quick responses and transboundary activities. (Flink 2020a; Values, Interests)

5.2.4 Deliberation

Due to the variegated backgrounds and worldviews of stakeholders, they probably hold inconsistent understandings of 'the' problem (e.g. its characteristics, causes, relevant actors, consequences, etc.) and appropriate and acceptable solutions to these. A fortiori, conflicting or contradictory processes and objectives can be present in the envisioned context of the Science Diplomacy activity (cf. Sensitivity). Not making these inconsistent understandings explicit, may lead to solving the wrong challenge (Dunn 2018) or not addressing any grand challenges at all. Science Diplomacy practices that intend to approach these frictions head-on

need to turn the continual discussion of (a) issues, interests and worldviews at stake, (b) conditions enabling effective science diplomacy and (c) arenas, domains, institutions involved into a routine. In other words, inter-actor reflection requires the iteration of critical evaluation processes.

This leads to the following principle:

Deliberation

Science diplomatic activities should encourage mutual understanding of actors' perspectives and needs as well as of the problem definition, the disciplinary and interdisciplinary knowledge required (incl. probing for other relevant scientific disciplines) and common narratives for the support of science diplomacy processes.

To ensure this principle is considered, ask yourself:

- What multiplicity of perspectives is involved in the activity in general and due to participating stakeholders?
- What does such a diversity of perspectives mean to the participants and how should it be addressed?
- What are your and your peer's core values?
- To what extent are some values (non-)negotiables?
- Which opportunities for consensual perspectives exist for all parties involved and under which conditions can consensus be achieved?

Example Framing of a water issue as a problem of water quality or of water as a scarce and contested resource makes a difference in how easily cooperation is achieved. (Tomalová et al. 2020; Values)

5.2.5 Reciprocity

The urgency of many grand challenges means addressing them cannot afford to be bogged down by distrust between stakeholders caused by perceptions of opportunism, selfishness or manipulativeness. Such behaviour may be counterproductive and lead to the feeling that one's contribution to the process is not equivalently matched by others. Productive Science Diplomacy requires empathic and cooperative attitudes and actions resulting in equivalent contributions to the process on behalf of all stakeholders involved.

This leads to the following principle:

Reciprocity

Science diplomatic activities should foster an attitude of understanding and cooperativeness leading stakeholders to trust that each actor participating in the activity contributes to addressing grand challenges in roughly equivalent ways according to their abilities, be it through knowledge or other resources.

To ensure this principle is considered, ask yourself:

- What are you willing to contribute to the activity and how does it measure up to what your peers contribute?
- What do you expect your peers to contribute to the activity?
- What are the potential consequences of an imbalance in the contributions to the activity by each stakeholder?

Example Pursuing common interests is not always the objective of science diplomacy activities. Rather, they figure on a continuum between competition and cooperation. (Degelsegger-Márquez 2020; Mayer 2020, Interests)

5.2.6 Complementarity & Manoeuvrability

Science Diplomacy relies on the interplay between the domains of international affairs and science. Stakeholders - be they countries, non-governmental organizations, research institutes, universities, etc. - have their own specialisms and, in turn, need to collaborate with others in areas where they are weaker. Such specialisms may refer to specific scientific fields, infrastructures or diplomatic skills and networks. The ideal Science Diplomacy activity makes use of the distribution of specialisms among participating stakeholders. Furthermore, the agreed process needs to give stakeholders sufficient room to play to their strengths without being forced into a straitjacket. For example, this may happen in case of too high levels of bureaucracy. In the worst case, a lack of awareness about others' strengths and potential contributions results in high transaction and opportunity costs. This may be the case, if stakeholders in a Science Diplomacy activity are responsible for an aspect that they are not an expert in or that is not one of their strengths.

This leads to the following principle:

Complementarity & Manoeuvrability

Science diplomatic activities should build on stakeholders' strengths to balance out others' weaknesses and embed them in governance arrangements that leave enough room to manoeuvre for these strengths to flourish.

To ensure this principle is considered, ask yourself:

- Who is who in the planned activity's landscape?
- What are each stakeholder's strengths and weaknesses?
- How can stakeholder's strengths and weaknesses be balanced, overcome, harnessed or mobilized in the benefit of others?

Example In the transition phase towards an Open Science system (a normative goal), restricting scientific publications in subscription journals can reduce scientists' room to manoeuvre. (Mayer 2020; Values)

5.2.7 Legitimacy

As a common problem in international politics, accepting and supporting international institutions or mechanisms is a precondition for their functioning (Boon and Edler 2018; Colebatch 2006; Oosterveer 2018; Schot and Steinmueller 2018; Stone 2020). Upholding national sovereignty and the absence of common legally binding arrangements present reasons to undermine the legitimacy of processes and outcomes addressing global challenges (e.g., USA & WHO; several countries & International Court of Justice; etc.). Furthermore, their footing in the worlds of science as well as diplomacy should pave the way for stakeholders to perceive Science Diplomats as authoritative actors when addressing global challenges.

This leads to the following principle:

Legitimacy

Science diplomatic activities should strive for the mutual acceptance of shared "rules of the game" in the interaction space, respecting participating stakeholders' expertises and framings. Science Diplomacy activities should enable 'democratic quality' of proposed and implemented mechanisms, processes and solutions.

To ensure this principle is considered, ask yourself:

- What are the relevant stakeholders' core values?
- How might the planned activity threaten these core values?
- How can the specific activity reinforce these core values instead?
- What are the determinants of the activity's legitimacy?
- How do you intend to maximize that legitimacy?
- What can be accomplished thanks to such legitimacy?
- Under which circumstances can the activity lose legitimacy?
- What would be the consequences of losing legitimacy?

Example	Strategic avoidance of labelling activities as 'Science Diplomacy', can in some cases make more sense, e.g. health diplomacy, cyber diplomacy or water diplomacy (Kadlecová et al. 2020; Šlosarčík, Meyer, and Chubb 2020; Tomalová et al. 2020; Explicitness/Implicitness, Values)

5.2.8 Alignment

Due to administrative "distance" and the formulation of sweeping, generic statements, large-scale international agreements, such as the Sustainable Development Goals, run the risk of a disconnect with the local contexts they address. Additionally, if implementation processes are riddled with bureaucratic hurdles, this may hinder Science Diplomacy objectives, too. Besides, the silos policy domains represent more often than not, complicate any form of international and interdisciplinary collaboration and co-construction. Science Diplomacy, thus, will fare well, if processes are designed in the simplest way conceivable and - in

the vertical governance dimension - as close to the implementation context as possible (McMichael 2005; Wanzenböck and Frenken 2018). Furthermore, even if appropriate assets and conditions are in place, a lack of leadership for orchestrating efforts may result in unnecessary costs or impracticable solutions. Science Diplomacy can be a very complex enterprise, involving multiple governance levels, stakeholders with their own agendas and even conflicting goals or incompatible processes (Haas 1992; cf. Deliberation; Van Lieshout et al. 2014). The smooth operation of all of these elements depends on their coordinated alignment.

This leads to the following principle:

Alignment

Science diplomatic activities should address problems on the lowest, i.e. most local and concrete, appropriate policy/instrumental level while coordinating all involved scales (temporal, spatial and administrative), governance dimensions (horizontal and vertical) and epistemic communities.

To ensure this principle is considered, ask yourself:

- What is the lowest level at which the activity will unfold its maximum impact?
- What should the activity's main goals be and who are its targeted beneficiaries?
- Who can affect achieving these goals (positively or negatively) and how?
- How should they be mobilized to achieve such goals?
- Which dimensions and epistemic communities need to be taken into account and aligned to maximize the activity's impact?

Example Response time to crises, e.g. cyber attacks or infectious disease outbreaks, can be reduced, if there are appropriate management systems in place (Kadlecová et al. 2020; Ravinet, Cos, and Young 2020; Šlosarčík, Meyer, and Chubb 2020; Governance systems, Rhythm and Timing, Instruments)

5.2.9 Evaluation

The evolution of open-ended science diplomacy efforts (as to their nature, co-evolving with implementation) needs to be evaluated, not at least to create accountability and legitimacy. Transformation-related science diplomacy activities require learning, with new capacities and capabilities. Science diplomacy agents need to build competence in 'navigation': diagnostic, evaluative and prospective studies (Strategic Intelligence; Kuhlmann et al. 1999). Strategic Intelligence-based evaluation will enable deliberation, the moderation of negotiations, and the ability to package and perform.

This leads to the following principle:

Evaluation

Science diplomatic activities should be reflective and facilitate learning throughout the process.

To ensure this principle is considered, ask yourself:

- How satisfactorily are the activities being performed?
- Can or should they be performed differently?
- What has been learned?
- Can future activities be adapted based on such learnings?

Example The Mutual Learning Exercise on Open Science was created specifically to learn from the way open science was being implemented, what went well and what could be improved or accelerated. (Mayer 2020)

5.3 Infrastructural principles

Before describing each infrastructural principle of the new Science Diplomacy Protocol in detail (section 5.3.1-5.3.3), Table 3 gives an overview of each principle, including their description, key questions and an example.

Table 3 Infrastructural principles

Principle	Description: "Science diplomatic activities should…"	Key questions	Example
CAPACITIES	Create, reinforce and/or draw on suitable and sufficient institutional and organizational resources, political will, reliable and inclusive knowledge resources, and gatekeeping proficiency.	• Which conditions does the activity require that are already in place? • Which conditions still need to be realized?	S4D4C online knowledge resources
CAPABILITIES	Empower individuals to become trained 'translators', 'multilingual' in the sense of speaking the language of science and diplomacy and enable them to opportunistically or incidentally interact with communities beyond their daily circles both in the domain of science and/or diplomacy.	• Is the existing human capital, including skills and knowledge, appropriate for the planned activity?	Physicist negotiating for public funding
TRUST	Produce mutual recognition and credibility on an individual level as well as clear 'rules of the game' on the process level, thereby stabilizing the process and contributing to the legitimacy of the process and involved individuals alike.	• How well-developed are trust relationships between potential stakeholders of the envisioned activity? • What needs to be done to improve these relationships?	Role of large-scale scientific knowledge infrastructures in international cooperation

5.3.1 Capacities

Science Diplomacy requires both physical and material, but also social enabling conditions to thrive. These should include not only the creation of robust, reliable, intuitive and secure platforms and networks for scientists, diplomats and policymakers for negotiation and access to knowledge,[6] but also communication, deliberation, dialogue and interaction mechanisms. It should also encompass norms and values that increase the likelihood of constructive and productive interactions. The development and maintenance of distributed but interconnected sources of Strategic Intelligence (Kuhlmann et al. 1999) will be a constitutive cornerstone of capacity building.

This leads to the following principle:

Capacities

Science diplomatic activities should create, reinforce and/or draw on suitable and sufficient institutional and organizational resources, political will, reliable and inclusive knowledge resources, and gatekeeping proficiency.

To ensure this principle is considered, ask yourself:

- What physical, social and material conditions does the specific activity require to be effective?
- Which of these appropriate conditions are already in place?
- What can be done to realize such conditions?

Example The accessibility of scientific knowledge as well as relevant stakeholders (networks) is paramount for science diplomacy and knowledge-based decision making in general. Knowledge infrastructures such as the S4D4C online knowledge resources can contribute to improving this accessibility. (Mayer 2020; Tomalová et al. 2020; Explicitness/Implicitness, Scale)

5.3.2 Capabilities

The presence of sufficient resources, infrastructures and good intentions cannot make up for a lack of highly skilled human capital trained in the peculiarities of Science Diplomacy. This includes basic diplomatic training for European researchers as well as basic training for diplomats in scientific thinking, various disciplines and philosophy of sciences. Broadly speaking, useful skills to acquire are gatekeeping, negotiation, out-of-the-box-, cross-sectoral-, and associative thinking and institutional entrepreneuring.

[6] such as https://www.s4d4c.eu/online-knowledge-resources/

This leads to the following principle:

Capabilities

Science diplomatic activities should empower individuals to become trained 'translators', 'multilingual' in the sense of speaking the language of science and diplomacy and enable them to opportunistically or incidentally interact with communities beyond their daily circles both in the domain of science and/or diplomacy.

To ensure this principle is considered, ask yourself:

- Is there the appropriate human capital necessary for the envisioned activity? If not, what's lacking?
- How can such human capital be sustained and grow?

Example The SESAME synchrotron would not have existed were it not for a physicist's political funding negotiating capabilities. (Rungius 2020; Individuals)

5.3.3 Trust

Trust is a crucial resource in international relations. This is not only particularly true considering the relatively high value associated with STI-relevant negotiations and interactions, but also considering the diversity of stakeholders and their typically competing agendas and goals. Trust is hard to gain but easy to lose. It takes time to earn, whereby actions are more important than words. Without a minimum level of trust between partners, science diplomacy becomes a very complex process.

This leads to the following principle:

Trust

Science diplomatic activities should produce mutual recognition and credibility on an individual level as well as clear 'rules of the game' on the process level, thereby stabilizing the process and contributing to the legitimacy of the process and involved individuals alike.

To ensure this principle is considered, ask yourself:

- How strongly do you trust your peers and vice versa?
- What are the consequences of losing trust in your peers, and of your peers losing trust in you?
- How can trust between involved stakeholders be built and maintained?

Example Large-scale science infrastructures, such as SESAME (studied within S4D4C) or CERN, but also all kinds of large-range telescopes or computing infrastructures, are often created with objectives of peace- and trust-building. (Rungius 2020; Scale, Individuals)

6 Conclusions and Recommendations

The overarching aim of this report was to present a governance framework for constructive and productive science diplomacy interactions that address grand societal challenges. We did so by arguing that such a governance framework benefits from meta-governance thinking as a lens and that it is something quite different than a conceptual framework. We have described our grasp of science diplomacy as a governance area characterized by a set of three connected governance arenas, which are embedded in specific international politico-scientific contexts. At the central overlap of these arenas a science diplomacy interaction space emerges. Only by mixing the practices from the three distinct arenas in this interaction space can science diplomacy activities be transformed productively and constructively. In turn, and most importantly, the interactions taking place at the intersection of these governance practices are guided by a set of twelve procedural and infrastructural principles which together constitute a new Science Diplomacy Protocol. These principles do not specify the actual behaviour, mechanisms and procedures in the three arenas. Rather – in the spirit of meta-governance – they represent the conditions enabling actors to design a science diplomacy activity suitable for the societal challenge at hand.

We conclude that the approach of meta-governance put forward in this report befits the boundary character of science diplomacy due to its focus on principles as enabling conditions instead of substance. Positioning social practices and arenas at the core of our understanding of science diplomacy enables a more nuanced, dynamic, and multi-layered look at actors or processes that would have been static from more essentialist perspectives. The principles, as enabling conditions, are capable of serving as resolvers of tensions that may occur in science diplomacy interactions, but have to balance each other out. If stakeholders in the science diplomacy interaction strike the right balance of principles, they are one step closer to constructive and productive science diplomacy interactions for grand societal challenges. Finally, we would like to draw attention to the fact that procedural and infrastructural principles cannot do without each other.

Based on our argument, we encourage practitioners intending to create or organize science diplomacy activities, i.e. activities at the intersection of foreign policy and science, to apply our framework and explore its possibilities. We hope that the governance framework we present in this report as a new Science Diplomacy Protocol will be usable and used by stakeholders from foreign policy and science alike. A more constructive and productive interaction about what science diplomacy means to stakeholders will benefit the outcomes and brings us a step closer to addressing and perhaps tackling the grand societal challenges the world is facing.

Bibliography

Abbott, Andrew. 2004. *Methods of Discovery: Heuristics for the Social Sciences*. New York/London: Norton.

Aukes, Ewert, Sanaz Honarmand Ebrahimi, Gonzalo Ordóñez-Matamoros, and Stefan Kuhlmann. 2020. *Towards effective science diplomacy practice. S4D4C Policy Brief no. 2.* S4D4C (Vienna). https://www.s4d4c.eu/wp-content/uploads/2020/01/S4D4C-Towards-effective-science-diplomacy-practice.pdf.

Beck, Silke, Tim Forsyth, Pia M. Kohler, Myanna Lahsen, and Martin Mahony. 2017. "The Making of Global Environmental Science and Politics." In *The Handbook of Science and Technology Studies*, edited by Ulrike Felt, Rayvon Fouché, Clark A. Miller and Laurel Smith-Doerr, 1059-1086. Cambridge, Mass.: MIT Press.

Beck, Ulrich. 2009. *Macht und Gegenmacht im globalen Zeitalter: Neue weltpolitische Ökonomie*. Frankfurt am Main: Suhrkamp.

Benz, Arthur. 2007. "Governance in Connected Arenas – Political Science Analysis of Coordination and Control in Complex Rule Systems." In *New Forms of Governance in Research Organizations: Disciplinary Approaches, Interfaces and Integration*, edited by Dorothea Jansen, 3-22. Dordrecht: Springer.

Berkman, Paul Arthur. 2019. "Evolution of Science Diplomacy and its Local-Global Applications." *European Foreign Affairs Review* 24 (Special Issue): 63-80. https://kluwerlawonline.com/journalarticle/European+Foreign+Affairs+Review/24.2/EERR2019019.

Blomgren Bingham, Lisa. 2011. "Collaborative Governance." In *The SAGE Handbook of Governance*, edited by Mark Bevir, 386-401. Los Angeles: Sage.

Boon, Wouter, and Jakob Edler. 2018. "Demand, challenges, and innovation. Making sense of new trends in innovation policy." *Science and Public Policy* 45 (4): 435-447. https://doi.org/10.1093/scipol/scy014.

Charmaz, Kathy. 2006. *Constructing Grounded Theory: A practical guide through qualitative analysis*. London: Sage.

Colebatch, Hal K. 2006. "Mapping the work of policy." In *Beyond the Policy Cycle: The policy process in Australia*, edited by Hal K. Colebatch, 1-19. Sydney: A&U Academic.

Colebatch, Hal K., Robert Hoppe, and Mirko Noordegraaf, eds. 2010. *Working for Policy*. Amsterdam: Amsterdam University Press.

Collingridge, D.G. 1979. "The entrenchment of technology: the case of lead petrol additives." *Science and Public Policy* 6 (5): 332–338. https://doi.org/https://doi.org/10.1093/spp/6.5.332.

Cooper, Andrew F., Jorge Heine, and Ramesh Thakur. 2013. "Introduction: The Challenges of 21st-Century Diplomacy." In *The Oxford Handbook of Modern Diplomacy*, edited by Andrew F. Cooper, Jorge Heine and Ramesh Thakur. Oxford: Oxford University Press.

Degelsegger-Márquez, Alexander. 2020. "International dimensions of the EU's FET Flagships: Large-scale strategic research investments as a site of de-facto science diplomacy." In *Science Diplomacy in the Making: Case-based insights from the S4D4C project*, edited by Mitchell Young, Tim Flink and Elke Dall. Vienna: S4D4C.

Degelsegger-Márquez, Alexander, Tim Flink, and Charlotte Rungius. 2019. *What it takes to do science diplomacy: Practices, identities, needs and challenges*

of science diplomacy practitioners. Baseline analysis and needs assessment. S4D4C (Vienna).

Dunn, W.N. 2018. *Public policy analysis: An integrated approach*. New York and London: Routledge.

Dunsire, Andrew. 1993. *Manipulating Social Tensions: Collibration as an Alternative Mode of Government Intervention.* Max-Planck-Institut für Gesellschaftsforschung (Köln).

---. 1996. "Tipping the balance: Autopoiesis and Governance." *Administration & Society* 28 (3): 299-334.

Ewert, Christian, and Martino Maggetti. 2017. "Regulating side by side: The role of hybrid organisations in transnational environmental sustainability." *Policy and Society* 35 (1): 91-102. https://doi.org/10.1016/j.polsoc.2015.12.004.

Fagerberg, Jan. 2018. "Mobilizing innovation for sustainability transitions: A comment on transformative innovation policy." *Research Policy* 47 (9): 1568-1576. https://doi.org/10.1016/j.respol.2018.08.012.

Flink, Tim. 2020a. "International Joint Research Programming." In *Science Diplomacy in the Making: Case-based insights from the S4D4C project*, edited by Mitchell Young, Tim Flink and Elke Dall. Vienna: S4D4C.

---. 2020b. "The Sensationalist Discourse of Science Diplomacy: A Critical Reflection." *The Hague Journal of Diplomacy* 15 (3): 359-370. https://doi.org/10.1163/1871191x-bja10032.

Flink, Tim, and Nicolas Rüffin. 2019. "The current state of the art of science diplomacy." In *Handbook on Science and Public Policy*, edited by Dagmar Simon, Stefan Kuhlmann, Julia Stamm and Weert Canzler, In Handbooks of Research on Public Policy, 104-121. Cheltenham, UK: Edward Elgar.

Flink, Tim, and Ulrich Schreiterer. 2010. "Science diplomacy at the intersection of S&T policies and foreign affairs: toward a typology of national approaches." *Science and Public Policy* 37 (9): 665-677. https://doi.org/10.3152/030234210x12778118264530.

French, Richard D. 2019. "Is it time to give up on evidence-based policy? Four answers." *Policy & Politics* 47 (1): 151-168. https://doi.org/10.1332/030557318x15333033508220.

Geels, Frank. 2005. "Co-evolution of technology and society: The transition in water supply and personal hygiene in the Netherlands (1850–1930)—a case study in multi-level perspective." *Technology in Society* 27 (3): 363-397. https://doi.org/10.1016/j.techsoc.2005.04.008.

Gluckman, Peter D., Vaughan C. Turekian, Robin W. Grimes, and Teruo Kishi. 2017. "Science Diplomacy: A Pragmatic Perspective from the Inside." *Science & Diplomacy* 6 (4): 1-13. http://www.sciencediplomacy.org/article/2018/pragmatic-perspective.

Haas, Peter M. 1992. "Introduction: epistemic communities and international policy coordination." *International Organization* 46 (1): 1-35. https://doi.org/10.1017/S0020818300001442.

---. 2016. "Social Constructivism and the Evolution of Multilateral Environmental Governance." In *Epistemic Communities, Constructivism, and International Environmental Politics*, edited by Peter M. Haas, 121-149. London: Routledge.

Hocking, Brian. 2016. "Diplomacy and Foreign Policy." In *The SAGE Handbook of Diplomacy*, edited by Costas M. Constantinou, Pauline Kerr and Paul Sharp, 67-78. Los Angeles: Sage.

Hoppe, Robert. 2010. "From "knowledge use" towards "boundary work": sketch of an emerging new agenda for inquiry into science-policy interaction." In *Knowledge Democracy: Consequences for Science, Politics, and Media*, edited by Roeland Jaap In 't Veld, 169-186. Heidelberg: Springer.

Jessop, Bob. 2002. *The Future of the Capitalist State*. Oxford: Blackwell.

---. 2003. "Governance, and meta-governance: on reflexivity, requisite variety and requisite irony." In *Governance as social and political communication*, edited by Henrik P. Bang, 101-116. Manchester: Manchester University Press.

---. 2011. "Metagovernance." In *The SAGE Handbook of Governance*, edited by Mark Bevir, 106-123. Los Angeles: SAGE.

---. 2015. "The course, contradictions, and consequences of extending competition as a mode of (meta-)governance: towards a sociology of competition and its limits." *Distinktion: Journal of Social Theory* 16 (2): 167-185. https://doi.org/10.1080/1600910x.2015.1028418.

Kadlecová, Lucie, Nadia Meyer, Rafaël Cos, and Pauline Ravinet. 2020. "Cyber Security: Mapping the Role of Science Diplomacy in the Cyber Field." In *Science Diplomacy in the Making: Case-based insights from the S4D4C project*, edited by Mitchell Young, Tim Flink and Elke Dall. Vienna: S4D4C.

Kaltofen, Carolin, and Michele Acuto. 2018. "Science Diplomacy: Introduction to a Boundary Problem." *Global Policy* 9: 8-14. https://doi.org/10.1111/1758-5899.12621.

Kingdon, John W. 2014. *Agendas, Alternatives, and Public Policies*. 2nd ed. Harlow, Essex: Pearson.

Kuhlmann, Stefan. 2001. "Future governance of innovation policy in Europe - three scenarios." *Research Policy* 30: 953-976.

Kuhlmann, Stefan, Patries Boekholt, Luke Georghiou, Ken Guy, Jean-Alain Heraud, Philippe Laredo, Tarmo Lemola, Denis Loveridge, Terttu Luukkonen, António Moniz, Wolfgang Polt, Arie Rip, Luis Sanz-Menendez, and Ruud Smits. 1999. *Improving Distributed Intelligence in Complex Innovation Systems. Final Report.* https://mpra.ub.uni-muenchen.de/6426/.

Kuhlmann, Stefan, and Arie Rip. 2018. "Next-Generation Innovation Policy and Grand Challenges." *Science and Public Policy* 45 (4): 1-7. https://doi.org/https://doi.org/10.1093/scipol/scy011.

Kuhlmann, Stefan, Peter Stegmaier, and Kornelia Konrad. 2019. "The tentative governance of emerging science and technology—A conceptual introduction." *Research Policy*. https://doi.org/10.1016/j.respol.2019.01.006.

Lindner, Ralf, Stefan Kuhlmann, Sally Randles, Bjørn Bedsted, Guido Gorgoni, Erich Griessler, Allison Loconto, and Niels Mejlgaard, eds. 2016. *Navigating Towards Shared Responsibility in Research and Innovation: Approach, Process and Results of the Res-AGorA Project*. Karlsruhe: Fraunhofer Institute for Systems and Innovation Research ISI.

López de San Román, Alea, and Simon Schunz. 2018. "Understanding European Union Science Diplomacy." *JCMS: Journal of Common Market Studies* 56 (2): 247-266. https://doi.org/10.1111/jcms.12582.

Maasen, Sabine, and Peter Weingart, eds. 2005. *Democratization of Expertise? Exploring Novel Forms of Scientific Advice in Political Decision-Making*. Edited by Peter Weingart, *Sociology of the Sciences*. Dordrecht: Springer.

Mayer, Katja. 2020. "Open Science Diplomacy." In *Science Diplomacy in the Making: Case-based insights from the S4D4C project*, edited by Mitchell Young, Tim Flink and Elke Dall. Vienna: S4D4C.

McMichael, Philip. 2005. "Globalization." In *The Handbook of Political Sociology: states, civil societies, and globalization*, edited by Thomas Janoski, John Alford, Alexander Hicks and Mildred A. Schwartz, 587-606. Cambridge: Cambridge University Press.

Melchor, Lorenzo. 2020. "What Is a Science Diplomat?" *The Hague Journal of Diplomacy* 15 (3): 409-423. https://doi.org/10.1163/1871191x-bja10026.

Melchor, Lorenzo, Ana Elorza Moreno, and Izaskun Lacunza. 2020. *Calling for a Systemic Change: Towards a European Union Science Diplomacy for Addressing Global Challenges. Version 1.0.* S4D4C (Vienna). https://www.s4d4c.eu/calling-for-a-systemic-change-towards-a-eu-science-diplomacy-for-addressing-global-challenges/.

Millwood, P. 2020. "An 'Exceedingly Delicate Undertaking': Sino-American Science Diplomacy, 1966–78." *Journal of Contemporary History*. https://doi.org/10.1177/0022009419888273.

Moomaw, William R. 2018. "Scientist Diplomats or Diplomat Scientists: Who Makes Science Diplomacy Effective?" *Global Policy* 9: 78-80. https://doi.org/10.1111/1758-5899.12520.

Müller, Jan Marco, and Maurizio Bona. 2018. "Past, Present, and Future of Science Diplomacy in Europe." *Science & Diplomacy* 7 (3): 7. https://www.sciencediplomacy.org/perspective/2018/past-present-and-future-science-diplomacy-in-europe.

Nye, Joseph S. 2008. "Public Diplomacy and Soft Power." *Annals of the American Academy of Political and Social Science* 616 (1): 94-109. https://doi.org/10.1177/0002716207311699.

Oosterveer, Peter. 2018. "Global Environmental Networks and Flows Addressing Global Environmental Change." In *Environment and Society: Concepts and Challenges*, edited by Magnus Boström and Debra J. Davidson, 95-118. Cham: Palgrave Macmillan.

Özkaragöz Doğan, Elif, Zafer Uygun, and İbrahim Semih Akçomak. 2020. "Can science diplomacy address the global climate change challenge?" *Environmental Policy and Governance*. https://doi.org/10.1002/eet.1911.

Penca, Jerneja. 2018. *The rhetoric of "science diplomacy": Innovation for the EU's scientific cooperation?* EL-CSID (Brussels).

Picot, Arnold, and Stefan Hopf. 2018. "Innovation by the Numbers: Crowdsourcing in the Innovation Process." In *Innovation Society Today: Perspectives, Fields, and Cases*, edited by Werner Rammert, Arnold Windeler, Hubert Knoblauch and Michael Hutter, 183-206. Wiesbaden: Springer VS.

Ravinet, Pauline, Rafaël Cos, and Mitchell Young. 2020. "The science and diplomacy of global challenges: Food security in EU-Africa relations." In *Science Diplomacy in the Making: Case-based insights from the S4D4C project*, edited by Mitchell Young, Tim Flink and Elke Dall. Vienna: S4D4C.

Rein, Martin, and Donald Schön. 1996. "Frame-critical policy analysis and frame-reflective policy practice." *Knowledge and Policy: The International Journal of Knowledge Transfer and Utilization* 9 (1): 84-104.

Rhodes, Rod A.W. 2007. "Understanding Governance: Ten Years On." *Organization Studies* 28 (8): 1243-1264.

Robinson, Sam. 2020. "Scientific imaginaries and science diplomacy: The case of ocean exploitation." *Centaurus*. https://doi.org/10.1111/1600-0498.12342.

Rüffin, Nicolas. 2020. "EU science diplomacy in a contested space of multi-level governance: Ambitions, constraints and options for action." *Research Policy* 49 (1). https://doi.org/10.1016/j.respol.2019.103842.

Ruffini, Pierre-Bruno. 2018. "The Intergovernmental Panel on Climate Change and the Science-Diplomacy Nexus." *Global Policy* 9: 73-77. https://doi.org/10.1111/1758-5899.12588.

---. 2020. "Collaboration and Competition: The Twofold Logic of Science Diplomacy." *The Hague Journal of Diplomacy* 15 (3): 371-382. https://doi.org/10.1163/1871191x-bja10028.

Rungius, Charlotte. 2020. "SESAME – a synchrotron light source in the Middle East: an international research infrastructure in the making." In *Science Diplomacy in the Making: Case-based insights from the S4D4C project*, edited by Mitchell Young, Tim Flink and Elke Dall. Vienna: S4D4C.

Rungius, Charlotte, and Tim Flink. 2020. "Romancing science for global solutions: on narratives and interpretative schemas of science diplomacy." *Humanities and Social Sciences Communications* 7 (1). https://doi.org/10.1057/s41599-020-00585-w.

Rungius, Charlotte, Tim Flink, and Alexander Degelsegger-Márquez. 2018. *State-of-the-art report: summarizing literature on science diplomacy cases and concepts.* S4D4C (Vienna).

Schot, Johan, and W. Edward Steinmueller. 2018. "Three frames for innovation policy: R&D, systems of innovation and transformative change." *Research Policy* 47 (9): 1554-1567. https://doi.org/10.1016/j.respol.2018.08.011.

Schwartz-Shea, Peregrine, and Dvora Yanow. 2012. *Interpretive Research Design. Concepts and Processes*. Oxford: Routledge.

Seawright, Jason, and John Gerring. 2008. "Case Selection Techniques in Case Study Research: A Menu of Qualitative and Quantitative Options." *Political Research Quarterly* 61 (2): 294-308. https://doi.org/10.1177/1065912907313077.

Shove, Elizabeth, Pantzar. Mika, and Matt Watson. 2012. *The Dynamics of Social Practice: Everyday Life and how it Changes*. London: Sage.

Šlosarčík, Ivo, Nadia Meyer, and Jennifer Chubb. 2020. "Science diplomacy as a means to tackle infectious diseases: The case of Zika." In *Science Diplomacy in the Making: Case-based insights from the S4D4C project*, edited by Mitchell Young, Tim Flink and Elke Dall. Vienna: S4D4C.

Soler, Marga Gual, Cynthia R. Robinson, and Tom C. Wang. 2017. *Connecting Scientists to Policy: Landscape Analysis of Mechanisms Around the World Engaging Scientists and Engineers in Policy. Executive Summary.* American Association for the Advancement of Science (Washington, D.C.).

Spaapen, J., and L. Van Drooge. 2009. "Introducing 'productive interactions' in social impact assessment." *Research Evaluation* 20 (3): 211–218.

Stone, Diane. 2020. *Making Global Policy*. Edited by M. Ramesh, Michael Howlett, Xun Wu, Judith Clifton and Eduardo Araral.*Elements in Public Policy*. Cambridge: Cambridge University Press.

The Royal Society. 2010. *New frontiers in science diplomacy: Navigating the changing balance of power.* The Royal Society (London).

Tomalová, Eliška, Eliška Černovská, Ewert J. Aukes, Jasper Montana, and Elke Dall. 2020. "Water Diplomacy and its Future in the National, Regional, European

and Global Environments." In *Science Diplomacy in the Making: Case-based insights from the S4D4C project*, edited by Mitchell Young, Tim Flink and Elke Dall. Vienna: S4D4C.

Torgerson, Douglas. 1986. "Interpretive policy inquiry: A response to its limitations." *Policy Sciences* 19: 397-405.

Trobbiani, Riccardo, and Constant Hatenboer. 2018. *The Future of EU Science Diplomacy: Conceptual and Strategic Reflections.* EL-CSID (Brussels).

Turnhout, Esther, and Thomas F. Gieryn. 2019. "Science, Politics, and the Public in Knowledge Controversies." In *Environmental Expertise: Conneceting Science, Policy, and Society*, edited by Esther Turnhout, Willemijn Tuinstra and Willem Halffman, 68-81. Cambrdige: Cambridge University Press.

Van Assche, Kristof, Raoul Beunen, Martijn Duineveld, and Monica Gruezmacher. 2017. "Power/knowledge and natural resource management: Foucaultian foundations in the analysis of adaptive governance." *Journal of Environmental Policy & Planning* 19 (3): 308-322. https://doi.org/10.1080/1523908x.2017.1338560.

Van de Ven, Andrew, Douglas E. Polley, Raghu Garud, and Sankaran Venkataraman. 2008. *The Innovation Journey*. New York: Oxford University Press.

Van Genderen, Ruben, and Jan Rood. 2011. *Water Diplomacy: a Niche for the Netherlands?* Netherlands Institute of International Relations 'Clingendael' (The Hague).

Van Lieshout, Maartje, Art Dewulf, Noelle Aarts, and Catrien Termeer. 2014. "The Power to Frame the Scale? Analysing Scalar Politics over, in and of a Deliberative Governance Process." *Journal of Environmental Policy & Planning*: 1-24. https://doi.org/10.1080/1523908x.2014.936581.

Walker, Karen. 2015. "The Rhetorical Work of Science Diplomacy: Border Crossing and Propheteering for U.S.-Muslim Engagement." *Poroi* 11 (2). https://doi.org/10.13008/2151-2957.1238.

Wanzenböck, Iris, and Koen Frenken. 2018. *The subsidiarity principle: Turning challenge-oriented innovation policy on its head.* Utrecht University (Utrecht).

Wesselink, Anna, Hal Colebatch, and Warren Pearce. 2014. "Evidence and policy: discourses, meanings and practices." *Policy Sciences* 47 (4): 339-344. https://doi.org/10.1007/s11077-014-9209-2.

Wilder, M.O., R.G. Varady, A.K. Gerlak, S.P. Mumme, K.W. Flessa, A.A. Zuniga-Teran, C.A. Scott, N.P. Pablos, and S.B. Megdal. 2020. "Hydrodiplomacy and adaptive governance at the U.S.-Mexico border: 75 years of tradition and innovation in transboundary water management." *Environmental Science and Policy* 112: 189-202. https://doi.org/10.1016/j.envsci.2020.05.013.

Young, Mitchell. 2020. *Building Better Science Diplomacy for Global Challenges: insights from the COVID-19 crisis. S4D4C POLICY BRIEF, June 2020.* (Vienna: S4D4C). https://www.s4d4c.eu/policy-brief-building-better-science-diplomacy-for-global-challenges-insights-from-the-covid-19-crisis/.

Young, Mitchell, Charlotte Rungius, Ewert J. Aukes, Lorenzo Melchor, Elke Dall, Eliška Černovská, Eliška Tomolová, Laure-Anne Plumhans, Pauline Ravinet, Tim Flink, and Ana Elorza Moreno. 2020. *The 'Matters' of Science Diplomacy: Transversal Analysis of the S4D4C Case Studies.* S4D4C (Vienna).