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Between global collaboration and national competition: Unraveling the many faces of Arctic science diplomacy

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Abstract

It has been argued that science diplomacy (SD) helps avoid or mitigate conflicts among stakeholders in the Arctic. Yet underlying some of these well-intended and sometimes successful initiatives is a one-sided understanding of SD. The most recent literature takes a more differentiated approach towards the means and ends of SD. It shows that international scientific interaction is shaped by the twofold logic of competition and collaboration. Instruments of SD can be meant to serve national interests, collective regional goals or global agendas. The present paper disentangles these confounding discourses of collaboration and competition based on a conceptually enhanced SD framework. It analyses Arctic strategies and two cases of Arctic SD, the Agreement on Enhancing International Arctic Scientific Cooperation and research activities on Svalbard, to reveal the mechanisms of collaboration and competition in the sphere of international science in relation to security, environment and economy. By pointing out where and how science is currently being used in the Arctic, this article provides (a) a systematic overview of the state of SD in the region and (b) a tool for policy-makers and scientists to assess what impact different facets of SD have in Arctic politics.

Introduction

It is widely recognised that the Arctic undergoes major environmental, economic and social transformations, many of which are interrelated and ambiguous. The decreasing level of Arctic sea ice gives rise to considerations of economic exploitation of new shipping routes, natural resources and tourism. At the same time, these processes might have a considerable impact on the environment, security and living conditions in the region. Newly emerging shipping routes along the North-Western and the North-Eastern passages, for instance, are perceived as an economic opportunity and a potential threat to national security as they may create open flanks in previously inaccessible territory. These ambivalences in the circumpolar North have fuelled media reports of increasing regional militarisation and threats of armed conflicts (for an overview of the discourse see Wilson Rowe, 2013). Experts counter this at times one-sided reporting by pointing out the region's relative political stability (Keil, 2014; Wegge, 2011, p. 167; Young, 2009, p. 74). For them, a range of different and continuously evolving jurisdictions and regimes are key to this stability (Albert & Vasilache, 2018; Exner-Pirot, 2012; Stokke, 2013). For instance, while littoral states of the Arctic Ocean exercise sovereign rights in the territories they control, disputes related to regions off their coasts are settled under the United Nations Convention on the Law of the Sea (UNCLOS), which is considered authoritative for the core of the Arctic Ocean around the North Pole. Numerous questions of regional governance are routinely discussed in the Arctic Council (AC), which represents the main forum of dialogue between coastal states, other Northern nations, observer countries and indigenous organisations. Finally, regional fora like the Barents Euro-Arctic Council (BEAC), and bilateral agreements supplement this multifaceted governance system.

Scholars have frequently pointed to the vital role of science in Arctic governance (Berkman & Young, 2009; Stokke, 2013). Often labelled as *science diplomacy* (SD), international research collaborations have been praised as a way to maintain peaceful interactions among stakeholders in the High North (Berkman, 2014). For instance, 2018 saw the entry into force of the *Agreement on Enhancing International Arctic Scientific Cooperation* (AEIASC), which was negotiated in the AC (Berkman, Kullerud, Pope, Vylegzha, & Young, 2017) and is a frequently mentioned example of Arctic SD. There are also ample examples of scientific cooperation among various (Arctic) countries. An important point of reference for Arctic science cooperation is the Svalbard archipelago. Since its demilitarisation 100 years ago, it has gained relevance as a hub for Arctic research, particularly in the last decade (Koivurova & Holiencin, 2017; Misund, Aksnes, Christiansen, & Arlov, 2017). Moreover, it has become an entry point for Asian states that show interest in polar matters, not least to express political stakes in the

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region (Pedersen, 2021; Stensdal, 2016). Another example is the role of science in the workings of the UN Commission on the Limits of the Continental Shelf (CLCS). According to UNCLOS, countries that claim exclusive jurisdiction over continental shelves have to submit a scientifically sound application to the CLCS to substantiate their claims. Hence, scientific insights, in particular from geology, play a vital role in this process. States like Russia have allocated notable funding to Arctic research expeditions to collect corresponding data (Graben & Harrison, 2015; Weber, 2009).

Although the claim that science plays a significant role in the Arctic seems well founded, the activities designated as Arctic SD cannot be subsumed under a uniform manifestation of a well-defined concept. The above examples represent a patchwork of diverse activities with a scientific component. Differences include, for example, the characteristics and interests of the actors involved, the institutional frameworks, time horizons and forms of financing. We argue that existing and frequently used taxonomies of SD are insufficient to fully understand the nuanced roles of science in Arctic policy.

The remainder of this paper is structured as follows: First, we briefly reconstruct the development of the original SD taxonomy by the Royal Society and the American Association for the Advancement of Science (AAAS) and the critical discourse following its publication to show the strengths and weaknesses of existing scholarship. Subsequently, we develop an enhanced, ideal-type framework for the categorisation of SD activities. Second, we put the enhanced framework to the test by (a) analysing statements from national Arctic strategies on the uses of science as a tool in international relations and (b) by situating two of the most common examples of Arctic SD in the conceptual framework. Finally, we discuss how our enhanced taxonomy provides an added value to scholars and practitioners.

The meaning and evolution of SD

A very short history of the term

SD, broadly speaking all activities at the intersection of science and foreign policy (Ruffini, 2017, p. 17), has only recently found its way into the field of International Relations as an explicit point of reference. Though scholars such as Skolnikoff (1967) have examined activities which would now be labelled SD as early as in the 1960s, it was not until the first decade of the 21st century that *the term* SD started to gain currency (Ruffini, 2020a, p. 2). SD has ranked particularly high on the agenda of US-based actors who were among the first to promote it as a foreign policy instrument (Fedoroff, 2009).

Key to the popularisation of SD, particularly in Europe and beyond, was a meeting sponsored by AAAS and the Royal Society in 2009 (Gluckman, Turekian, Grimes, & Kishi, 2017, p. 1). An important outcome of this gathering was the definition of SD as "a still fluid concept" applicable to the role of science, technology and innovation in three dimensions of policy (Royal Society & AAAS, 2010, p. v). These dimensions are:

- Science in Diplomacy (SiD): Informing foreign policy objectives with scientific advice;
- Diplomacy for Science (D4S): Facilitating international scientific cooperation via diplomacy;
- Science for Diplomacy (S4D): Using science cooperation to improve international relations between countries.

On the European level, then Commissioner for Research, Science and Innovation, Carlos Moedas, put SD on the policy agenda (Moedas, 2016). Agencies like the European External Action Service embraced it "to develop and maintain links of all kinds" with states like Iran (European External Action Service, n.d.).

On a national level, SD is often promoted as a policy tool by the responsible ministries and incorporated into broader internationalisation strategies of major research institutes or national academies. For example, both Germany and France took up the notion of SD and issued strategy papers on the topic. Spain, the US and the UK have further established SD networks within their embassies to foster closer relations with their respective host countries based on cooperation in science and technology (Krasnyak, 2018, p. 46; Moreno et al., 2017). BRICS countries were latecomers to the SD buzz. India's Department of Science and Technology, for example, only funded a major SD initiative in 2018 (Sabzalieva, Sá, Martinez, & Kachynska, 2021, p. 6).

On a local level, finally, institutionalised SD initiatives are rare. One example of a local SD initiative is the public–private Barcelona-based SciTech Diplo Hub, which sees itself "in charge of deploying Barcelona's science diplomacy" (Roig, Sun-Wang, & Manfredi-Sánchez, 2020, p. 4).

Towards a more nuanced understanding of SD

Until recently, a predominantly positive image of SD has prevailed among scholars and practitioners. Both groups have touted SD as a panacea for most grand challenges of our time. These accounts have largely made use of the Royal Society–AAAS taxonomy. While the definition has thus come to be widely used, it has not remained unchallenged. In the following, we summarise three main strands of criticism it has been exposed to.

The main argument voiced in the first strand is that the Royal Society–AAAS taxonomy needs further refinement. Professional scientific advisors, such as Gluckman et al. (2017), point out that the original SD definition has been useful for academic and theoretical discussions, but fails to capture the wide range of SD practices in everyday politics (Gluckman et al., 2017, p. 2; see also Berkman, 2019). In contrast to the means-ends relations proposed by the Royal Society and AAAS, Gluckman et al. suggest to factor in the different levels that SD initiatives can be targeted at. This includes the national level, where SD activities aim to advance a country's national agenda, the regional or bilateral level when cross-border interests are at stake, and finally, the global level whenever the target is to tackle worldwide challenges and national interests align rather than clash. In a similar vein, Krasnyak (2018, p. 38) proposes to add "SD for global governance" as an additional category to the Royal Society–AAAS taxonomy. These accounts primarily address interactions from the state level upwards. The implementation of SD policies on the ground, however, does not always have to be fully in line with national interests. Analysing the interactions of member states of the EU with regard to SD, Rüffin (2020) found that local SD initiatives are sometimes only loosely coupled to overarching national SD policies. This illustrates that SD activities at the local, national, regional and global levels are intertwined in complex and multidirectional ways (Berkman, 2019).

A second strand rejects the notion of SD as a genuinely benevolent factor in politics. Gluckman et al. (2017), for instance, were among the first to underline that SD activities also bear potential for conflict. They point to the frictions that can arise from

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diverging interests between national SD advocates. Their findings resonate with newer scholarly contributions that call for a more nuanced understanding of SD. Rungius and Flink (2020), for example, doubt that science can always "act as a unifying point of orientation deliberately opposing competing national interests" (p. 5). They question one of the main assumptions of SD proponents, namely that "political conflicts can be settled on the grounds of scientific values and principles" (Rungius & Flink, 2020, p. 5). Like other scholars, they believe that this "romanticised" image of SD is used by SD advocates to perpetuate a seemingly positive legacy of the concept based on a small number of historical examples (Flink, 2020, p. 365; Flink & Rüffin, 2019; Turchetti, Adamson, Rispoli, Olšáková, & Robinson, 2020).

These two strands of criticism have been supplemented by studies that attribute a dual nature to SD. In addition to emphasising the unifying and soft power of SD, these studies assume that SD contains innate competitive qualities (Ruffini, 2020a, 2020b). In this view, SD needs to be understood as a tool for "those disposed towards morality and ethics in international affairs *and* those who see the world in terms of power politics" (Ruffini, 2020b, p. 372; emphasis added). SD speaks to both of these camps because on the one hand it "brings to the forefront the need and will of countries to find common ground" (Ruffini, 2020b, p. 379). On the other, it relates to the scientific aspects of attractiveness, access and ability to exert influence (Flink & Schreiterer, 2010). In other words, SD can take on a competitive *and* a collaborative form. A fitting example that illustrates SD's dual nature are so-called science and innovation centers or networks. During the past two decades, countries like the UK and Switzerland have established such hubs in strategic locations, for example, in BRICS countries, to promote their national education, research and innovation systems abroad (Epping, 2020, p. 4). On the one hand, these hubs are used to find partners in host countries and to set up cooperative programmes. On the other, they also serve economic objectives such as securing national competitiveness by strengthening a country's education, research and innovation system through internationalisation, visibility and occasionally also brain gain (Epping, 2020, p. 11; UK Science and Innovation Network, n.i.). Another highly topical example of how collaborative D4S can turn into competitive S4D is the race to find corona vaccines. At the beginning of the COVID-19 pandemic, most governments promoted open data sharing to accelerate international research on the virus (Grimm, 2020). This cooperative stance changed quickly, however, the further scientists around the world progressed with vaccine development. Terms like vaccine nationalism or vaccine diplomacy illustrate how the US and other wealthy countries eventually put national needs and interests above global ones (Kupferschmidt, 2020).

The review of the literature has important implications for the present study of SD in the Arctic. First, one cannot assume that all actors in the area agree on a single definition of the term. It is far more likely that every country and governmental agency employs its own concept of SD in line with its respective ambitions, capacities and goals. These agendas do not necessarily tally with those of non-governmental, international organisations or individual scientists. Research shows that the latter have a good understanding of SD, but at the same time a strong aversion against being instrumentalised for its ends (Fähnrich, 2017). Second, the relation between science and politics is not as simple as suggested in some accounts. Science is neither necessarily disinterested or neutral, nor is there always international consensus on scientific questions. Instead, scientific insights, science organisations and individual scientists might serve (willingly or unconsciously) both national or regional/transnational agendas. Thus, while science might provide solutions for policy problems in one area, at other times it might be utilised to support competitive policy objectives in another. For instance, SD might be seen and championed as a means to ease foreign policy tensions between rivaling countries. Yet on other occasions, actors rely on science to seize economic opportunities in competition with other actors (Flink & Schreiterer, 2010; Ruffini, 2020a). This blurry boundary between science, diplomacy and economic considerations is thus another indicator of the shortcomings of the taxonomy proposed by the Royal Society and AAAS.

The analysis of Arctic SD has to find ways to account for these challenges. The critique raised about the taxonomy can help us better understand the phenomenon in all its facets. It is necessary, for instance, to look beyond explicitly formulated SD initiatives as these might only cover a fraction of actual SD-like interactions between countries. Furthermore, science-related policies must be analysed in relation to several policy areas. This applies in particular to topics pertaining to the environment, regional security and economic growth, which rank high on the agenda of many Arctic stakeholders (Heininen, Everett, Padrtova, & Reissell, 2020). Thus, we argue that the AAAS–Royal Society definition and its alternatives represent a valuable basis to construct a SD framework based on *ideal types*. In our interpretation, the original taxonomy and the alternative definitions are complementary to each other. If cross-tabulated, the two perspectives create a table of nine SD types which may be used to categorise SD-related activities (see Table 1). Based on the Royal Society's definition, we argue that the means-end relations of S4D, D4S and SiD specify the relation between the spheres of science and diplomacy (Royal Society & AAAS, 2010). The practitioner's perspective of Gluckman et al. (2017) provides us with three different levels where SD – understood as a policy instrument – can be applied: national, cross-border/regional and global. These levels correspond to a distinction of unilateral, bilateral and multilateral political action. Building on Ruffini (2020a, 2020b), we furthermore suggest that each type of SD initiative on the national and regional level can be characterised as either collaborative or competitive in nature. On the level of global interests, this duality is by definition absent (cf. Gluckman et al., 2017, p. 3). For in this conception, the global level is characterised by the fact that national interests coincide and actors seek consensual, multilateral cooperation. Any activity that deviates from this collaborative level for one's own benefit (e.g., strategies of opting out of agreements or free-riding) needs to be situated at the level of national-competitive actions. The previously mentioned COVID-19 example illustrates this coexistence and mutability of different policies: The pandemic has prompted policy initiatives on the global level *and* on the national level. The Covid-19 Vaccines Global Access (COVAX) initiative is an inherently collaborative, global endeavor to provide the world population with vaccines. Yet individual countries established their own, sometimes highly competitive vaccination strategies in addition to – and sometimes at odds with – the global initiative.

This leaves us with a SD framework consisting of a hypothetical number of nine, mostly bimodal ideal types of SD. Of course, it is not to be expected that ideals types perfectly match empirical reality. Yet they should help to analytically disentangle inherent characteristics of SD-related activities. The field of Arctic SD provides an excellent case to apply the developed framework: Can we assume, for instance, that all stakeholders in the region hold similar views in terms of the role of science and SD? Simply put: Do all

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Table 1. Conceptual framework of SD-types.

	Level of engagement		
	National	Regional	Global
SiD	unilateral SiD	bi-/multilateral SiD	*multilateral SiD*
S4D	unilateral S4D	bi-/multilateral S4D	*multilateral S4D*
D4S	unilateral D4S	bi-/multilateral D4S	*multilateral D4S*

Notes: Non-italicised SD-types can have competitive and collaborative qualities. Italicised types are conceptualised as collaborative only.

Arctic actors perceive science as a means to mitigate tensions and conflicting interests in fields as different as security, economy or environment?

In the remainder of this paper, we use the case of Arctic SD to show how the matrix of nine, mostly bimodal ideal types of SD can help to systematically categorise a plethora of diverging – and sometimes contradicting – SD activities.

Method and data

To put the enhanced framework to the test, our empirical study combines two complementary perspectives on SD in the Arctic. First, we approach the topic from a top-down perspective via analysing the strategic considerations of Arctic stakeholders at the national level. Second, we situate two frequently mentioned examples of SD in the Arctic within our framework, thus adopting a bottom-up perspective.

Top-down perspective: National Arctic strategies

It makes sense to test the framework in this hybrid way for several reasons. As for the top-down perspective, every elaboration on the concept of SD has to take into account states as important players that can propel (or hinder) SD initiatives (see Section 2; Copeland, 2016, p. 630; Turekian et al., 2015, p. 5). Locally, regionally or globally oriented SD programmes likewise rely on support from national administrations (Colglazier, 2021). The role of national funding is illustrative of this dependency on state interests. To date, national governments provide the lion's share of funding for Arctic research either directly by allocating funds to certain projects or indirectly by financing autonomous funding organisations (Aksnes, Osipov, Moskaleva, & Kullerud, 2016). For instance, a year-round expedition into the central Arctic, MOSAiC, received about 50% of its funds from the German government via the Ministry of Education and Research. Other governments provided additional financial resources, either directly or through national funding bodies (National Oceanic and Atmospheric Administration, 2019). The relationship between science funding and SD is certainly not simple or linear. Yet it is intuitive that SD initiatives – in particular those on a larger scale – rely on continued financial support. In the Arctic, because states act as research funders either directly or indirectly, the strategic documents they publish are of particular importance.

Our approach in this part of the study is based on the theoretic assumption that language expresses and structures how actors perceive and make sense of the world (Fischer & Forester, 1993; Hansen-Magnusson, 2019). Language in politics matters as it creates and constructs reality. This may be illustrated by a recent example. In 2019, US Secretary of State Pompeo rejected China's claim to be a "near-Arctic" state at the AC Meeting in Reykjavik (Quinn, 2019). This actor category was coined just a few years before and has served the Chinese government as a vehicle to legitimise its interest in the polar region. By rejecting the semantic category of near-Arctic states, Pompeo arguably tried to undermine potential claims by the People's Republic. Some observers might see these language games as semantic appendages with little relevance to actual policymaking. We take a different stance as we perceive them as illustrative examples of governmental communication in their function to both legitimise and represent national aspirations – just as the analysed national strategies (Hansson, 2018). They explain and justify a country's aspiration to become or remain an actor in the Arctic. They express their strategic thoughts and policies vis-à-vis other parties or call out partners and adversaries in the region. National strategies are also designed to *represent* and sum up the experiences, plans and expectations of different national stakeholders. Thus, we can expect the documents to transport carefully minced political statements with regard to the past, present or future relations with external players.

Over the last decade, several countries have issued policy documents that identify challenges, lay out national priorities and describe political means to achieve their goals with regard to Arctic affairs (Heininen, 2020; Heininen et al., 2020). It is a tried and tested approach to rely on this type of policy paper to gain a better understanding of national interests in the Arctic, either for specific policy sectors or holistic analyses of governmental responses to policy challenges (Heininen et al., 2020; Luszczuk, Padrtova, & Szczerbowicz, 2020; Schulze, 2017). Previous research has already dealt with individual positions by analysing single Arctic policies (Chen, 2012; Koivurova et al., 2020; Staun, 2017; Watson, 2016). There is also literature on bilateral perceptions between dyads or groups of countries (Lundestad & Tunsjø, 2015; Østhagen, Sharp, & Hilde, 2018; Solli, Wilson Rowe, & Yennie Lindgren, 2013). We add to these studies by examining *mutual perceptions of several countries with regard to scientific interactions*.

We tapped into this network of relations via a combination of automated and qualitative text analysis. We analysed 26 documents on Arctic strategies from 18 countries (see Table 2). The selection of documents was based on the comprehensive survey recently conducted by Heininen et al. (2020) and covers the strategies of Arctic states and observer states in the AC from 2009 to February 2021. With the exception of the Russian strategies from 2013 to 2020, which have not yet been officially translated, we employed English documents to secure comparability of terms and phrases. We translated the Russian strategy into German and English, using Deepl.com. Page numbers do not correspond with the original Russian document. Using the software MAXQDA, we systematically searched all documents for terms like "competition", "collaboration", associated expressions, as well as for names of countries and organisations. We coded all text passages found in this way along the lines of the developed SD matrix, i.e., with regard to the levels of interaction and the type(s) of SD addressed. Finally, we decided for each passage whether it was more inclined towards a competitive or collaborative stance (see Appendix A for search terms and Appendix B for examples of coded segments). Controversial codings were discussed among the authors to find a consolidated perspective. After the coding process, we used the SD framework to identify clusters of SD-like interactions on the national, regional and global levels.

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Table 2. Overview of analysed documents. Countries are listed in alphabetical order.

Country	Document title	Year published
Canada	Canada's Arctic and Northern Policy Framework	Last retrieved Dec 2020
	Canada's Northern Strategy	2009
People's Republic of China	China's Arctic Policy	2018
Denmark	Strategy for the Arctic 2011–2020	2011
Finland	Finland's Strategy for the Arctic Region 2013	2013
France	The Great Challenge for the Arctic – National Roadmap for the Arctic	2016
Germany	Germany's Arctic Policy Guidelines - Assuming Responsibility, Creating Trust, Shaping the Future	2018
	Germany's Arctic Policy guidelines - Assume responsibility, seize opportunities	2013
Iceland	A Parliamentary Resolution on Iceland's Arctic Policy	2011
India	India and the Arctic	2013
Italy	Towards an Italian Strategy for the Arctic – National Guidelines	2015, updated May 2016
Japan	Japan's Future Priority Areas of Arctic Policy	2017
	Outline of Japan's Arctic Policy	2015
Republic of Korea	Arctic Policy of the Republic of Korea	2013
Netherlands*	Pole Position – NL 2.0 Strategy for the Netherlands Polar Programme 2016–2020	2014
Norway	Norway's Arctic Strategy	2017
	Norway's Arctic Policy	2014
Russia	Strategy for Developing the Russian Arctic Zone and Ensuring National Security through 2035**	2020
	On the Strategy for Development of the Arctic Zone of the Russian Federation and National Security up to 2020**	2013
	Basics of the state policy of the Russian Federation in the Arctic for the period till 2020 and for a further perspective	2009
Spain	Guidelines for a Spanish Polar Strategy	2016
Sweden	Sweden's strategy for the Arctic region	2020
	Sweden's strategy for the Arctic region	2011
United Kingdom	Beyond the Ice UK policy towards the Arctic	2018
	Adapting To Change UK policy towards the Arctic	2013
United States of America	National Strategy for the Arctic Region	2013

Notes: Only strategies published before February 2021 were included in the analysis. Countries marked with an asterisk (*) have subsequently published new strategies. Strategies with two asterisks (**) were translated using the software deepl.

Bottom-up perspective: The Arctic science agreement and research on Svalbard

The national strategies provide a broad overview of scientific interactions in Arctic affairs that are not necessarily framed as SD. The bottom-up analysis of two case studies allows us to examine salient Arctic SD activities in-depth (Gerring, 2009, p. 48). Combining these two approaches thus enables us to analyse Arctic SD in its full breadth *and* depth.

The two case studies chosen for this study are AEIASC and research activities on Svalbard. These cases were picked on the basis of Gerring's typical-case approach (Gerring, 2007). Under this approach, a case is selected because it "is considered to exemplify a typical set of values, given some general understanding of a phenomenon" (Gerring, 2007, p. 91). This applies to both cases as they have repeatedly been referred to as emblematic examples of SD (see, for instance, Berkman et al., 2017; Bertelsen, 2020). We analyse the two cases in an exploratory fashion and point out which

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types of SD play into foreign policies of the involved states. The data for the case description stem from a range of different document types, including relevant legal documents, government statements and scholarly articles. The diversity of data is intended to allow each of the two cases to be situated in the SD framework as comprehensively as possible.

Results

In the following, we present the results of our content and case study analysis based on the different cells of the developed SD framework. First, we describe five clusters containing distinct SD-like interactions that we have identified using the described coding procedure. Second, we situate our two case studies in the SD framework.

As expected, we found that few countries directly referred to the term "science diplomacy". On the one hand, it seems that countries like France that have incorporated the concept into their policy-making are keener to label their activities in the Arctic as SD. Scandinavian countries, on the other hand, were not inclined to explicitly refer to SD in their strategies. Yet their documents contained a number of references to the role of science in the wider governance of the Arctic. SD in this regard could be more generally described as *the integration of science into policy-making with an international dimension*. This shows that it makes sense to use an extended SD framework for the analysis to consider all relevant activities.

Cluster I – collaborative D4S on a regional level in the AC

In congruence with previous research, our analysis revealed that several countries, among them Sweden, Denmark and Russia, ranked scientific collaboration high on their agenda. The coded segments often showed no ulterior motive in this regard, meaning there was no mention of science as a tool to tackle political challenges. Rather, the documents showed commitment to support research in the Arctic as an end in itself, in particular to produce new insights into environmental issues. From all possible venues for these initiatives, which we understand to be D4S, the AC was mentioned most frequently across all investigated countries. For example, the Swedish strategy states that "cooperation in the Arctic Council is central" in efforts "to strengthen (...) research in and about the Arctic" (Government Offices of Sweden, 2020, p. 38). A similar stance can be found in the Russian strategy which states that the Federation wants to ensure "effective work of the Arctic Council under Russian Chairmanship (...) including the promotion of joint projects on sustainable development" (Government of Russia, 2020, own translation). In addition, several countries expressed interest in collaborating with science organisations like the International Arctic Science Committee. In these cases, we consider the political agreement to promote and cooperate in science to be a case of regional D4S.

Cluster II – collaborative S4D among neighbouring countries

Among all the codings, we noticed the descriptions of various bilateral relationships that embed science in the context of other social spheres. This applies in particular to the border regions in Northern Scandinavia. In the documents from Sweden, Finland and Norway, we found that science is either mentioned in addition to other cooperative activities or is directly part of a set of measures that address the border regions in terms of economic development, environmental protection or security. The Norwegian document mentions, for instance, that "Norway and Finland have established a partnership to strengthen economic and scientific cooperation in the Arctic" via "student exchanges, research cooperation, dialogue on transport and logistics, closer regional cooperation and flows of labour and services" (Norwegian Ministry of Foreign Affairs, 2014, p. 19). Most of these statements are characterised by symmetry (similar statements on bilateral collaborations in science and other spheres in each national strategy) with the exception of Russia which mentions neighbouring states only sparsely, while the aforementioned countries show a high interest in cooperating with Russia. We found a similar pattern centered around Greenland. Here, Denmark – on behalf of Greenland –, Iceland and Canada expressed their interest in cooperation in science and other spheres. The Danish strategy reports on an exemplary project "to establish a new 'Centre for Arctic Research' at Aarhus University with close ties to Greenland's Climate Research Centre, which creates the basis for a highly integrated and coordinated climate research collaboration between Denmark, Greenland and Canada around much of the Arctic" (Danish Ministry of Foreign Affairs, 2011, p. 38). Characteristic of this cluster, then, is its geographical proximity and its emphasis on scientific collaborations. Science, in other words, helps preserve interstate relations and contributes to regional understanding, rendering this type of interaction collaborative S4D in our SD framework.

Cluster III – collaborative SiD to address challenges at a global level

In the third cluster, states underline the importance of reliable scientific data to preserve global public goods. Particularly Scandinavian countries stress that both national decision-makers and the international community can only effectively address Arctic challenges through policies which are informed by precise scientific data. European observer states like Spain also emphasise that "the creation of protected terrestrial areas" needs to be "underpinned by the best scientific basis" (Comite Polar, 2016, p. 15). A majority of these states perceive international scientific collaboration as the best way to collect and interpret this data. We attribute such statements to the SiD dimension due to the tight links between scientists and scientific knowledge on the one hand and policymakers on the other. It is further striking that science seems to play a particularly important role in addressing environmental challenges in the Arctic. By underlining that "scientific findings towards solving global environmental issues due to changes in the Arctic environment" need to be "actively communicated" (The Headquarters for Ocean Policy, 2015, p. 5), states like Japan attribute a global dimension to these challenges and imply that changes in the Arctic environment affect the region and the world community as a whole.

Cluster IV – competitive S4D at the continental shelves

In contrast to the bulk of collaborative bilateral and regional statements, we also found a number of accounts that we identify as competitive S4D closely tied to the thematic complex of continental shelves. Coastal states like Denmark (via Greenland) and Russia mention efforts to substantiate territorial claims with scientific means, for instance, through research expeditions and geological insights (see Government of Russia, 2013). The Danish government initiated a project to obtain data "[t]o document the claim on the continental shelf" (Danish Ministry of Foreign Affairs, 2011, p. 14). The Danish Ministry of Science,

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Technology and Innovation, in collaboration with research organisations, was "charged with identifying areas where the rights to new seabed claims can be made, and to collect, interpret and document the data necessary to submit a claim to the CLCS" (Danish Ministry of Foreign Affairs, 2011, p. 14). These statements touch upon the SD facet of competitive S4D which is primarily driven by national interests. In a comparable vein, the Norwegian strategy from 2014 states that the "mapping of the Barents Sea will provide new geological insights into the oil and gas potential in large parts of the Barents Sea" which "is necessary in order to safeguard Norwegian national interests" (Norwegian Ministry of Foreign Affairs, 2014, p. 28). Here, regional or global scientific collaboration fades into the background as it is clearly the nation state that profits most from scientific insights. The political stance is, in other words, competitive and science is meant to foster national ambitions in the economic and security-related realms. The question of continental shelf rights has, of course, a global and collaborative dimension due to the necessary acknowledgement of UNCLOS. Recognising this convention is a prerequisite for countries to claim parts of the continental shelf. Yet this merely represents the setting in which the competitive use of scientific knowledge takes place.

Cluster V – competitive S4D in Arctic governance

Closely related to the previous cluster, we discerned a group of statements in which states refer to science as a means to maintain a competitive advantage in Arctic governance. In their strategies, both Arctic and observer states mention that they need to increase their scientific efforts, specifically in fora such as the AC. In doing so, most countries refer to other states' scientific efforts in a given area, for instance another state's growing research ice-breaking fleet. Japan, for example, observes that "China and Korea have already constructed and are operating icebreaking research vessels" (Study Group for the Future of the Arctic, 2017, p. 4). Not wanting to lag behind its neighbours, Japan underlines that "it is essential (. . .) to construct its own icebreaking research vessels (. . .)" (Study Group for the Future of the Arctic, 2017, p. 4). Therewith the country implies that in order to prevail as a legitimate actor in the Arctic it must at least match other states with similar capacities. Other nations, such as France, even seem to feel threatened by the scientific prowess of emerging powers like China. Noting the increasing participation of the Asian observer states in the AC's working groups, where every state regularly needs to re-apply for observer status by submitting "relevant information about their activities in the Arctic and their contributions to the work of the Council", France underlines the importance of providing "appropriate resources to strengthen its scientific presence in the working groups" (French Ministry for Foreign Affairs, 2016, p. 46). This statement shows that countries at times perceive each other as competitors in gaining a seat at the Arctic governance table. Such rhetoric further effectively follows a zero-sum-game logic where one state's gain in Arctic science is another's loss. Instead of global or regional interests, national ones take centre stage in such statements, which leads us to characterise them as competitive S4D.

Case study I: AEIASC

In May 2017, the eight member states of the AC signed the "Agreement on Enhancing International Arctic Scientific Cooperation". By applying our enhanced SD framework to AEIASC, we show that at least five facets of SD can be identified in the agreement itself and in the discourse surrounding it.

The signing of AEIASC in 2017 marks the culmination of a process that Smieszek (2017, pp. 440–442) traces back to the fourth International Polar Year and the parallel International Polar Initiative. These scientific megaprojects had shown that collaborative research across borders was key to better understand the Arctic as an ecosystem. Yet past experiences have also demonstrated that scientists studying the Arctic in collaboration face several obstacles. Arctic states decided to tackle these through negotiations on an agreement to facilitate cooperative Arctic research between 2013 and 2016. While Canada and subsequently the US held the AC chairmanship in this period, the US and Russia took a leading role in the negotiations (Berkman et al., 2017).

When applying the enhanced SD framework to the process and content of AEIASC, the first and probably most obvious SD element that appears is that of collaborative regional D4S. As a follow-up initiative to the International Polar Year, the outspoken intention of the agreement is to reduce barriers and "to enhance cooperation in Scientific Activities in order to increase effectiveness and efficiency in the development of scientific knowledge about the Arctic" (Arctic Council, 2017, art. 1). Similarly, the parties agreed to include a statement on "the importance of using the best available knowledge for decision-making" (Arctic Council, 2017, preamble). Given that this knowledge is likely to be produced in international research collaborations, AEIASC also contains elements of collaborative regional SiD.

Looking at the policy process, we notice that negotiations continued while geopolitical tensions in other parts of the world increased. National interests of several Arctic countries clashed, for instance, in Syria or in the Ukraine in the last decade, yet the work on a legally binding agreement continued (Smieszek, 2017). The lasting line of communication despite these tensions fits into the narrative of the Arctic as a unique region of collaboration. AEIASC can thus also be deemed an example of regional S4D (Berkman et al., 2017).

However, it has been pointed out that AEIASC is an agreement concluded between Arctic countries alone (Smieszek, 2017). Though countries other than the signatory states were involved in the drafting process and may benefit from the treaty's provisions (AEIASC, Article 17; Smieszek, 2017, p. 442), non-Arctic states need a formal bilateral cooperation agreement with scientists from an Arctic state to claim said benefits. The agreement hence reaffirms the central role of the signatory states in the High North who could use the agreement to exclude non-Arctic states in the future (Han, 2018). Put differently, AEIASC can be seen as collaborative regional S4D for the in-group of Arctic countries; yet it also contains potential competitive elements vis-à-vis non-Arctic states.

Last but not least, AEIASC touches upon the national dimension of the SD framework. It has been noticed that the motivation of different countries to work towards this binding agreement was quite diverse. Smieszek (2017, p. 441) points out that Russia was keen to negotiate an agreement to facilitate domestic policy coordination. Berkman et al. (2017) noted that proponents of AEIASC designated very different parts of their territory to be included in the agreement. In particular, they mention Norway choosing "the most cautious approach" (Berkman et al., 2017, p. 14) in defining what areas are applicable to AEIASC. We can interpret these examples as instances of national S4D as AEIASC facilitates collaborative science in the Arctic while also allowing states to promote their respective national priorities.

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Svalbard

The second case study focuses on a long-lasting example of SD, going back at least to 1920, when the Svalbard Treaty was signed. Prior to the treaty's adoption, several countries, in particular Norway and Russia, had made claims to Svalbard, mainly to access its coalfields (Pedersen, 2009, p. 148; Roberts & Paglia, 2016). The treaty's first article recognises Norway's "full and absolute sovereignty" over the archipelago; yet as a compromise it grants all other signatory parties the right to undertake mining and other commercial activities.

Initially focused on mining in Svalbard, the Norwegian government shifted its focus onto scientific activities after the "Kings Bay Affair" in 1962 when an explosion killed 21 Norwegian miners (Paglia, 2020, p. 2). This process was set in motion by the Norwegian Polar Institute (NPI) and reinforced by the installation of a European Space Research Organization satellite ground station in Ny-Alesund in 1964 (Grydehoj, 2014, p. 52). From the late 1980s onwards, Norwegian authorities started to promote Ny-Alesund as a research site to foreign polar institutes (Paglia, 2020, p. 3). These benefit from the "near-pristine conditions" on Svalbard (Paglia, 2020, p. 6), which Norway carefully preserves to maintain the archipelago's function as a "laboratory" for the study of global environmental and climate change (Paglia, 2020, p. 10).

On Svalbard, two different types of SD dimensions are at play on two different levels of engagement. On a national level, we see science as (a) a means to legitimate Norwegian sovereignty claims to Svalbard and (b) a way for observer states to assert their "right to be present in the Arctic" (competitive D4S) (Pedersen, 2021, p. 3). For Norway, scientific engagement depicts a way to assert its presence on Svalbard "by stealth", particularly vis-à-vis Russia, the only other treaty signatory with mining operations and settlements in the archipelago (Grydehoj, 2014, p. 53). Scientific activities helped Norway contain Russia's activities and presence on Svalbard after Norwegian mining lost its legitimising function in 1962 (Pedersen, 2009, p. 148). By promoting Svalbard and in particular Ny-Alesund as an international research hub that is managed and administered through Norway, the country continually legitimises its claims in the archipelago while simultaneously co-opting foreign actors, such as observer states, into its preferred geopolitical and governance script for the archipelago (Robert & Paglia, 2016). Although Norway is obliged to tolerate other actors' presence on Svalbard and collaborates with them to advance knowledge of environmental change in the Arctic, its approach to governing the archipelago mainly serves to defend its national-competitive policy interests.

Observer states, in turn, see international research cooperation as a means to affirm their national-competitive interests in the region and to express their Arctic stakeholder status (Pedersen, 2021; Roberts & Paglia, 2016). Like Norway's former mining settlements on Svalbard, observer states' research stations in Ny-Alesund provide them with a permanent physical presence and a research platform which legitimises their participation in Arctic governance (Roberts & Paglia, 2016, p. 904). Fearing that their interests could be sidelined by Arctic states, observer states have invested large amounts of human, monetary and political capital to assert their presence on Svalbard (Grydehoj, 2020, p. 279). While this capital is also used to conduct research collaboratively (D4S), we argue that the establishment of research stations serves the respective countries' individual national interests just as much (S4D). Two observations support this claim. First, many research stations show clear signs of national posturing (Pedersen, 2021). The Chinese research barrack formerly known as *Ungkarsheimen* ("the bachelor's home"), for instance, has been renamed to "The Chinese Yellow River Arctic Station" and decorated with two *shishizi*, Chinese guardian lions (Pedersen, 2021, p. 1). Second, as a host, Norway observes such signs of national posturing with increasing concern. In its 2019 Research Strategy for Ny-Alesund, the country reaffirms its support for international research cooperation, but calls for the hosting of researchers inside common, theme-based infrastructure rather than autonomous stations under various national flags (The Research Council of Norway, 2019, p. 28).

On the global level, science activities on Svalbard appear in the form of collaborative D4S as several observer and Arctic states finance research institutes in Ny-Alesund to facilitate the international study of climate change. Both Arctic and non-Arctic states are extremely interested in this type of research as all of them will eventually feel the consequences of climate change. Therefore, they invest considerable funds to facilitate cooperation on the issue, for example, by initiating joint research projects on Svalbard. National interests thus coincide, leading actors to seek consensual, multilateral cooperation – all of which are hallmarks of collaborative D4S and resonate with its global dimension.

Discussion and outlook

This article's starting point was that simple taxonomies of SD fail to grasp the diverging meanings and uses of the term. We developed a more nuanced framework based on the literature and subsequently analysed national Arctic strategies and two specific cases to identify different types of SD employed. In the following section, we discuss our findings, firstly in terms of the current state of Arctic SD, secondly in terms of the viability of our SD framework. Finally, we draw attention to some caveats and develop suggestions for future research on SD in the Arctic and beyond.

Empirical and conceptual insights

In line with previous research, our study points to the importance of science in the Arctic and its governance (Lanteigne, 2017; Luszczuk et al., 2020). Yet it goes beyond existing research as it disentangles multiple types of SD currently at play in the Arctic and highlights an often overlooked duality of the collaborative and the competitive uses of SD in the High North.

We can identify at least four distinct intersections of science and international affairs in the Arctic. These intersections are for the most part also present in our two case studies. First, in some cases, science is instrumental in promoting (exclusive) national interests. On the one hand, it is instrumental to gain a seat at the table of Arctic governance, for instance, for observer states that lack sovereignty claims in the region. They are aware that Arctic states are more inclined to welcome countries in the High North that contribute to regional governance through, for example, scientific engagement. For these states, scientific investments like the establishment of research stations are one way to accumulate political capital in the Arctic. On the other hand, states also employ science as a way to "defend" an already claimed seat at the Arctic table, particularly against newcomers. France's fierce statement on the increasing activity of the Asian observer states in the AC is an emblematic example of such behaviour, as is Norway's strategy of asserting its sovereignty over Svalbard through science following the collapse of its mining industry in the archipelago. Similarly, the conclusion of AEIASC can be seen as an effort of Arctic states to

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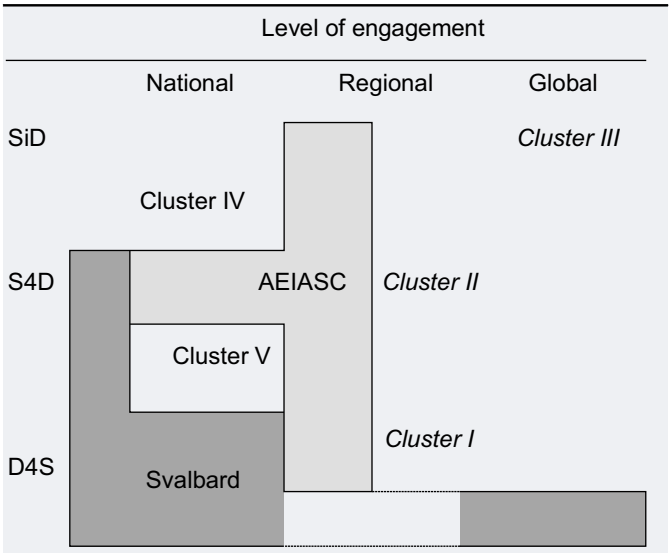
enshrine claims and authority over Arctic science in legal frameworks.

Second, almost all national strategies acknowledge the pivotal role science plays in addressing the Arctic's environmental challenges. Some states, such as Japan, link these challenges to global developments that can only be tackled in a joint effort, giving their own (scientific) presence in the Arctic more legitimacy. For many states, research data is the only legitimate foundation for the development of policies and (global) governance mechanisms capable of mitigating climate change. AEIASC in particular resonates with this conception as collaborative scientific results are intended to be used in diplomatic contexts on a regional and global level. Practically, this rationale is visible in science policies like those in the "natural" laboratory of Svalbard. Here, the near-pristine conditions facilitate the collection of reliable scientific data on global climate change which gives a vivid example of the complexity of Arctic SD. Third, our clusters reveal that states are more likely to employ and accept science as a means to address issues in areas of low politics, such as environmental protection. Our broader analysis underpins this finding: Two societal spheres closely related to high politics, economy and security, were rarely associated with science. For instance, though we identified a cluster of economic, and partially environmental, collaboration revolving around the BEAC, it lacked references to scientific collaboration. Another example of regional collaboration without a scientific dimension is military cooperation on the bilateral and regional level. One reason for this might be that security fora are often closed off and less accessible for outsiders like scientists. Where science is used to further economic interests, namely in the process of demarcating the continental shelves and in promoting Norwegian sovereignty over Svalbard, it takes on a competitive stance. Advantages that countries could gain from the exclusive exploitation of gas and oil deposits from the continental shelves render science a formidable tool in an economic competition. Whether this will eventually lead to open conflicts as some media outlets predict remains to be seen. As the second case study illustrates, science activities have gradually substituted economic ones on Svalbard as Norway's main justification for its dominant position in the archipelago. Although such scientific activities are also carried out in cooperation with Arctic and non-Arctic states, they mainly further Norway's national-competitive interests and sovereignty claims.

Scandinavian countries regularly mentioned scientific collaboration either as a stand-alone or in connection with economic development, environmental protection or security as a venue for closer cooperation amongst each other and their neighbour Russia. Similarly, we found a geographical focus on Greenland within the documents, with Canada, Iceland and Denmark putting great emphasis on regional scientific collaboration. Similar regional clusters of scientific collaboration also exist in the Antarctic (Young, 2011). Here and in the Arctic, we can see that despite science's image as a *global* institution, policymaking might channel and concentrate SD efforts on specific geographical locations or hubs. Interestingly, Svalbard does not feature as prominently in the Arctic strategies. While it is mentioned in some strategies, especially in the Norwegian and British documents, the quality and quantity of references do not match those of the regional clusters around Scandinavia and Greenland. This is surprising as the secondary literature on Svalbard depicts the archipelago as a crucial regional hub for Arctic science. This gap between national strategies and bottom-up case study points to the complexity of Arctic SD which we will discuss further below.

Table 3. The results from the bottom-up and the top-down analyses as situated in the SD framework.



Notes: Clusters in italics represent collaborative endeavors. Non-italicized clusters are predominantly competitive. The aspects of AEIASC are shown in light gray. The facets of the activities on Svalbard are shown in dark gray. Both case studies contain collaborative *and* competitive components.

Conceptually, we find that the extended taxonomy proves useful for distinguishing the many faces of Arctic SD. Figuratively speaking, the framework functions as a dispersive prism in the analysis of both national strategies and case studies. Just as an optical prism can disperse light into its spectral colors, the extended taxonomy helps identify different facets of SD. To extend the analogy: Just as physical light can consist of different wavelengths not immediately apparent to the observer, different cases of SD in the Arctic contain a mixture of diverging levels, intentions and tools. Taken together, we found that seven of the nine dimensions of the framework surfaced either in the case studies or the national strategies (see Table 3). Still, the use of the framework as a prism is an artificial, analytical tool based on ideal types. We cannot expect a perfect match between the developed taxonomy and the empirical findings just as we cannot assume that visible light consists solely of electromagnetic radiation of a single wavelength. Ambiguity is created in particular by the diverging interests of involved states and actors and by the temporal dimension of SD. For instance, science initiatives once launched without ulterior motives might be politicised later on. In other cases, political initiatives in line with national interests might later take on a regional dimension if other actors join in. Although we did not find indications of radical change in the workings of SD-like policies in the Arctic, critical events like the Russian annexation of the Crimea peninsula in 2014 might affect the uses of regional SD in the long run (Norwegian Ministry of Foreign Affairs, 2014, p. 11; Bertelsen, 2020, p. 238 ff.). What is needed here is a stronger focus on the temporal dimension of SD to track shifts in policies over time. Nevertheless, the proposed framework could support both scholars and practitioners as it provides an instrument of reflection on – sometimes only seemingly clear-cut and unambiguous – SD policies. In this regard, it is also important to note that while our framework has been tested with a focus on one specific world region – the Arctic – it could also be applied to other cases.

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Limitations of the study

Though our study uncovers several SD activities in the High North that have thus far not been addressed, there are some limitations to our findings regarding the situation of SD in the Arctic and the conceptual argument. The first caveat concerns our choice of data. Although we aimed to use two perspectives, top-down and bottom-up, the picture we get from analysing this data is still incomplete (see Heininen et al., 2020).

A closely associated second limitation is the focus on English documents. The language-based approach and the strategy to search for keywords might have skewed our results in some regards. For example, we found that some Scandinavian countries placed great emphasis on collaborations with Russia which did not reciprocate with similar statements. An explanation for this imbalance could be that the translation of the Russian strategies is not sufficiently fine-grained. In fact, the secondary literature on Russia's Arctic policies shows a general Russian interest in regional cooperation – we might have come to the same conclusion if we had analysed the Russian documents instead of their translations.

More generally, one has to bear in mind that the conceptual and methodical approach, we chose for this study partly focuses on a discursive level which necessarily contains elements of performative language. In other words, states may take political actions that contradict statements made in Arctic strategies. Indeed, the literature is often concerned with how communicated interests and actions actually align (e.g., Chen, 2012). We tried to counterbalance these concerns by including actual cases.

A final caveat touches upon the above-mentioned dimension of time. As seen in the case of Svalbard, the relevance of science and its uses can change over time. This means that some cases would "move" through the cells or might even appear in hitherto empty corners of our framework. Singular events might similarly impact the role and nature of SD in the Arctic. Examples of such events would be tensions arising from the Crimea crisis in 2014 or the plan for climate action laid down in 2015 in the Paris Agreement. Still, based on our coding results, we argue that the general uses and modes of science and SD-related activities have not radically changed in the period covered.

Outlook – future research with the framework

Our results show that SD in the Arctic is seldom one-dimensional. Both the top-down and the bottom-up perspectives illustrate a large spectrum of means-ends relations, interests and levels. The enhanced framework was meant to disperse these nuances to learn more about Arctic SD policies.

Building on this, there are at least three ways to refine the taxonomy and enhance our understanding of SD. First, we could focus on blind spots within the framework. As depicted in Table 3, both the cases and the strategies omit some cells in the taxonomy. Here, it is possible that – over time – new forms of SD arise. For instance, a rapidly advancing climate change might accelerate the use of science in economic activities. Science might strengthen fault lines between Arctic and non-Arctic states as well as East and West over the question of whether and how to exploit the resources the Arctic harbours. In our framework, such (scientific) stand-offs between two regional groups would represent competitive regional S4D. Other vacant spots like those of global D4S or global SiD could be filled with upscaled versions of existing policy initiatives. For example, if one were to build on the idea of the Arctic as "a global observatory", institutionalised research activities in an international research organisation could become an option. While the scope of scientific projects would be regional, membership could be global. The recent AEIASC and Norway's strategy for Svalbard point in this direction, yet to reach the global level, consensus is needed among more states.

Second, we could refine the taxonomy by applying our framework to additional cases. These could include particular policies, for instance in the BEAC. Cases may be selected from other typical SD examples. The framework could be applied to study Big Science projects, such as the International Experimental Thermonuclear Reactor (ITER), which is frequently mentioned as an instance of complex SD (Lami, 2017). ITER is an emblematic example of global collaborative D4S as it seeks to find a solution to growing global energy needs *and* a vehicle for competitive S4D since it may yield first-mover advantages for participating countries if fusion develops into a viable future energy source. This indicates that the enhanced framework should be able to disperse facets of SD in other cases as well.

Finally, we could shift the scope beyond the Arctic in an attempt to adapt the enhanced framework to other world regions. In addition to the Arctic, SD could help govern other global commons, such as the ocean. In ocean governance, science has a dual role: it takes on the form of collaborative global SiD when scientists inform internationally binding legislation that helps preserve marine habitats and that of competitive national S4D when states make use of scientific data to explore possibilities of ocean fracking. While such conflicts over alternative uses – consumptive versus non-consumptive – are characteristic for international spaces like the ocean (Young, 2011), an in-depth analysis of ocean SD with the enhanced taxonomy could result in striking new insights (see Polejack, Gruber, & Wisz, 2021).

The authors would like to point out that the substantial research for this article was done before the events of 2022. Potential effects of current events for the uses of SD in the Arctic were therefore out of the scope of the present paper. Nevertheless, it can be assumed that SD-like policies in many venues – just like the types of SD found in the present analysis – will continue to overlap, exist in parallel or possibly contradict each other on occasions. In fact, identifying configurations of factors that favour one type of SD over others in a given situation would be a particularly worthwhile endeavour (Flink, 2021). In such cases, our framework may help to keep a clear-cut analytical view of the prismatic SD developments in the Arctic and beyond.

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