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Oil pollution and black carbon in the Arctic:
Dynamic shipping governance in a rapidly warming region

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Chapter 20 explores the management of increased shipping activities in the Arctic Ocean, which is changing dramatically due to regional warming and declines in the extent and thickness of sea ice. Increased shipping, which has been made possible by climate change, poses new threats to Arctic Ocean ecosystems, including the growing danger of accidental spillage of fuel oil and emissions of black carbon – itself a contributor to climate change – into the atmosphere. In response to these threats, traditional state-based governance approaches, notably in the context of the International Maritime Organization (IMO), are being supplemented by newer forms of transnational governance that involve nongovernmental and corporate actors. This combination of traditional approaches to marine environmental governance with newer innovative approaches can serve as an example for governing other marine environments affected by global change. The chapter advocates innovative governance involving nonstate actors in the region, which in turn can stimulate traditional state-oriented institutions to bring their resources to bear on addressing the impacts of global environmental change.

Introduction

Climate change has multiple adverse effects on ocean environments (Henson *et al.* 2017; Harris 2019). These effects are particularly pronounced in the Arctic which, between 1971 and 2019, warmed three times faster than the global average (AMAP 2021: 2). Rapid warming directly affects Arctic ecosystems and enables increasing regional economic activity (see Chapter 19). Higher economic activity comes with new environmental externalities that put additional pressure on vulnerable Arctic marine ecosystems. An important growth sector in a warming Arctic is shipping. Shipping routes through the Arctic Ocean become more accessible as sea ice retreats and more demanded as regional economic activity rises. Ship traffic in the Arctic has been growing accordingly (Dawson *et al.* 2018; Gunnarsson 2021), with new cruise ships, tankers, bulk carriers, and container ships venturing into the area. A matter of environmental concern is that many ships are operating on heavy fuel oil (HFO) (Prior and Walsh 2018; Chircop 2020). HFO entails high oil pollution risks in case of accidental spillage and contributes to climate-forcing emissions of black carbon. Finding adequate governance responses to HFO use in growing Arctic shipping is important for protecting the Arctic marine environment in an era of environmental change.

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The effects of global environmental change can be governed through traditional, state-based arrangements or more innovative, transnational arrangements (Hale 2020). Governance encompasses all kinds of regulatory, programmatic, and knowledge-generating activities. Traditional governance responses are given by individual states on the domestic level or by states cooperating with each other on regional or global levels (DeSombre 2000). By contrast, innovative governance responses are developed by civil society organizations and/or business, sometimes also together with state actors (Abbott and Snidal 2009; Andonova, Betsill and Bulkeley 2009). The scholarly literature recently began to integrate these two research streams by examining interactions between state-based and transnational governance (Cashore *et al.* 2021). This chapter studies governance responses of states and nonstate actors in an integrated way to generate insights into flexible and adaptive societal responses to global environmental change. The Arctic is an informative case as rapid warming has transformed this region into a laboratory for governing change. Lessons from this laboratory can inform future governance efforts in other sea regions for which major environmental changes are projected, too.

This case study examines the sequence and interplay of traditional and innovative governance arrangements regarding HFO use in Arctic shipping in five steps. First, I outline the distinction between traditional, state-based governance and innovative, transnational forms of governance. Second, I explain that Arctic warming is enabling shipping growth and that HFO use by ships entails oil pollution risks and climate effects. Third, I analyse the gaps that traditional governance responses have left in addressing these threats. Fourth, I show that innovative governance responses have partly filled these gaps and facilitated the development of traditional regulatory measures. Fifth, I conclude that nonstate leadership is an encouraging lesson for ocean protection well beyond the Arctic but is contingent on public concern about environmental changes and their impacts.

The interaction of traditional and innovative governance responses

Researchers have studied how states as well as transnational initiatives involving nonstate actors have governed environmental problems. The study of state-based governance includes the making, design, and effectiveness of domestic policies (Harrison and Sundstrom 2010; Schaffrin, Sewerin and Seubert 2014) and of international environmental agreements and regimes (Young 2014; Mitchell *et al.* 2020). The study of transnational governance is a growing field exploring, amongst others, the growth and impacts of private environmental standards (Green 2013; Auld 2014). One way to bring these research streams together is the concept of institutional complexity (Zelli, Möller and Asselt 2017). For instance, the static notion of a regime complex captures the observation that an issue is governed by various bodies rather than a single international regime (Abbott 2012). Another way to capture governance diversity is to study interactions of state-based and transnational arrangements (Cashore *et al.* 2021) and their dynamic development over time. Environmental change promises to be a fruitful context for identifying sequences of different governance responses and interactions between them.

For this case study, I make a simple distinction between traditional and innovative forms of governance. Traditional governance refers to state actions on different geographical levels. First, coastal states take regulatory and other policy measures on the domestic level. This is useful for addressing local marine problems and industries not subject to global competition. Second, states cooperate with other states through regional organizations like the Arctic Council, organizations established under the UN regional seas programme, regional fisheries organizations, and other regional arrangements (cf. Mahon and Fanning 2019). This form of cooperation seems appropriate for targeting problems in a specific sea region and regional economic

context. Third, states cooperate with each other on the global level through international organizations with broad membership. This matches globalized industrial sectors and processes of environmental change extending across several sea regions (cf. Mendenhall 2019). Examples include the UN Environment Programme (UNEP) for general ocean challenges, the International Maritime Organization (IMO) for shipping, and the Food and Agriculture Organization (FAO) for fisheries. States thus govern on domestic, regional, and global levels.

Innovative, transnational governance is different from state-led responses as it relies on non-state actors like business and civil society organizations. The governance literature has identified initiatives with different actor combinations (Abbott and Snidal 2009). Some initiatives are led by civil society or business actors alone, while other initiatives are led jointly by civil society and business (see Chapters 9, 10, and 11). Finally, civil society and/or business cooperate with states in hybrid governance arrangements (Andonova, Betsill and Bulkeley 2009). Like state-based responses, these transnational arrangements may develop at different geographical scales. Importantly, the simple distinction between traditional and innovative governance is not meant to replace more fine-grained governance typologies (e.g., Abbott and Snidal 2009). Rather, it is a tool broadly capturing how state-based and transnational responses to ocean changes differ and interact.

Shipping in a warming Arctic: oil pollution risks and emissions of black carbon

The dynamic development and interaction of traditional and innovative governance forms are studied here for environmental threats posed by shipping in a warming Arctic. Warming has led to a rapid decrease in Arctic sea ice extent and thickness (Kwok 2018). Retreating sea ice makes Arctic shipping lanes more accessible. In the long term, trans-Arctic shipping may become a commercially viable alternative to existing shipping routes (Theocharis *et al.* 2018). For instance, the Northern Sea Route along Russia's north coast is the shortest connection between ports in East Asia and Northwest Europe. In the short to medium term, better accessibility of the Arctic region will enable more economic activity in sectors like resource extraction and tourism. This will increase shipping to destinations in the Canadian and Russian Arctic, and perhaps also Greenland (Lasserre 2019; Gunnarsson 2021). These developments are likely to continue even under ambitious international climate mitigation efforts. The vast majority of latest climate models predicts a practically ice-free Arctic Ocean in September before 2050 (Notz and SIMIP Community 2020). As sea ice retreats further, shipping from, to, and across the Arctic will grow. Growing Arctic shipping entails many new environmental threats for this vulnerable ocean area (Hofmann 2019).

Two major threats related to Arctic shipping are oil pollution and emissions of black carbon due to the use of HFO as fuel. HFO consists mainly of residues from refining processes, is cheaper than distillate fuel, and the most widely used fuel in global shipping (Comer *et al.* 2017: 2). An accidental spill of HFO would threaten seabirds, marine mammals, and other organisms living close to the water surface and on beaches. An HFO spill would be difficult to clean up in Arctic conditions and biodegradation be reduced in cold climate (DNV 2011; Fritt-Rasmussen *et al.* 2018). Spill risks in the Arctic are generally high given navigational challenges and harsh weather. Oil pollution risks could be reduced by using lighter distillate fuel instead of HFO (DNV 2011: 42) or eliminated through alternative fuels, like Liquefied Natural Gas. Moreover, incomplete combustion of HFO in ship engines leads to emissions of black carbon. Black carbon is a type of particulate matter and a potent climate-forcing agent (cf. Brewer 2019). It accelerates Arctic warming when deposited on ice and snow by increasing sunlight absorption and reducing the albedo of these surfaces (IPCC 2019: 247). Black carbon

also adversely affects human health (Janssen *et al.* 2012). A phaseout of HFO is one among many potential control measures for black carbon. However, it would be feasible in a relatively short timeframe, reduce fleet-wide emissions of black carbon by around one third, and enable the use of even more effective control measures like diesel particulate filters (Zhang *et al.* 2019). Hence, the phaseout of HFO as a fuel in Arctic shipping would reduce both oil pollution impacts and climate-forcing emissions.

The use of HFO in Arctic shipping is a revelatory case for studying governance dynamics. First, pre-existing institutions enabled state actions on different levels. This includes domestic regulation by Arctic coastal states, regional cooperation in the Arctic Council, and measures by the global shipping regulator IMO (Stokke 2013; Rayfuse 2014; see Chapter 23). Second, the warming Arctic with its high symbolic value has mobilized governments, scientists, environmental activists, and companies alike to think about sustainable shipping (Keil 2019). This is a favourable condition for innovative governance responses. Third, Arctic warming and shipping growth exemplify a process of rapid change with environmental impacts that initially were little regulated (Hofmann 2019). This should be conducive to sequences of innovative and traditional governance responses within a relatively short time span. The case study draws on rich primary and secondary sources: documents and records of IMO meetings; participatory observation in IMO meetings and events organized by nonstate actors; scientific literature; media sources; and background interviews with state, NGO, and business representatives. The analysis ranges from the issue's emergence on the international agenda in 2009/10 to the IMO's agreement on an HFO ban in 2020/21.

Traditional governance responses by states

States responded to the oil pollution risks and climate effects of HFO use in Arctic shipping in four ways. The first response was domestic regulation in Norway. Well before the issue appeared on the international agenda, Norway had introduced a local HFO ban in protected areas around Svalbard in 2007 (Norwegian Ministry of Justice and Public Security 2017: 60). Internationally, within the IMO, HFO use by ships in Arctic waters received attention in connection with an HFO ban for the Antarctic area in 2010. In contrast to Antarctica, however, the Arctic has a permanent population and much more economic activity. Arctic warming has fuelled aspirations to expand activities in oil and gas, mining, transport, tourism, and fisheries. As all these activities usually involve shipping, a regulation of HFO use in the Arctic would affect a much broader range of interests than in the Antarctic case. Accordingly, the international community did not take any swift action. Even Norway extended the exemptions from its partial HFO ban around Svalbard until 2015 (Norwegian Ministry of Justice and Public Security 2017: 60). Because of this and its local scale, this measure did not have any larger impact on Arctic-wide shipping.

The second response of states to threats from HFO use was to generate more knowledge on the regional level (cf. Bai and Chircop 2020: 267–269). Based on a Norwegian initiative, the Arctic Council launched a series of studies through its working group on the Protection of the Marine Environment (PAME 2010: annex II). This approach promised to enable international cooperation in two ways. First, more knowledge could help the Arctic states to better understand their own interests. The studies assessed how much HFO was used, by which ship types, and on which routes (DNV 2011, 2013). Second, the idea was to build regional consensus within the Arctic Council before going to the IMO. Regional consensus was considered important as Canada and Russia with their long coastlines play key roles in implementing IMO regulations for the Arctic. The hopes for a knowledge-based, regional consensus around an HFO phaseout did

not materialize though. Pre-defined interests guided the knowledge gathering and not vice versa, for instance, when the policy option of an HFO ban was excluded from further studies (PAME 2012: 4). Besides knowledge generation, the Arctic Council served to conclude the Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic in 2013. This agreement provides a basis for coordinated oil spill response but does not address HFO use as a major risk factor.

The third state-led response was the adoption of a nonbinding recommendation not to use HFO as a fuel in Arctic shipping by the global regulator IMO. Disagreements among the Arctic states prevented a binding provision on HFO in the IMO Polar Code. The Polar Code regulates safety and environmental aspects of shipping in the polar regions. Amongst others, it prescribes the installation of fuel tank protection for certain categories of ships to prevent accidental oil spills (IMO 2015: II-A, §1.2.1). During the Code's development, environmental NGOs also proposed a mandatory ban of HFO use by ships in the Arctic (FOEI *et al.* 2013). Negotiations in the IMO globalized the issue, with non-Arctic countries like Germany, France, and Spain supporting a ban. Among the Arctic states, however, Canada and Russia were firmly opposed to banning HFO (cf. Bognar 2018: 38–39). Given the lack of regional consensus, even Arctic states generally in favour of a ban, like Norway and the US, did not support its incorporation into the Code. As a softer alternative, in 2015, the IMO adopted a nonbinding provision as part of the Polar Code recommending all ships to refrain from using HFO in Arctic waters (IMO 2015: II-B, §1.1). While this provision has not had any legal teeth to effectively reduce HFO use, it flagged the issue for further consideration.

The fourth response by states was the decision to replace the IMO recommendation with a mandatory ban of HFO use as fuel in Arctic shipping. Two years after the Polar Code's adoption, IMO decided to reopen negotiations about risk mitigation measures (IMO 2017: 61). In 2019, most Arctic coastal states presented impact assessments confirming the benefits of an HFO ban, while Canada and Russia took sceptical positions (IMO 2020: 42–44). They expected that a ban would increase consumer prices and adversely affect supply of Northern settlements. Moreover, higher shipping prices for raw materials would undermine the competitiveness of Arctic resource extraction. Given these objections, IMO weakened the envisaged ban (IMO 2020: 44–47). The text agreed on in 2020 and scheduled for formal adoption in June 2021 delays the ban's entry into force to 2024 and allows for exemptions until 2029 (IMO Secretariat 2021). Observers consider these to be major loopholes in reducing oil spill risks and black carbon emissions (Comer *et al.* 2020). Parallel IMO work on other black carbon control measures will not close these gaps either because, at the time of writing in June 2021, it aimed for nonbinding guidelines only (IMO 2021: 11–12). In light of slow global progress, Norway announced plans to extend its local HFO ban to all areas around Svalbard (*Euractiv* 2020). Yet, despite the observed shortcomings, IMO regulation is set to force changes in fuel choice within the next decade.

Overall, state-based responses to the new environmental challenges of HFO use in growing Arctic shipping evolved over time on the domestic, regional, and global level. The partial HFO ban by Norway around Svalbard did not target Arctic-wide shipping. Regional cooperation in the Arctic Council generated new knowledge but did not attempt to reduce HFO use. The nonbinding recommendation not to use HFO in the Arctic by the global agency IMO was primarily symbolic. Its replacement with a mandatory ban marks an improvement with loopholes. Thus, while traditional governance responses to HFO use by ships in a warming Arctic have become stronger, they have also left important gaps (see Table 20.1).

Table 20.1 Traditional governance responses to HFO use in Arctic shipping

Level	State or international organization	Year	Governance response
Domestic	Norway	2007	Partial HFO ban with exemptions in protected areas around Svalbard
		2015	Exemptions of partial HFO ban around Svalbard expired
		2020	Plans to extend HFO ban to all areas around Svalbard
Regional	Arctic Council	2011-	Studies on HFO use in Arctic shipping
		2013	Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic
Global	IMO	2011-	Knowledge collection on black carbon and potential control measures
		2015	Polar Code: recommendation to refrain from using HFO, provision on fuel tank protection
		2021	Mandatory ban of HFO with exemptions and delayed implementation

Source: Compiled by the author.

Innovative governance responses by nonstate actors

The gaps left by traditional, state-led governance have partly been filled by innovative governance arrangements involving nonstate actors. Among civil society organizations, environmental NGOs were early proponents of an Arctic HFO ban by the IMO (FOEI *et al.* 2010). In 2016, a group of environmental NGOs stepped up their efforts by forming the Clean Arctic Alliance (CAA; 22 members in 2021). This coalition launched the "HFO-Free Arctic" campaign to build support among IMO member states for a rapid and comprehensive HFO ban. One of its main achievements has been the mobilization, collection, and dissemination of scientific and indigenous knowledge about risks posed by HFO to Arctic ecosystems and inhabitants (e.g., FOEI *et al.* 2018, 2019; FOEI, WWF, and Pacific Environment 2019). In addition to environmentalists, research organizations have become active. For instance, the US-based International Council on Clean Transportation (ICCT) gathered extensive knowledge about HFO and black carbon control measures (e.g., Comer *et al.* 2017; ICCT 2018). By injecting new knowledge into IMO negotiations, different civil society organizations complemented the studies carried out under the auspices of the Arctic Council.

In the business sector, some shipping actors decided to transition away from HFO in their Arctic operations. The first notable company to phase out HFO was the Norwegian expedition cruise operator Hurtigruten (2018: 14). Its decision reflected the need to comply with local HFO bans around Svalbard and concerns about public reputation in case of accidental fuel oil spillage. Other expedition cruise companies advertising a pristine Arctic to their customers, like Ponant (2020) from France, have followed Hurtigruten's example. The Association of Arctic Expedition Cruise Operators (AECO) also issued a recommendation for its members to

use distillate fuel in Arctic operations (AECO 2013: 4). In 2019, AECO turned this recommendation into a mandatory provision (AECO 2019). The expedition cruise sector was the first to demonstrate the feasibility of an HFO phaseout.

Business and civil society also joined forces. In 2018, the Clean Arctic Alliance together with Hurtigruten initiated the Arctic Commitment, which calls for an HFO phaseout in Arctic shipping (CAA 2018). The Arctic Commitment targets both the practices of shipping companies and international regulation by the IMO. Its signatories mainly come from environmental activism, academia, and the expedition cruise sector. Prominent supporters are the Icelandic ports and IKEA Supply. However, the Arctic Commitment has not found as much business support as its initiators may have hoped for. For instance, even the rather progressive shipowners' associations of Denmark and Norway have not signed it. Nevertheless, the initiative further increased public awareness of HFO risks. The Arctic Commitment also gave the small expedition cruise sector a visible platform for its use of less polluting fuels in contrast to the much larger overseas cruise sector.

A more far-reaching initiative of civil society and business is the Arctic Corporate Shipping Pledge. Since 2019, this initiative has committed member firms to refrain from using trans-Arctic shipping routes (Ocean Conservancy 2020). This limits future growth of HFO use and other adverse impacts of shipping on the Arctic environment. The Arctic Corporate Shipping Pledge was initiated by the environmental NGO Ocean Conservancy and the company Nike. Signatory companies include major shippers (e.g., Bestseller, Gap, H&M, and Li & Fung) and some of the world's largest container shipping companies (e.g., CMA CGM, MSC, Evergreen Line, and Hapag Lloyd). While this has been a setback for trans-Arctic shipping visions in the short to medium term, it appears questionable whether shipping companies can afford this pledge in the long run. Trans-Arctic routes may become more accessible and competitive in the future and other shipping companies, like the Chinese COSCO (*High North News* 2019), may be willing to exploit their advantages. This governance arrangement may thus not endure under global competition and continued environmental change. For now, however, the Arctic Corporate Shipping Pledge reduces the number of potential trans-Arctic shipping actors with an interest in blocking an HFO ban.

Pressure by environmental NGOs, mounting public attention, and new business opportunities have led more, but far from all, companies to end HFO use in Arctic operations. Targeted by the HFO-Free Arctic campaign, Crystal Cruises, Carnival Corporation, and Maersk declared to use alternatives to HFO in Arctic operations (*The Guardian* 2016; *World Maritime News* 2018; *Marine Insight* 2019). Other companies that have been moving into cleaner fuels include Hapag Lloyd Cruises (2019) and the Finnish ice-breaking company Arctia (2016). This development has not extended to all shipping segments though. Resupply shipping in Canada and Russia still uses HFO. The Russian Federation (2019: 30–31) noted that techno-economic barriers were preventing its relatively old Northern Supply fleet from switching to lighter fuels. Canada (2019: 7–11) stressed socio-economic reasons for the continued use of HFO in its Sealift operations. Similarly, bulk shipping of Arctic mining products relies on HFO to remain competitive on the world market. Both resupply and bulk shipping play special roles in the Arctic as fuel price increases may lead to higher consumer prices and loss of mining jobs and revenues. Environmental threats appear to be politically more accepted when originating from shipping segments with high strategic priority.

Collaborations of civil society, business, and states have not played a major role in governing HFO use. One initiative that includes representatives from all three types of actors is the Arctic

Shipping Best Practice Information Forum established by the Arctic Council. The forum primarily contributes to the implementation of the IMO Polar Code (Engtrø, Gudmestad and Njå 2020: 59). Furthermore, it makes progressive business actors like AECO visible. While not specifically focused on HFO, the forum is a channel for communicating green shipping advances.

The innovative governance responses of nonstate actors have interacted with international regulatory negotiations in the IMO. Knowledge provision by environmental NGOs drew non-Arctic states like Germany, France, and the Netherlands into the negotiations (cf. Denmark *et al.* 2019). Change in business practices played a crucial role in reducing potential opposition to a ban. Countries in which major shipping companies had gone green, including Finland, Norway, and the US, clearly supported a ban (cf. Finland *et al.* 2018). By contrast, the hesitance of resupply and bulk shipping to switch to cleaner fuels was mirrored in sceptical positions of Canada, Russia, and major non-Arctic flag states like the Marshall Islands (cf. Canada and Marshall Islands 2018; Russian Federation 2018). Hence, innovative governance responses by nonstate actors and their limitations foreshadowed the political compromises in the realm of traditional governance (see Table 20.2).

Table 20.2 Innovative governance responses to HFO use in Arctic shipping

Type of actors	Organization or initiative	Year	Governance response
Civil society	Environmental NGOs, Clean Arctic Alliance, research institutes (ICCT)	2010-	Knowledge generation, gathering, and dissemination on HFO use and risks
Business	Various companies (e.g., Arctia, Carnival Corp., Hurtigruten, Hapag Lloyd, Ponant, Maersk)	2007-	Voluntary phaseout of HFO from Arctic operations (sometimes in response to NGO or public pressure)
	Association of Arctic Expedition Cruise Operators (AECO)	≤2013	Voluntary operational guideline for member firms to use distillate fuel in the Arctic
		2019	No-HFO policy made mandatory for members
Civil society and business	Clean Arctic Alliance and Hurtigruten; other companies, AECO	2018-	Arctic Commitment: signatories call for phaseout of HFO
	Ocean Conservancy and Nike; other shippers and major shipping companies	2019-	Arctic Corporate Shipping Pledge: member firms do not use trans-Arctic shipping routes
States, business, civil society	Arctic Shipping Best Practice Information Forum of Arctic Council	2017-	Exchange about experiences and challenges in implementation of Polar Code, incl. safety

Source: Compiled by the author.

In sum, innovative governance responses by nonstate actors have fulfilled two functions. First, they have filled gaps left by traditional, state-led governance. Environmental NGOs put pressure on companies to reveal and justify their fuel choices. Commitments of business to phase out HFO or refrain from using Arctic shipping routes made shipping somewhat greener even in the absence of public regulation. Second, nonstate actors also injected new momentum into international regulatory negotiations. Knowledge gathering and dissemination by civil society organizations complemented the study activities of the Arctic Council. Moreover, green commitments of major companies reduced potential opposition to an HFO ban among IMO member states. Innovative, transnational governance initiatives were thus an important precursor to progress in traditional state-based regulation.

Conclusion

Observations on the governance of HFO use in Arctic shipping can inform the search for suitable governance models in other sea regions and marine issues. The Arctic is subject to rapid climate change which enables more economic activity and brings new environmental threats to the region's ecosystems and inhabitants. I used Arctic shipping growth as a case that involves increasing risks of accidental oil pollution and emissions of climate-forcing black carbon. Both threats could be mitigated by phasing out HFO as a ship fuel in the region. The case study examined how traditional governance responses by states and innovative governance responses involving nonstate actors have evolved and interacted. Without doubt, many specific elements of this case are unique to the Arctic and its climatic, economic, and navigational conditions. More generally, however, rapid warming has turned the Arctic into a laboratory for governing global environmental changes that may unfold in different forms and over longer time spans in other sea regions, too (see Chapters 17, 18 and 25).

So, what can researchers and practitioners learn from the Arctic laboratory for governing environmental change? I propose three lessons that also add to ideas on how to use the United Nations Decade of Ocean Science for Sustainable Development (2021-2030) (Claudet *et al.* 2020). First, do not wait for states to respond. Traditional governance responses by states have emerged only slowly and left important policy gaps. Domestic responses have not been comprehensive enough to govern changes extending beyond national borders. Regional and global responses have been hampered by the many diverging interests in the cumbersome search for political compromise. One should therefore not overestimate the capacity of states to quickly respond to new problems in marine ecosystems. Other actors need to fill the gaps left by traditional governance.

Second, mobilize nonstate actors for rapid responses to new ocean challenges. Innovative governance responses involving civil society and business actors have evolved in a flexible way and filled policy gaps left by states. Environmental NGOs and research institutes have facilitated decision-making of states by gathering and disseminating knowledge. Even more importantly, they have reached out to business in search for pragmatic ways to improve environmental performance. Several business actors have assumed the role of green leaders that go beyond regulatory compliance. Green leadership by companies, in turn, has reduced barriers to an agreement among states on regulatory responses. Innovative, transnational governance arrangements of nonstate actors can facilitate traditional governance responses by states.

Third, develop systematic linkages between innovative and traditional forms of governance. The sequence identified in this case study only worked because of sufficient links between green business practices and regulatory negotiations of states. The consultative status of civil

society organizations and business actors in international organizations like the IMO is an important institutional element in this respect. Forums fostering exchange between practice and policy may be another useful building block. Yet, these institutional links do not appear sufficient for kick-starting and maintaining dynamic governance sequences. Public attention has strongly contributed to company decisions to phase out HFO in Arctic shipping. Likewise, it has created pressures for states to address the issue using available expertise from civil society and business. Hence, both the public and different types of actors need to be mobilized to successfully govern the challenges of global change in marine environments.

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References

Abbott, K. W. (2012) 'The transnational regime complex for climate change', *Environment and Planning C: Government and Policy*, 30(4), pp. 571–590.

Abbott, K. W. and Snidal, D. (2009) 'The governance triangle: Regulatory standards institutions and the shadow of the state', in Mattli, W. and Woods, N. (eds) *The politics of global regulation*. Princeton, NJ: Princeton University Press, pp. 44–88.

AECO. (2013) 'AECO's guidelines for expedition cruise operations in the Arctic'.

AECO. (2019) *Expedition cruise industry charts course for sustainable Arctic tourism*, *Press releases*. Available at: https://www.aeco.no/2019/11/expedition-cruise-industry-charts-course-for-sustainable-arctic-tourism/ (Accessed: 31 May 2021).

AMAP. (2021) *Arctic climate change update 2021: Key trends and impacts. Summary for policymakers*. Oslo: Arctic Monitoring and Assessment Programme (AMAP). Available at: https://www.amap.no/documents/doc/arctic-climate-change-update-2021-key-trends-and-impacts.-summary-for-policy-makers/3508 (Accessed: 24 May 2021).

Andonova, L. B., Betsill, M. M. and Bulkeley, H. (2009) 'Transnational climate governance', *Global Environmental Politics*, 9(2), pp. 52–73.

Arctia. (2016) *Next-generation icebreaker Polaris ready for action*, *News*. Available at: http://arctia.fi/en/2016/10/31/next-generation-icebreaker-polaris-ready-for-action/ (Accessed: 2 February 2020).

Auld, G. (2014) *Constructing private governance: The rise and evolution of forest, coffee, and fisheries certification*. New Haven, CT: Yale University Press.

Bai, J. and Chircop, A. (2020) 'The regulation of heavy fuel oil in arctic shipping: Interests, measures, and impacts', in Chircop, A. *et al.* (eds.) *Governance of Arctic shipping*: *Rethinking risk, human impacts and regulation*. Cham: Springer, pp. 265–284.

Bognar, D. (2018) 'Russia and the polar marine environment: The negotiation of the environmental protection measures of the mandatory Polar Code', *Review of European, Comparative & International Environmental Law*, 27(1), pp. 35–44.

Brewer, T. L. (2019) 'Black carbon emissions and regulatory policies in transportation', *Energy Policy*, 129, pp. 1047–1055.

CAA. (2018) 'The arctic commitment'. Available at: https://www.hfofreearctic.org/wp-content/uploads/2018/01/The-Arctic-Commitment-text-EN.pdf (Accessed: 31 May 2021).

Canada. (2019) 'Assessment of the benefits and impacts associated with a ban on the use and carriage of heavy fuel oil as fuel by ships operating in the Arctic'. PPR 7/INF.16.

Canada and Marshall Islands. (2018) 'Comments on document MEPC 72/11/1 on measures to reduce risks of use and carriage of heavy fuel oil as fuel by ships in Arctic waters'. MEPC 72/11/4.

Cashore, B. *et al.* (2021) 'Private authority and public policy interactions in global context: Governance spheres for problem solving', *Regulation & Governance*, Early view online. Available at: https://onlinelibrary.wiley.com/doi/abs/10.1111/rego.12395 (Accessed: 25 May 2021).

Chircop, A. (2020) 'The polar code and the arctic marine environment: Assessing the regulation of the environmental risks of shipping', *The International Journal of Marine and Coastal Law*, 35(3), pp. 533–569.

Claudet, J. *et al.* (2020) 'A roadmap for using the UN decade of ocean science for sustainable development in support of science, policy, and action', *One Earth*, 2(1), pp. 34–42.

Comer, B. *et al.* (2017) *Prevalence of heavy fuel oil and black carbon in Arctic shipping, 2015 to 2025*. Washington, DC: ICCT. Available at: https://theicct.org/sites/default/files/publications/HFO-Arctic_ICCT_Report_01052017_vF.pdf (Accessed: 18 August 2019).

Comer, B. *et al.* (2020) *The international maritime organization's proposed Arctic heavy fuel oil ban: Likely impacts and opportunities for improvement*. White Paper. Washington, DC: ICCT, p. 46. Available at: https://theicct.org/sites/default/files/publications/Arctic-HFO-ban-sept2020.pdf (Accessed: 31 May 2021).

Dawson, J. *et al.* (2018) 'Temporal and spatial patterns of ship traffic in the Canadian Arctic from 1990 to 2015', *Arctic*, 71(1), pp. 15–26.

Denmark *et al.* (2019) 'Draft language for a ban of use and carriage of heavy fuel oil as fuel by ships in Arctic waters'. PPR 7/14/4.

DeSombre, E. R. (2000) *Domestic sources of international environmental policy: Industry, environmentalists, and U.S. power*. Cambridge, MA: MIT Press.

DNV. (2011) *Heavy fuel in the Arctic (Phase I)*. Akureyri: PAME.

DNV. (2013) *Heavy fuel in the Arctic - Phase II*. 2013-1542-16G8ZQC-5/1. Høvik.

Engtrø, E., Gudmestad, O. T. and Njå, O. (2020) 'Implementation of the polar code: Functional requirements regulating ship operations in polar waters', *Arctic Review*, 11, pp. 47–69.

Euractiv. (2020) 'Norway plans heavy oil ban around Svalbard', 9 November. Available at: https://www.euractiv.com/section/energy/news/norway-plans-heavy-oil-ban-around-svalbard/ (Accessed: 28 May 2021).

Finland *et al.* (2018) 'Proposal to ban heavy fuel oil use and carriage as fuel by ships in Arctic waters'. MEPC 72/11/1.

FOEI *et al.* (2010) 'Additional MARPOL provisions for the Polar Code'. DE 54/13/8.

FOEI *et al.* (2013) 'Heavy fuel oil use by vessels in Arctic waters'. DE 57/11/11.

FOEI *et al.* (2018) 'Residuals bunker fuel ban in the IMO Arctic waters – an assessment of costs and benefits'. PPR 6/INF.25.

FOEI *et al.* (2019) 'Infographic on reducing Black Carbon emissions from international shipping'. MEPC74/INF.31.

FOEI, WWF, and Pacific Environment (2019) 'Arctic Indigenous Support for the Ban of Heavy Fuel Oil in the Arctic'. PPR 7/14/1.

Fritt-Rasmussen, J. *et al.* (2018) *Heavy Fuel Oil (HFO): A review of fate and behaviour of HFO spills in cold seawater, including biodegradation, environmental effects and oil spill response*. 549. Copenhagen: Nordic Council of Ministers. Available at: http://urn.kb.se/resolve?urn=urn:nbn:se:norden:org:diva-5380 (Accessed: 24 May 2021).

Green, J. F. (2013) *Rethinking private authority: Agents and entrepreneurs in global environmental governance*. Princeton, NJ: Princeton University Press.

Gunnarsson, B. (2021) 'Recent ship traffic and developing shipping trends on the Northern Sea Route—Policy implications for future arctic shipping', *Marine Policy*, 124, 104369.

Hale, T. (2020) 'Transnational actors and transnational governance in global environmental politics', *Annual Review of Political Science*, 23, pp. 203–220.

Hapag-Lloyd Cruises. (2019) *The Hapag-Lloyd Cruises' fleet is set to operate without heavy fuel oil - Hapag-Lloyd Cruises, Press Releases*. Available at: https://www.hl-cruises.de/presse/pressemeldungen/detail/the-hapag-lloyd-cruises-fleet-is-set-to-operate-without-heavy-fuel-oil (Accessed: 13 January 2020).

Harris, P. G. (2019) 'Climate change at sea: Interactions, impacts, and governance', in Harris, P. G. (ed.) *Climate change and ocean governance: Politics and policy for threatened seas*. Cambridge: Cambridge University Press, pp. 3–26.

Harrison, K. and Sundstrom, L. M. (2010) *Global commons, domestic decisions: The comparative politics of climate change*. Cambridge, MA: MIT Press.

Henson, S. A. *et al.* (2017) 'Rapid emergence of climate change in environmental drivers of marine ecosystems', *Nature Communications*, 8(1), 14682.

High North News. (2019) 'Chinese shipping company COSCO to send record number of ships through arctic', 13 June. Available at: https://www.highnorthnews.com/en/chinese-shipping-company-cosco-send-record-number-ships-through-arctic (Accessed: 31 May 2021).

Hofmann, B. (2019) 'Policy responses to new ocean threats: Arctic warming, maritime industries and international environmental regulation', in Harris, P. G. (ed.) *Climate change and ocean governance: Politics and policy for threatened seas*. Cambridge: Cambridge University Press, pp. 215–235.

Hofmann, B. (2021) *Arguing over technology: The coproduction of business practices and international maritime environmental regulation*. Dissertation, University of St. Gallen.

Hurtigruten. (2018) 'Environmental Report 2017'. Available at: https://secure.viewer.zmags.com/publication/72ebfbed#/72ebfbed/1 (Accessed: 2 February 2020).

ICCT. (2018) *Workshop summary: Fifth ICCT workshop on marine black carbon emissions: Appropriate black carbon control measures*. San Francisco: International Council on Clean Transportation. Available at: https://theicct.org/sites/default/files/Workshop%20summary_5th%20ICCT%20BC%20workshop_vf_rev4.pdf (Accessed: 18 August 2019).

IMO. (2015) 'Resolution MEPC.264(68): International Code for ships operating in polar waters (polar code)'.

IMO. (2017) 'Report of the Marine Environment Protection Committee on its Seventy-First Session'. MEPC 71/17.

IMO. (2020) 'Report to the Marine Environment Protection Committee'. PPR7/22.

IMO. (2021) 'Report to the Marine Environment Protection Committee'. PPR8/13.

IMO Secretariat. (2021) 'Draft amendments to MARPOL Annex I'. MEPC76/3/1.

IPCC. (2019) *IPCC Special report on the ocean and cryosphere in a changing climate*. [Pörtner, H.-O. *et al.* (eds.)]. Intergovernmental Panel on Climate Change.

Janssen, N. A. H. *et al.* (2012) *Health effects of black carbon*. Bonn: WHO European Centre for Environment and Health.

Keil, K. (2019) 'Sustainability understandings of Arctic shipping', in Gad, U. P. and Strandsbjerg, J. (eds) *The politics of sustainability in the Arctic: Reconfiguring identity, space, and time*. London: Routledge, pp. 34–51.

Kwok, R. (2018) 'Arctic sea ice thickness, volume, and multiyear ice coverage: Losses and coupled variability (1958–2018)', *Environmental Research Letters*, 13(10), 105005.

Lasserre, F. (2019) 'Arctic shipping: A contrasted expansion of a largely destinational market', in Finger, M. and Heininen, L. (eds) *The globalarctic handbook*. Cham: Springer, pp. 83–100.

Mahon, R. and Fanning, L. (2019) 'Regional ocean governance: Polycentric arrangements and their role in global ocean governance', *Marine Policy*, 107, 103590.

Marine Insight. (2019) 'Carnival makes bombshell claim to only use cleaner fuel on cruise ships in arctic', 12 March. Available at: https://www.marineinsight.com/shipping-news/carnival-makes-bombshell-claim-to-only-use-cleaner-fuel-on-cruise-ships-in-arctic/ (Accessed: 29 August 2019).

Mendenhall, E. (2019) 'The ocean governance regime: International conventions and institutions', in Harris, P. G. (ed.) *Climate change and ocean governance: Politics and policy for threatened seas*. Cambridge: Cambridge University Press, pp. 27–42.

Mitchell, R. B. *et al.* (2020) 'What we know (and could know) about international environmental agreements', *Global Environmental Politics*, 20(1), pp. 103–121.

Norwegian Ministry of Justice and Public Security. (2017) 'Svalbard. Meld. St. 32 (2015–2016) Report to the Storting (white paper)'.

Notz, D. and SIMIP Community. (2020) 'Arctic sea ice in CMIP6', *Geophysical Research Letters*, 47(10), e2019GL086749.

Ocean Conservancy. (2020) *Take the arctic corporate shipping pledge, protecting the arctic*. Available at: https://oceanconservancy.org/protecting-the-arctic/take-the-pledge/ (Accessed: 11 June 2020).

PAME. (2010) 'Working Group Meeting Report PAME I-2010'.

PAME. (2012) 'Working Group Meeting Report PAME I-2012'.

Ponant. (2020) *Environment, Ponant*. Available at: https://au.ponant.com/why-ponant/environment/ (Accessed: 13 January 2020).

Prior, S. and Walsh, D. (2018) 'A vision for a heavy fuel oil-free arctic', *Environment: Science and Policy for Sustainable Development*, 60(6), pp. 4–11.

Rayfuse, R. (2014) 'Coastal state jurisdiction and the polar code: A test case for Arctic Ocean governance?', in Stephens, T. and VanderZwaag, D. L. (eds) *Polar oceans governance in an era of environmental change*. Cheltenham: Edward Elgar, pp. 235–252.

Russian Federation. (2018) 'Comments on the document with the proposal to ban heavy fuel oil use and carriage as fuel by ships in Arctic waters (MEPC 72/11/1)'. MEPC 72/11/3.

Russian Federation. (2019) 'Impact Assessment Report'. PPR7/INF.13.

Schaffrin, A., Sewerin, S. and Seubert, S. (2014) 'The innovativeness of national policy portfolios – climate policy change in Austria, Germany, and the UK', *Environmental Politics*, 23(5), pp. 860–883.

Stokke, O. S. (2013) 'Regime interplay in Arctic shipping governance: explaining regional niche selection', *International Environmental Agreements: Politics, Law and Economics*, 13(1), pp. 65–85.

The Guardian. (2016) 'Large cruise ship voyage through Arctic ice rekindles rows', 13 August. Available at: https://www.theguardian.com/environment/2016/aug/13/large-cruise-ship-voyage-arctic-ice-crystal-cruises (Accessed: 7 February 2020).

Theocharis, D. *et al.* (2018) 'Arctic shipping: A systematic literature review of comparative studies', *Journal of Transport Geography*, 69, pp. 112–128.

World Maritime News. (2018) 'Venta Maersk starts historic arctic voyage using ultra-low sulphur fuel', 23 August. Available at: https://worldmaritimenews.com/archives/259311/venta-maersk-starts-historic-arctic-voyage-using-ultra-low-sulphur-fuel/ (Accessed: 9 February 2020).

Young, O. R. (2014) 'The effectiveness of international environmental regimes: Existing knowledge, cutting-edge themes, and research strategies', in Betsill, M. M., Hochstetler, K., and Stevis, D. (eds) *Advances in international environmental politics*. 2nd edn. Basingstoke: Palgrave Macmillan, pp. 273–299.

Zelli, F., Möller, I. and Asselt, H. van (2017) 'Institutional complexity and private authority in global climate governance: The cases of climate engineering, REDD+ and short-lived climate pollutants', *Environmental Politics*, 26(4), pp. 669–693.

Zhang, Q. *et al.* (2019) 'Reducing black carbon emissions from arctic shipping: Solutions and policy implications', *Journal of Cleaner Production*, 241, 118261.