The Law-Science Interface in the Arctic: Science and the Law of the Sea

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Abstract

Law and science are both crucial for effective and legitimate decision-making in the Arctic. Yet their interaction is not always successful. This contribution discusses the various ways in which the law of the sea interacts with science in the geographical context of the Arctic, by looking at the references to science in the text of the United Nations Convention on the Law of the sea; the influence of scientific developments and/or new scientific knowledge on the interpretation and application of the United Nations Convention on the Law of the Sea; and the way in which the United Nations Convention on the Law of the Sea regulates science. It concludes by analysing the interactions between law and science in the Arctic in light of Luhmann's systems theory, by comparing the two bodies of knowledge to autopoietic, operationally closed, but cognitively open, systems.

Keywords

law of the sea – science – Arctic – law-science interface – Luhmann

1 Introduction

Law and science are both crucial for decision-making in the Arctic.[1] Law, together with policy, regulates activities in the Arctic, and the protection and conservation of the area and its resources. One of the main legal instruments in this regard is the United Nations Convention on the Law of the Sea (UNCLOS).[2] Science, on the other hand, provides essential knowledge that informs law and

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[1] According to Norchi and Mayewski, in the Arctic context, 'science vividly interacts with law and the policies it expresses.' Charles H. Norchi and Paul A. Mayewski, 'The Arctic: Science, Law, and Policy', *Ocean and Coastal Law Journal* 22 (2017): 98.

[2] United Nations Convention on the Law of the Sea, December 10, 1982, 1833 UNTS 397.

policy.[3] Science has always played an important role in Arctic governance,[4] but this is especially true in light of climate change and the recognized vulnerability of the Arctic region. Academic literature is beginning to recognize the importance of science in legal and political decision-making.[5] Yet law and science are two different creatures. Where law favours stability and predictability, science is based upon the premises of innovation and change. Law prescribes how society ought to function, whereas science observes how the world actually operates.[6] Due to the differences between the two bodies of knowledge and the crucial role both law and science play in Arctic governance, it is important to understand how law and science interact, rather than simply observing that they do.

This contribution first discusses the law-science interface in the Arctic (Section 2). This section looks at the ways in which the Arctic legal framework reflects the role and importance of science, how this is true for the law of the sea in particular, and introduces three different kinds of interaction between law and science within the law of the sea. Sections 3-5 each discuss one kind of interaction between law and science. Section 3 focuses on the references to science in the text of the UNCLOS, Section 4 discusses the influence of scientific developments and/or new knowledge on the law of the sea, and Section 5 describes the ways in which the UNCLOS regulates the conduct of science. Section 6 then analyses the interaction between law and science, and discusses to what extent these interactions may be successful, or whether structural preconditions exist that limit meaningful interaction between the two bodies of knowledge. Section 7 concludes this contribution.

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[3] According to Gao, marine scientific research in the Arctic is 'essential for understanding and mitigating environmental change in both the Arctic and any other given region of the world', because of the Arctic's 'extreme' vulnerability to climate change and because changes in the Arctic impact other regions in the world. Zhiguo Gao, 'Legal Issues of MSR in the Arctic: A Chinese Perspective', in *Arctic Science, International Law and Climate Change: Legal Aspects of Marine Science in the Arctic Ocean*, ed. Susanne Wasum-Rainer, Ingo Winkelmann, and Katrin Tiroch, Beiträge Zum Ausländischen Öffentlichen Recht Und Völkerrecht (Berlin, Heidelberg: Springer, 2012), 141.

[4] According to Jacobsson, scientific activities 'have always played a role in the drawing of the Arctic legal and political map'. She further writes that science was used to 'prove' presence, 'provide evidence in connection with geographical disputes', and that scientific activities have 'served as a currency and a management tool'. M Jacobsson, 'International Law and Scientific Research in the Arctic - The Role of Science in Law and the Role of Law in Science', *Zeitschrift Für Ausländisches Öffentliches Recht Und Völkerrecht* 69 (2009): 684.

[5] See for example Susanne Wasum-Rainer, Ingo Winkelmann, and Katrin Tiroch, eds., *Arctic Science, International Law and Climate Change*, Beiträge Zum Ausländischen Öffentlichen Recht Und Völkerrecht (Berlin, Heidelberg: Springer, 2012); Froukje Maria Platjouw, Eirik Hovland Steindal, and Trude Borch, 'From Arctic Science to International Law: The Road towards the Minamata Convention and the Role of the Arctic Council', *Arctic Review on Law and Politics* 9 (2018): 226–243; Jacobsson, 'International Law and Scientific Research in the Arctic - The Role of Science in Law and the Role of Law in Science'. Another example is the 'Policy-Law-Science Nexus in Polar Regions' Panel of the 13th Polar Law Symposium (November 2020).

[6] Sheila Jasanoff, 'The Intersections of Science and Law', in *Science at the Bar: Law, Science, and Technology in America*, Reprint edition (Cambridge, Mass: Harvard University Press, 1997), 7; Cedric Charles Gilson, *The Law-Science Chasm: Bridging Law's Disaffection with Science as Evidence* (New Orleans, Louisiana: Quid Pro, LLC, 2012), 32; Hilde Woker, 'Interactions between Law and Science within the Law of the Sea: A Systems Theory Perspective', in *The Law of the Sea: Normative Context and Interactions with Other Legal Regimes*, ed. Nele Matz-Lück, Øystein Jensen, and Elise Johansen (Routledge, forthcoming).

2 The Law-Science Interface in the Arctic

Many legal instruments that are applicable in the Arctic reflect the law-science interface. Many of these instruments refer to science, establish scientific bodies or institutions, and/or encourage States to take into account scientific information in legal and political decision-making. This applies both to agreements that are specifically applicable in the Arctic as well as to those agreements that apply more generally but also to the Arctic.

For example, the three polar bear agreements applicable in the Arctic each emphasize the importance of science. The Agreement on the Conservation of Polar Bears (1973) requires Contracting Parties to manage polar bear populations in accordance with 'sound conservation practices on the *best available scientific data*'.[7] It prohibits the taking of polar bears except for certain circumstances, which includes the taking of polar bears for 'bona fide scientific purposes'.[8] It also requires Contracting Parties to conduct research programmes on polar bears, and to coordinate and exchange such research amongst the Parties.[9] The Inuvialuit-Inupiat Polar Bear Management Agreement in the Southern Beaufort Sea (2000) encourages 'the collection of adequate scientific, traditional, and technical information' to facilitate management decisions.[10] It furthermore subjects the annual sustainable harvest of polar bears to an annual review of scientific evidence, and provides for the exchange of information and research plans.[11] The Agreement between the Government of the United States of America and the Government of the Russian Federation on the Conservation and Management of the Alaska-Chukotka Polar Bear Population (2000) recognizes that 'reliable biological information', including 'scientific data', 'serves as the basis for development of an effective strategy' for the conservation and management of the Alaska-Chukotka polar bear population.[12] It defines "sustainable harvest level" by reference to 'reliable scientific information'; it allows for the taking of polar bears for the conduct of scientific research (consistent with the 1973 Agreement); and it establishes a joint commission that determines 'on the basis of reliable scientific data' the polar bear population's annual sustainable harvest level, considers scientific research programmes, examines scientific data, and establishes a scientific working group.[13]

Other regional Arctic treaties and institutions also reflect the law-science interface. In 2017, the eight Arctic governments signed the Agreement on Enhancing International Arctic Scientific Cooperation.[14] The purpose of this agreement is 'to enhance cooperation in Scientific Activities in order to increase effectiveness and efficiency in the development of scientific knowledge about the

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[7] Agreement on the Conservation of Polar Bears, November 15, 1973, 2898 UNTS 243, Article II (emphasis added).

[8] Agreement on the Conservation of Polar Bears, Article I(1); Article III(1)(a).

[9] Agreement on the Conservation of Polar Bears, Article VII.

[10] Inuvialuit-Inupiat Polar Bear Management Agreement in the Southern Beaufort Sea, March 4, 2000, Article II(d).

[11] Inuvialuit-Inupiat Polar Bear Management Agreement in the Southern Beaufort Sea, Article III(d); Article IV(c).

[12] Agreement between the Government of the United States of America and the Government of the Russian Federation on the Conservation and Management of the Alaska-Chukotka Polar Bear Population, October 16, 2000, preamble.

[13] Agreement between the Government of the United States of America and the Government of the Russian Federation on the Conservation and Management of the Alaska-Chukotka Polar Bear Population, Article I; Article 6(2); Article 8(7)(b); Article 8(7)(f); Article 8(7)(i); Article 8(8).

[14] Agreement on Enhancing International Arctic Scientific Cooperation, May 11, 2017.

Arctic'.[15] In 2018, several Arctic and non-Arctic States (including the European Union) concluded the Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean.[16] The Agreement encourages the conduct of scientific research and establishes a Joint Program of Scientific Research and Monitoring aimed to increase knowledge of the living marine resources and ecosystems of the Central Arctic Ocean.[17] The Agreement also obliges the Parties to review the implementation of the Agreement and to consider whether commercial fisheries are sustainable in the Central Arctic Ocean taking into account scientific information derived from the Joint Program or otherwise.[18] The OSPAR Convention, which is applicable to the European part of the Arctic region, also obliges Contracting Parties to establish complementary or joint programmes of scientific or technical research, and to transmit the results of such and other relevant research to the OSPAR Commission.[19] The Spitsbergen Treaty, which applies specifically to the Svalbard area, recognized in 1925 the 'utility' of establishing an international meteorological station, although this station has never been established, and calls for the conclusions of conventions laying down the conditions under which scientific investigations may be conducted in the Svalbard area.[20]

Furthermore, the Arctic Council – the intergovernmental forum crucial for Arctic legal and political decision-making – includes various scientific institutions. The six working groups of the Arctic council (ACAP, AMAP, CAFF, EPPR, PAME and SDWG)[21] are engaged in scientific research of which the outcomes are relevant for Arctic legal and political decision-making. In addition, Arctic governance benefits from the International Arctic Science Committee (IASC), which aims to encourage and facilitate cooperation in all aspects of Arctic research.[22] Other regional scientific

[15] Agreement on Enhancing International Arctic Scientific Cooperation, Article 2.

[16] Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean, October 3, 2018. The Parties to this agreement are: Canada, the People's Republic of China, the Kingdom of Denmark in respect of the Faroe Islands and Greenland, Iceland, Japan, the Republic of Korea, the Kingdom of Norway, the Russian Federation, the United States of America and the European Union.

[17] Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean, Article 3(2); Article 4(1).

[18] Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean, Article 5(1)(c).

[19] Convention for the Protection of the Marine Environment of the North-East Atlantic, September 22, 1992, 2354 UNTS 67, Article 8.

[20] Treaty between Norway, The United States of America, Denmark, France, Italy, Japan, the Netherlands, Great Britain and Ireland and the British Overseas Dominions and Sweden Concerning Spitsbergen Signed in Paris 9th February 1920, Article 5.

[21] The official names of the working groups are: Arctic Contaminants Action Program (ACAP), Arctic Monitoring and Assessment Programme (AMAP), Conservation of Arctic Flora and Fauna (CAFF), Emergency Prevention, Preparedness and Response (EPPR), Protection of the Arctic Marine Environment (PAME), and Sustainable Development Working Group (SDWG). For more information, see 'The Arctic Council', Arctic Council, accessed 23 February 2021, https://arctic-council.org/en/.

[22] 'About IASC - International Arctic Science Committee', accessed 23 February 2021, https://iasc.info/iasc/about-iasc. See also Yoshinobu Takei, 'Marine Scientific Research in the Arctic', in *The Law of the Sea and the Polar Regions: Interactions between Global and Regional Regimes*, ed. Erik J. Molenaar, Alex G. Oude Elferink, and Donald R. Rothwell, vol. 76, Publications on Ocean Development (Leiden | Boston: Martinus Nijhoff Publishers, 2013), 354–55.

bodies whose geographic coverage extend to parts of the marine Arctic are the International Council for the Exploration of the Sea (ICES), and the North Pacific Marine Science Organization (PICES).[23]

In addition to these regional Arctic agreements and institutions, the Arctic is also governed by international legal instruments that apply to the Arctic. These agreements also often reflect the law-science interface. For example, the Convention on Biological Diversity requires Contracting Parties to '[e]stablish and maintain programmes for scientific and technical education', to promote 'international technical and scientific cooperation', and establishes the Subsidiary Body on Scientific, Technical and Technological Advice.[24] Another international agreement that applies to the Arctic is MARPOL, the IMO Convention for the prevention of pollution from ships.[25] Article 17 of the amended MARPOL Convention calls upon States Parties to the Convention to promote support for technical assistance for the training of scientific and technical personnel, and the encouragement of research.[26] Furthermore, Annex III of MARPOL allows for the prohibition for carriage of certain harmful substances, 'for sound scientific and technical reasons'.[27] And finally, the Arctic is governed by the UNCLOS.

Unlike the Antarctic (land surrounded by water), the Arctic region is a marine area surrounded by land. Thus, the UNCLOS is an important legal instrument in Arctic governance. Indeed, the Arctic States recognized the importance of the UNCLOS in the Illullisatt Declaration.[28] Like other legal instruments applicable in the Arctic, the UNCLOS reflects the law-science interface.[29] The UNCLOS is thus a useful case study to understand the law-science interface and the interactions between science and law in the Arctic.

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[23] 'About ICES - International Council for the Exploration of the Sea', accessed 27 February 2021, https://www.ices.dk/about-ICES/Pages/default.aspx; 'About Us - PICES - North Pacific Marine Science Organization', accessed 27 February 2021, https://meetings.pices.int/about. See also Takei, 'Marine Scientific Research in the Arctic', 359–62; Betsy Baker, 'ICES, PICES, and the Arctic Council Task Force on Arctic Marine Cooperation', *UC Irvine Law Review* 6 (2016): 1–22.

[24] Convention on Biological Diversity, June 5, 1992, 1760 UNTS 79, Article 12(a); Article 18(1); Article 25.

[25] International Convention for the Prevention of Pollution from Ships (MARPOL 1973) as Modified by the Protocol 1978 Relating Thereto, February 17, 1978, 1340 UNTS 61.

[26] International Convention for the Prevention of Pollution from Ships (MARPOL 1973) as modified by the Protocol 1978 relating thereto, Article 17.

[27] International Convention for the Prevention of Pollution from Ships (MARPOL 1973) as modified by the Protocol 1978 relating thereto, Annex III, Regulation 6.

[28] Ilulissat Declaration, May 28, 2008.

[29] See for example Woker, 'Interactions between Law and Science within the Law of the Sea: A Systems Theory Perspective'; Pieter Bekker and Robert van de Poll, 'Unlocking the Arctic's Resources Equitably: Using a Law-and-Science Approach to Fix the Beaufort Sea Boundary', *The International Journal of Marine and Coastal Law* 35, no. 2 (26 September 2019): 163–200, https://doi.org/10.1163/15718085-23441076; Satya Nandan, 'The Relationship Between the United Nations Convention on the Law of the Sea and Developments in Science and Technology', in *New Developments in Marine Science and Technology: Economic, Legal and Political Aspects of Change: Proceedings of the 22nd Annual Conference of the Law of the Sea Institute*, ed. Lewis M. Alexander, Scott Allen, and Lynne Carter Hanson (Honolulu: Law of the Sea Institute, 1988); Christopher K. Vanderpool, 'Marine Science and the Law of the Sea', *Social Studies of Science* 13, no. 1 (1 February 1983): 107–29, https://doi.org/10.1177/030631283013001006.

Interactions between law and science occur in many areas of the law of the sea, such as the delineation and delimitation of maritime zones,[30] fisheries management, the protection and preservation of the marine environment, the deep seabed mining regime, marine scientific research, the development and transfer of technology, and dispute settlement.[31] Throughout these areas of the law of the sea, one may identify three different kinds of interaction between law and science within the law of the sea.[32] First, one observes textual references to science or scientific terms throughout the text of the UNCLOS. Secondly, scientific developments and/or new scientific knowledge may influence the development, application, or interpretation of the UNCLOS. Thirdly, the UNCLOS also regulates the conduct of science by setting out parameters for marine scientific research and the development and transfer of technology. All of these kinds of interactions are directly relevant to the Arctic. The following sections discuss these three kinds of interaction as observed in the Arctic.

3 References to Science in UNCLOS

The first form of interaction between law and science occurs when the UNCLOS refers to scientific information, concepts, or knowledge in the text of the UNCLOS. There are many scientific references in the Convention. These can be explicit references, referring explicitly to "science"; implicit references, terms that do not refer to science directly, but for which one must turn to science to interpret them; or "borrowed" references, when the UNCLOS borrows terms from the natural sciences. Explicit references include 'best scientific evidence available',[33] 'marine scientific research',[34] 'marine biology',[35] and 'study'.[36] These examples directly refer to scientific knowledge, processes or studies. Examples of implicit references to science are 'harm to the marine environment',[37] 'maximum sustainable yield',[38] and perhaps 'conservation'[39] and 'preservation'.[40] An example of a "borrowed" reference is the 'continental shelf'.[41] The reference to science in the

[30] See for example Bekker and Poll, 'Unlocking the Arctic's Resources Equitably'.

[31] See David Anderson, 'Scientific Evidence in Cases Concerning the Law of the Sea', in *Modern Law of the Sea: Selected Essays*, vol. 59, Publications on Ocean Development (Leiden | Boston: Martinus Nijhoff Publishers, 2008), 569–76; Tullio Treves, 'Law and Science in the Jurisprudence of the International Tribunal for the Law of the Sea', in *Science, Technology, and New Challenges to Ocean Law*, ed. Harry N. Scheiber, James Kraska, and Moon-Sang Kwon (Brill Nijhoff, 2015), 13–26.

[32] See Woker, 'Interactions between Law and Science within the Law of the Sea: A Systems Theory Perspective'.

[33] United Nations Convention on the Law of the Sea, Article 61(2); Article 119(1)(a); Article 234. Note the difference between 'best scientific evidence available' in Articles 61(2) and 119(1)(a) and 'best available scientific evidence' in Article 234.

[34] United Nations Convention on the Law of the Sea, Part XIII.

[35] United Nations Convention on the Law of the Sea, Article 277(a).

[36] United Nations Convention on the Law of the Sea, Preamble, Fourth Recital; Article 65; Article 277.

[37] See for example United Nations Convention on the Law of the Sea, Article 145; Article 234; Article 290.

[38] United Nations Convention on the Law of the Sea, Article 61(3); Article 119(1)(a).

[39] See for example United Nations Convention on the Law of the Sea, Preamble, Fourth Recital; Article 21(1)(d); Articles 61-66; Articles 117-120; Article 123(a); Article 145(b); Article 150.

[40] See generally United Nations Convention on the Law of the Sea, Part XIII.

[41] United Nations Convention on the Law of the Sea, Article 76. In the case of the continental shelf, the legal concept of the continental shelf differs from the scientific concept of the continental shelf. In other words, once the scientific

UNCLOS encompasses the reference to a multitude of natural sciences, including mathematics, geography, hydrography, geology, and biology.

References to science, whether explicit, implicit or "borrowed" terms, can be found throughout the entire Convention, and occur in most areas of the law of the sea described above. As the entire UNCLOS is applicable to the Arctic, these scientific references thus also apply to the Arctic. However, there is one specific article that is especially relevant to the Arctic: Article 234. Article 234 is situated within Part XII of the UNCLOS, concerned with the protection and preservation of the marine environment. It is also called the "Arctic exception",[42] and allows for coastal States with ice-covered areas to establish more stringent environmental protection measures than otherwise allowed for.

Article 234 reads as follows:

> Coastal States have the right to adopt and enforce non-discriminatory laws and regulations for the prevention, reduction and control of *marine pollution* from vessels in *ice-covered areas* within the limits of the exclusive economic zone, where *particularly severe climatic conditions* and the *presence of ice* covering such areas for most of the year create obstructions or exceptional hazards to navigation, and *pollution of the marine environment* could cause *major harm to or irreversible disturbance of the ecological balance*. Such laws and regulations shall have due regard to navigation and the protection and preservation of the marine environment based on the *best available scientific evidence*.[43]

Many of the terms in this article (those italicized) directly refer to science or are terms for which we need to resort to science to understand their meaning.

For example, "marine pollution" is defined in the UNCLOS as 'the introduction by man [...] of substances or energy into the marine environment' which may result in 'such deleterious effects as harm to living resources and marine life, hazards to human health, and 'impairment of quality for use of sea water'.[44] This definition itself includes scientific terms. Other scientific references in Article 234 are "ice-covered areas" and the "presence of ice". Although uncertainty remains as to the precise meaning of ice coverage especially in light of climate change,[45] it is likely that some kind of

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concept of the continental shelf entered the legal arena, it obtained a specific legal definition that, despite having scientific roots, developed differently. For more on this topic, see Hilde Juliette Woker, 'The Law-Science Interface within the Law of the Sea: A Case Study of the Continental Shelf' (A dissertation for the degree of Philosophiae Doctor, Tromsø, UiT - The Arctic University of Norway, 2021).

[42] Kristin Bartenstein, 'The "Arctic Exception" in the Law of the Sea Convention: A Contribution to Safer Navigation in the Northwest Passage?', *Ocean Development & International Law* 42, no. 1–2 (17 February 2011): 22–52, https://doi.org/10.1080/00908320.2011.542104; D. McRae, 'The Negotiation of Article 234', in *Politics of the Northwest Passage*, ed. f. Griffiths (Kingston and Montreal: McGill-Queen's University Press, 1987), 98–114.

[43] United Nations Convention on the Law of the Sea, Article 234 (emphasis added).

[44] United Nations Convention on the Law of the Sea, Article 1(4).

[45] Viatcheslav Gavrilov, Roman Dremliuga, and Rustambek Nurimbetov, 'Article 234 of the 1982 United Nations Convention on the Law of the Sea and Reduction of Ice Cover in the Arctic Ocean', *Marine Policy* 106 (1 August 2019): 103518, https://doi.org/10.1016/j.marpol.2019.103518; Roman Dremliuga, 'A Note on the Application of Article 234 of the Law of the Sea Convention in Light of Climate Change: Views from Russia', *Ocean Development & International Law* 48,

scientific assessment is required to determine the presence of ice.[46] The same is true for "particularly severe climatic conditions" and "major harm to or irreversible disturbance of the ecological balance". These terms do not refer to science explicitly but require scientific information and assessments to determine whether the threshold of these terms has been met. Finally, Article 234 provides that the laws and regulations enacted in accordance with Article 234 must be based on the "best available scientific evidence". This is a direct reference to science and suggests that the data used as evidence in support of the laws and regulations adopted pursuant to Article 234 is obtained as a result of 'rigorous scientific methods'.[47]

4 Influence of Scientific Developments and/or New Knowledge

The second form of interaction between law and science in the UNCLOS concerns the influence of scientific developments and/or new scientific knowledge on the UNCLOS.[48] Historically, 'science and technology have been among the major drivers of the law of the sea'.[49] Indeed, developments in science and technology were an important reason for the adoption of the UNCLOS. In the aftermath of the 1958 Geneva Convention on the law of the sea, developments in science and technology opened up the oceans, the seabed and subsoil to a 'mode and rate of exploitation hitherto undreamed of.'[50] In this context, Ambassador Arvid Pardo of Malta famously argued that the mineral

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no. 2 (3 April 2017): 128–35, https://doi.org/10.1080/00908320.2017.1290486; Ryan O'Leary, 'Protecting the Arctic Marine Environment: The Limits of Article 234 and the Need for Multilateral Approaches', *Journal of Environmental Law and Practice* 23, no. 3 (2012): 287–304.

[46] However, for an alternative view, see Gavrilov, Dremliuga, and Nurimbetov, 'Article 234 of the 1982 United Nations Convention on the Law of the Sea and Reduction of Ice Cover in the Arctic Ocean'; Dremliuga, 'A Note on the Application of Article 234 of the Law of the Sea Convention in Light of Climate Change'. These authors argue that the term "ice-covered" was chosen to 'divide the Arctic from other vulnerable zones or special areas', and that it was a 'legal technicality, rather than an intention to link the special legal regime in the Arctic with the condition of ice coverage in the Arctic Ocean'.

[47] Jan Solski, 'Russian Coastal State Jurisdiction over Commercial Vessels Navigating the Northern Sea Route' (A dissertation for the degree of Philosophiae Doctor, Tromsø, UiT - The Arctic University of Norway, 2018), 181–82. According to Proelss' commentary on the law of the sea, this requirement obliges the coastal State 'to justify its actions, based on scientific studies suitable'. Erik Franckx and Laura Boone, 'Article 234', in *United Nations Convention on the Law of the Sea: A Commentary*, ed. Alexander Proelss (Munich, Germany: BECK, 2017), 1580.

[48] See Joseph W Dellapenna, 'Law in a Shrinking World: The Interaction of Science and Technology with International Law', *Kentucky Law Journal* 88 (2000): 832 who asserts: 'Science and technology have changed the ends pursued by international law, the means available to international law for pursuing those ends, and the structure of international law itself.'

[49] Jin-Hyun Paik, 'Disputes Involving Scientific and Technical Matters and the International Tribunal for the Law of the Sea', in *New Knowledge and Changing Circumstances in the Law of the Sea*, ed. Tomas Heidar, Publications on Ocean Development 92 (Leiden, The Netherlands: Brill Nijhoff, 2020), 15.

[50] Jens Evensen, 'The Effect of the Law of the Sea Conference upon the Process of the Formation of International Law: Rapprochement between Competing Points of View', in *The Developing Order of the Oceans* (*Proceedings of the 18th Annual Conference of the Law of the Sea Institute*), ed. R.B. Krueger and S.A. Riesenfeld (Honolulu: Law of the Sea Institute, University of Hawaii), 24. See also Nandan, 'The Relationship Between the United Nations Convention on the Law of the Sea and Developments in Science and Technology', 7; and generally, M. W. Mouton, 'The Impact of Science on

resources of the seabed should be declared the common heritage of mankind.[51] His speech triggered the UN General Assembly to convene a third UN Conference on the Law of the Sea (UNCLOS III), which adopted the UNCLOS in 1982.

Thus, the law of the sea has always responded to scientific developments, new knowledge and changing circumstances. This is still true today, and especially relevant in an Arctic context. One example is that of climate change. The Arctic 'is probably the region in the world most affected by climate change'.[52] Global warming has led to reductions in Arctic sea ice extent and thickness.[53] New shipping routes will become available in the Arctic, challenging the adequacy of the current legal regime.[54] Due to the decrease of sea ice it may become possible to access previously inaccessible areas containing hydrocarbon resources.[55] Furthermore, sea level rise may challenge existing baselines begging the question whether the extent of the maritime entitlements will also change.[56] Warming of the oceans due to climate change may also lead to fish stocks moving to higher latitudes or to different areas, which may challenge the current regulatory framework.[57] Climate change – as an example of scientific developments, new knowledge and changing circumstances – can thus be

International Law (Volume 119)', *Collected Courses of the Hague Academy of International Law*, 31 December 1966, 194–203; Dellapenna, 'Law in a Shrinking World', 839–40.

[51] See UNGA, 'Note Verbale Dated 17 August 1967 from the Permanent Mission of Malta to the United Nations Addressed to the Secretary-General', 18 August 1967.

[52] Elise Johansen and Tore Henriksen, 'Climate Change and the Arctic: Adapting to Threats and Opportunities in Arctic Marine Waters', in *Research Handbook on Climate Change, Oceans and Coasts*, ed. Jan McDonald, Jeffrey McGee, and Richard Barnes (Cheltenham, UK: Edward Elgar Publishing, 2020), 239.

[53] H-O Pörtner et al., eds., 'Summary for Policymakers', in *IPCC Special Report on the Ocean and Cryosphere in a Changing Climate*, 2019, A.1.

[54] Rosemary Rayfuse, 'Climate Change and the Poles', in *Research Handbook on Polar Law*, ed. Karen N. Scott and David L. VanderZwaag (Cheltenham, UK: Edward Elgar Publishing Limited, 2020), 415; Elise Johansen, 'Climate Change and the Arctic: Legal Regulations in Changing Times', in *The Marine Environment and United Nations Sustainable Development Goal 14: Life Below Water*, ed. Myron H. Nordquist, John Norton Moore, and Ronán Long, vol. 22, Center for Oceans Law and Policy (Leiden ; Boston: Brill | Nijhoff, 2018), 381; Rosemary Rayfuse, 'Climate Change and the Law of the Sea', in *International Law in the Era of Climate Change*, ed. Rosemary Rayfuse and Shirley V. Scott (Cheltenham, UK: Edward Elgar Publishing Limited, 2012), 158.

[55] Johansen, 'Climate Change and the Arctic', 373.

[56] See for example Clive Schofield, 'Holding Back the Waves? Sea Level Rise and Maritime Claims', in *Climate Change: International Law and Global Governance: Legal Responses and Global Responsibility*, ed. O.C. Ruppel, C. Roschmann, and K. Ruppel-Schlichting, vol. 1, 2013, 593–614; Signe Veierud Busch, 'Sea Level Rise and Shifting Maritime Limits: Stable Baselines as a Response to Unstable Coastlines', *Arctic Review* 9 (22 June 2018): 174–94, https://doi.org/10.23865/arctic.v9.1162; Signe Veierud Busch, 'Law of the Sea Responses to Sea-Level Rise and Threatened Maritime Entitlements: Applying an Exception Rule to Manage an Exceptional Situation', in *The Law of the Sea and Climate Change: Solutions and Constraints*, ed. Elise Johansen, Signe Busch, and Ingvild Ulrikke Jakobsen (Cambridge, United Kingdom ; New York, NY: Cambridge University Press, 2020).

[57] Rayfuse, 'Climate Change and the Law of the Sea', 159–61; Jóhann Sigurjónsson, 'Changes in Distribution and Migration of Fish Stocks in the Northeast Atlantic Ocean Due to Climate Variations', in *Challenges of the Changing Arctic: Continental Shelf, Navigation, and Fisheries*, ed. Myron H. Nordquist, John Norton Moore, and Ronán Long, Center for Oceans Law and Policy 19 (Leiden | Boston: Brill Nijhoff, 2016), 405–28; Johansen, 'Climate Change and the Arctic', 379–80.

seen as a 'motivating and/or normative factor' in the development and application of the legal regime applicable to the Arctic.[58]

The legal initiative concerning the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (the BBNJ process) is also an example of this form of interaction between law and science.[59] After a lengthy preliminary and preparatory process, an international governmental conference has been initiated to negotiate a new implementing agreement to the UNCLOS, which has as one of its goals to regulate marine genetic resources. We only know about these resources due to developments in science and technology. The BBNJ process is thus another example of the influence of scientific developments and/or new scientific knowledge on the UNCLOS. As large parts of the Arctic region are areas beyond national jurisdiction, this legal initiative – and the law-science interface it represents – is applicable to the Arctic.[60]

There are other examples in which developments in science and technology have challenged the existing legal provisions or have led to new interpretations. For example, there are new ways to conduct marine scientific research in the Arctic, which were not envisioned at the time of drafting the UNCLOS.[61] As new scientific and technological developments emerge, the UNCLOS may be challenged and it will need to respond accordingly.

5 Regulation of Science by UNCLOS

The third form of interaction between law and science within the law of the sea concerns the regulation of science. Not only does the UNCLOS refer to science, or is it influenced by developments in science and technology; it also actively regulates how science is conducted.[62] Law is 'instrumental' in producing and certifying new types of scientific knowledge, and 'constructs the very environment in which science and technology come to have meaning, utility, and force'.[63]

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[58] Rayfuse, 'Climate Change and the Poles', 415.

[59] For the latest updates, see UN, 'Intergovernmental Conference on Marine Biodiversity of Areas Beyond National Jurisdiction', accessed 24 February 2021, https://www.un.org/bbnj/.

[60] See for example Vito De Lucia et al., 'Arctic Marine Biodiversity in the High Seas between Regional and Global Governance', *Arctic Review* 9 (3 December 2018): 264–66, https://doi.org/10.23865/arctic.v9.1470.

[61] See for example Hilde Woker et al., 'The Law of the Sea and Current Practices of Marine Scientific Research in the Arctic', *Marine Policy* 115 (1 May 2020): 103850, https://doi.org/10.1016/j.marpol.2020.103850; Katharina Bork et al., 'The Legal Regulation of Floats and Gliders—In Quest of a New Regime?', *Ocean Development & International Law* 39, no. 3 (6 August 2008): 298–328, https://doi.org/10.1080/00908320802235338; Tobias Hofmann and Alexander Proelss, 'The Operation of Gliders Under the International Law of the Sea', *Ocean Development & International Law* 46, no. 3 (3 July 2015): 167–87, https://doi.org/10.1080/00908320.2015.1053374.

[62] McEldowney and McEldowney submit that 'the interrelationship between science and law does not solely rest on science influencing environmental regulation and law, but that developments in environmental law and policy can push science forward.' John McEldowney and Sharron McEldowney, 'Science and Environmental Law: Collaboration across the Double Helix', *Environmental Law Review* 13 (2011): 185. See also Vanderpool, 'Marine Science and the Law of the Sea', 125 for an overview of the impact of law on science.

[63] Sheila Jasanoff, 'Making Order: Law and Science in Action', in *The Handbook of Science and Technology Studies*, ed. Edward J. Hackett et al., 3rd ed. (Cambridge: MIT Press, 2007), 779; Sheila Jasanoff, *Science at the Bar: Law, Science, and Technology in America*, Reprint edition (Cambridge, Mass: Harvard University Press, 1997), 16.

The UNCLOS sets out a legal framework for the conduct of marine scientific research and the transfer of technology. This is especially notable in Part XIII on marine scientific research and in Part XIV on the development and transfer of marine technology. Yet, there are other provisions throughout the UNCLOS that also regulate the conduct of science, for example in Part XI on the Area,[64] or in Part XII on the conduct of environmental impact assessments and monitoring.[65]

Frequently, these provisions simply encourage, facilitate, or promote the conduct of marine scientific research or the development and transfer of technology.[66] These provisions usually do not prescribe *what* the science or technology should look like. They are simply obligations of conduct. For example, Articles 238 and 239 recognize the right to conduct marine scientific research, and the obligation to promote and facilitate the development and conduct of marine scientific research; Article 240 sets out general principles for the conduct of marine scientific research; Article 246 establishes the consent regime for research activities in the EEZ or on the continental shelf of coastal States; and Articles 248 and 249 provide the duty to comply with certain conditions (such as to provide information, access for the coastal State, and the removal of research equipment).[67] Before the adoption of the Arctic Science Agreement, this resulted in regulatory inconsistency in the Arctic.[68] The five Arctic coastal States each claim to be in accordance with the UNCLOS, but the degree to which researchers were notified of decisions or granted permission varied from State to State.[69] Hopefully, the Arctic Science Agreement will improve access for research in the Arctic as well as increase regulatory consistency amongst the Arctic States.

In addition to provisions that encourage, facilitate, or promote the conduct of science, other provisions reference the qualification of science, such as '*best available* scientific evidence',[70] or

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[64] United Nations Convention on the Law of the Sea, Article 143.

[65] United Nations Convention on the Law of the Sea, Articles 204-206.

[66] See for example United Nations Convention on the Law of the Sea, Preamble, Fourth Recital; Article 61; Article 119; Article 143; Article 144; Article 202; Article 238; Article 239; Article 243; Article 244; Article 246; Article 252; Article 255; Article 266; Article 268; Article 269; Articles 275-277; Annex II, Article 3; Annex III, Article 2; Annex III, Article 5; Annex III, Article 13; Annex III, Article 15. However, there are also some provisions that may limit the conduct of marine scientific research, when the UNCLOS balances this activity with others. See for example United Nations Convention on the Law of the Sea, Article 240 (providing that marine scientific research shall not "unjustifiably" interfere with other legitimate uses of the seas and oceans), Articles 245 and 246 (requiring consent from the coastal State for marine scientific research in its maritime zones), and Article 19 (providing that the carrying out of research or survey activities is considered non-innocent passage).

[67] United Nations Convention on the Law of the Sea, Article 238-239; Article 240; Article 246; Article 248-249.

[68] Betsy Baker, 'Common Precepts of Marine Scientific Research Access in the Arctic', in *Arctic Science, International Law and Climate Change: Legal Aspects of Marine Science in the Arctic Ocean*, ed. Susanne Wasum-Rainer, Ingo Winkelmann, and Katrin Tiroch, Beiträge Zum Ausländischen Öffentlichen Recht Und Völkerrecht (Berlin, Heidelberg: Springer, 2012), 210, https://doi.org/10.1007/978-3-642-24203-8_20; Takei, 'Marine Scientific Research in the Arctic', 350.

[69] Baker, 'Common Precepts of Marine Scientific Research Access in the Arctic', 209–10.

[70] United Nations Convention on the Law of the Sea, Article 61(2); Article 119(1)(a); Article 234 (emphasis added). Again, note the difference between 'best scientific evidence available' in Articles 61(2) and 119(1)(a) and 'best available scientific evidence' in Article 234.

'*appropriate* scientific methods and means'.[71] Here, the UNCLOS does not merely regulate the *conduct* of science, but also the *content* of the science that is required in some UNCLOS contexts. These provisions add a qualifying threshold to the conduct and use of marine scientific research. Not just any scientific evidence should be taken into account, only the "best available". Marine scientific research should not be carried out by any scientific method and means, only those that are "appropriate". The UNCLOS, however, does not clarify what these qualifying terms mean. In the Arctic, where the unique circumstances of the region call for the use of novel technologies (such as remote sensing or floating ice-tethered observatories) to conduct marine scientific research, the interpretation of "appropriate" may require an evolutionary interpretation.[72] It remains unclear what the criteria are for determining whether scientific evidence is "best available", or whether scientific methods and means are "appropriate".[73] Despite these uncertainties, it is clear that the law of the sea – in addition to referring to science and being influenced by it – also regulates both the conduct and quality of science to some extent.

6 Interactions between Law and Science: (un)Successful?

The sections above explain how science and the law of the sea interact in the Arctic. The sections highlight the complexity of the law-science interface within the law of the sea in an Arctic context. Although law and science often interact, it is clear that there are challenges inherent to those interactions. Sometimes, law-science interactions result in non-alignment between law and science, miscommunication, or friction. Examples are the use of scientific evidence or experts in dispute settlement procedures, the (mis)translation of scientific terms or concepts into law (such as the "continental shelf"), or the notion that law is slow to respond to new scientific developments (such as the discovery of marine genetic resources in hydrothermal vents).[74] One of the main problems within the law-science interface is the translation of scientific information to law.

How can we account for the miscommunication between law and science? Are there any structural preconditions preventing meaningful interaction between the two bodies of knowledge? According to Luhmann and his systems theory, law and science may be considered as two functionally differentiated, autopoietic, operationally closed, systems of society.[75] Each system fulfils

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[71] United Nations Convention on the Law of the Sea, Article 240(b) (emphasis added).

[72] Woker et al., 'The Law of the Sea and Current Practices of Marine Scientific Research in the Arctic'.

[73] For a discussion on the meaning of 'appropriate scientific methods and means', see Alfred H.A. Soons, *Marine Scientific Research and the Law of the Sea* (Deventer, The Netherlands: Kluwer Law And Taxation Publishers, 1982), 136; Nele Matz-Lück, 'Article 240', in *United Nations Convention on the Law of the Sea: A Commentary*, ed. Alexander Proelss (Munich, Germany: BECK, 2017). A further ambiguity is the lack of a definition of "marine scientific research". See for example Takei, 'Marine Scientific Research in the Arctic', 346.

[74] An exception is the Central Arctic Ocean Fisheries Agreement, as it adopts a precautionary approach and establishes a ban on commercial fishing in the Central Arctic Ocean, before scientific knowledge is conclusive on whether or not those commercial fisheries are viable. See *supra* n 16.

[75] See generally Niklas Luhmann, *Social Systems* (Stanford, California: Stanford University Press, 1995); Niklas Luhmann, *Introduction to Systems Theory*, ed. Dirk Baecker, trans. Peter Gilgen (Cambridge, UK ; Malden, MA: Polity Press, 2012); Niklas Luhmann, *Theory of Society, Volume 1*, trans. Rhodes Barrett (Redwood City, United States: Stanford University

a different function in society;[76] each is autopoietic and thus self-defining and self-referential;[77] and each system is surrounded by an environment to which it is operationally closed.[78] In fact, each system is defined by its distinction from its environment because it communicates in a distinct language (a binary code) and filters out anything that does not "fit" within this binary code.[79] According to Luhmann, the system of law only communicates in the binary code of legal/illegal,[80] whereas the system of science communicates in the binary code of true/false.[81] This would mean that no system would be able to communicate with any other system of society.

However, Luhmann submits that despite (or because of) the operational closure of the systems of law and science, they are cognitively open.[82] This means that the systems may be able to interact with each other through their respective environments. A system may interact with its environment (which includes other systems), but throughout this interaction, each system sees the other system (or the environment) only through its own lens. Thus when law interacts with "science", it actually only interacts with the image of science it has created for itself.[83] This means that law and science 'see things differently and there is no possibility of one system being able to internalize the world-view of another' – it is only able to internalize 'according to its own "way of seeing" of what it understands from the communications of the other system.'[84] This is an important realization in the context of law-science interactions in the Arctic, as it may explain possible miscommunication between the two bodies of knowledge. Interactions between law and science may occur through "irritations" offered by the system of science to the system of law.[85] When the law of the sea responds to "irritations" (such as sea level rise, or the discovery of marine genetic resources) offered by science, it does not interpret those "irritations" in the context in which they are offered (namely the scientific context). Rather, the legal system interprets those "irritations" within the legal context, which could lead to different results.

Press, 2012); Niklas Luhmann, *Ecological Communication* (Cambridge: Polity Press, 1989). For further elaboration, see Woker, 'The Law-Science Interface within the Law of the Sea: A Case Study of the Continental Shelf', Chapter 4.

[76] Michael King and Chris Thornhill, *Niklas Luhmann's Theory of Politics and Law* (Basingstoke: Palgrave Macmillan, 2003), 11.

[77] For a discussion of the meaning of the term 'autopoiesis', see Luhmann, *Introduction to Systems Theory*, 76–83.

[78] See Luhmann, 77.

[79] Luhmann, *Social Systems*, 17. The binary code represents the way in which systems like law and science 'structure their communication through a binary or dual-valued code that, from the viewpoint of its specific function, claims universal validity and excludes further possibilities.' Luhmann, *Ecological Communication*, 36.

[80] Luhmann, *Ecological Communication*, 64; Niklas Luhmann, *Law as a Social System* (Oxford: Oxford University Press, 2004), 100.

[81] Luhmann, *Ecological Communication*, 76.

[82] Luhmann, *Law as a Social System*, 105.

[83] Jasanoff also recognizes that 'the image of science the law defers to is importantly a construct of the legal process itself.' Jasanoff, 'Making Order: Law and Science in Action', 771.

[84] King and Thornhill, *Niklas Luhmann's Theory of Politics and Law*, 27.

[85] See Luhmann, *Theory of Society, Volume 1*, 66–67. Luhmann also employs different terms to refer to the same or similar effects, such as "disturbance", "stimulus", or "perturbation". See for example Luhmann, *Introduction to Systems Theory*, 89.

Analysing the interface between the law of the sea and science in light of Luhmann's systems theory explains why communication between science and law may not always be successful, and why it is difficult to transform scientific information into effective legal and political decision-making. Although Luhmann's theory is both complex and abstract, and not without criticism,[86] it is his ability to explain the aspects of miscommunication between law and science that makes his theory relevant for an analysis of the law-science interface. It offers a way of explaining why scientific knowledge may not always translate well into a legal setting (and vice versa), or why lawyers and scientists may have difficulties understanding each other.

7 Conclusion

From a legitimacy perspective, it is vital that law and policy in the Arctic are based upon, informed by, and compatible with science. This contribution has showcased the law-science interface in the Arctic, and discussed three ways in which the law of the sea interacts with science. These interactions are not always successful, and this may be explained by Luhmann's systems theory. The interaction between science and law may be seen as an asymptotic relationship, where the two bodies of knowledge will never completely meet. However, it is still possible to push the two closer together. This is extremely important, especially in the polar regions.

Often, debates about the science-policy interface discuss how scientific research results (from all scientific disciplines) are used in legal and political decision-making. However, it is also important to investigate the "other" side of the interface, namely: what happens within law and policy when they are faced with such scientific information? How can legal and political decision-makers interpret those scientific research results, and what are the tools available for interaction? Bridging the gap between law and science requires awareness of the different functions of the two bodies of knowledge in society, their differences and similarities, and their respective inherent assumptions and languages. We are only able to effectively improve the relationship between law and science once we understand the opportunities and challenges of their relationship. It is this understanding that the present contribution has aimed to further explain and analyse.

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[86] For an overview of some of the criticisms to his theory, see King and Thornhill, *Niklas Luhmann's Theory of Politics and Law*, ch. 6. See also Christian Borch, *Niklas Luhmann* (Abingdon, Oxon ; New York: Routledge, 2011), 137–40; Michael King, 'What's the Use of Luhmann's Theory?', in *Luhmann on Law and Politics: Critical Appraisals and Applications*, ed. Michael King and Chris Thornhill (Oxford - Portland Oregon: Hart Publishing, 2006).

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