Informed Decisionmaking for Sustainability

Paul Arthur Berkman · Alexander N. Vylegzhanin · Oran R. Young
David Balton · Ole Øvretveit *Editors*

Building Common Interests in the Arctic Ocean with Global Inclusion

Volume 2

This book contains an inclusive compilation of perspectives about the Arctic Ocean with contributions that extend from Indigenous residents and early career scientists to Foreign Ministers, involving perspectives across the spectrum of subnational-national-international jurisdictions. The Arctic Ocean is being transformed with global climate warming into a seasonally ice-free sea, creating challenges as well as opportunities that operate short-to-long term, underscoring the necessity to make informed decisions across a continuum of urgencies from security to sustainability time scales. The Arctic Ocean offers a case study with lessons that are especially profound at this moment when humankind is exposed to a pandemic, awakening a common interest in survival across our globally-interconnected civilization unlike any period since the Second World War. This second volume in the Informed Decisionmaking for Sustainability series reveals that building global inclusion involves common interests to address changes effectively *"for the benefit of all on Earth across generations."*

ISBN 978-3-030-89311-8

#2

▸ springer.com

Berkman · Vylegzhanin · Young · Balton · Øvretveit *Eds.*

Building Common Interests in the Arctic Ocean with Global Inclusion

Informed Decisionmaking for Sustainability

Paul Arthur Berkman
Alexander N. Vylegzhanin
Oran R. Young · David Balton
Ole Øvretveit *Editors*

Building Common Interests in the Arctic Ocean with Global Inclusion

Volume 2

Science Diplomacy Center™ EvREsearch®

Springer

Chapter 1
Introduction: Building Common Interests with Informed Decisionmaking for Sustainability

Paul Arthur Berkman, Oran R. Young, Alexander N. Vylegzhanin, David A. Balton, and Ole Rasmus Øvretveit

Abstract This chapter introduces conceptual threads woven within and between the chapters, applying the book title as the organizing framework and the Arctic as a case study with global relevance. The book focuses on science diplomacy and its engine of informed decisionmaking together with the theory, methods and skills introduced in view of BUILDING COMMON INTERESTS. As an exemplar, the ARCTIC OCEAN highlights holistic (international, interdisciplinary and inclusive) integration with marine and surrounding terrestrial systems interacting with humanity at local-global levels, especially in relation to Earth's changing climate. The importance of this book is WITH GLOBAL INCLUSION, recognizing challenges to engage diverse stakeholders, rightsholders and other actors, as illustrated with special respect for the Indigenous peoples who have inhabited the Arctic for millennia with resilience across ice ages

P. A. Berkman (✉)
Science Diplomacy Center, EvREsearch LTD and MGIMO University, Moscow, Russian Federation AU1

United Nations Institute for Training and Research (UNITAR), Geneva, Switzerland

Program on Negotiation at Harvard Law School, Harvard University, Falmouth, MA, USA
e-mail: paul.berkman@unitar.org; pberkman@law.harvard.edu

O. R. Young
Bren School of Environmental Science & Management, University of California Santa Barbara, Santa Barbara, CA, USA
e-mail: oran.young@gmail.com

A. N. Vylegzhanin
International Law School, MGIMO University, Moscow, Russian Federation
e-mail: danilalvy@mail.ru

D. A. Balton
Polar Institute, Wilson Center, Washington, DC, USA
e-mail: davebalton@comcast.net

O. R. Øvretveit
Initiative West Bergen, Bergen, Norway
e-mail: ole@initiativvest.no

P. A. Berkman et al. (eds.), *Building Common Interests in the Arctic Ocean with Global Inclusion*, Informed Decisionmaking for Sustainability,
https://doi.org/10.1007/978-3-030-89312-5_1

and past periods of global warming. The goal of this book on BUILDING COMMON INTERESTS IN THE ARCTIC OCEAN WITH GLOBAL INCLUSION (involving contributions from graduate students to foreign ministers at the *Arctic Frontiers* 2020 conference) is to help produce informed decisions that operate short-to-long term at local-global levels *for the benefit of all on Earth across generations.*

1.1 Building Common Interests

1.1.1 Science as the 'Study of Change'

We are living during a complex period in human history, reflecting our evolution as a **globally-interconnected civilization**.[1] The book series on INFORMED DECISIONMAKING FOR SUSTAINABILITY is conceived to offer lessons that have **local-global** relevance *"for the benefit of all on Earth across generations"* (Berkman et al., 2017, 2020a; Berkman 2018, 2019, 2020a, b; Young et al., 2020a, b).

This volume on BUILDING COMMON INTERESTS IN THE ARCTIC OCEAN WITH GLOBAL INCLUSION is second in the book series and linked to others with **holistic** (international, interdisciplinary and inclusive) integration. On this journey, VOLUME 1. GOVERNING ARCTIC SEAS: REGIONAL LESSONS FROM THE BERING STRAIT AND BARENTS SEA introduced the concept of **'ecopolitical'** to elevate the focus on our homes ('eco') above the geopolitical fray of nations (Table 1.1).

In the book series, the first three volumes are a trilogy with the Arctic Ocean as a global case-study to elaborate decisionmaking with holistic integration (Fig. 1.1). The Arctic Ocean is international unlike the surrounding national territories on land, involving areas within and beyond sovereign jurisdictions with impacts, issues and resources in constant motion. Dynamics of the Arctic Ocean system as an integral part of our globally-interconnected civilization are a portrait of change with interdisciplinary analogues elsewhere on Earth in view of diverse time and space scales, revealed with natural and social sciences along with Indigenous knowledge. Importantly, the Arctic Ocean represents an inclusive journey of common-interest building, considering most immediately the eight Arctic States and six Indigenous Peoples Organizations that established the Arctic Council in 1996 as high-level forum (Ottawa Declaration 1996), progressively engaging non-Arctic States and other observers.

This book connects to the third volume (Pan-Arctic Implementation of Coupled Governance and Infrastructure) with the goal of contributing to decisionmaking for sustainable development in the Arctic, where progress is measured across generations on a Pan-Arctic scale. The intergenerational feature of sustainable development underlies the quest to operate short-to-long term inclusively. Moreover, like the Earth system with its local-global connections, Pan-Arctic progress involves

[1] **Highlighted terms** in Chapter 1 involve definitions to avoid jargon with concepts that are threaded through this book series.

Table 1.1 Holistic characteristics of ecopolitical regions with informed decisionmaking to couple governance mechanisms and built infrastructure for sustainable development[a]

Ecopolitical region characteristics	Bering Strait Region (BeSR)	Barents Sea Region (BaSR)
International	Russian Federation and United States	Russian Federation and Norway
Local-global connections	Maritime ship-traffic gateway	Marine living and mineral resources
Cultural and historical heritage	Small predominantly Indigenous communities	Large populations with settler majorities and close links to national governments
System dimensions for comparisons over time and space	Regions defined explicitly within polygon boundaries that are mapped	
Operating across a 'Continuum of urgencies'	Informed decisionmaking at security to sustainability time scales with skills, methods and theory that are being applied, trained and refined	
Common-interest building	Skill to facilitate inclusive dialogues among allies and adversaries alike	
Holistic integration	Skill to be international, interdisciplinary and inclusive	

[a]This table is adapted from the concluding chapter in Governing Arctic Seas: Regional Lessons from the Bering Strait and Barents Sea. Volume 1. Informed Decisionmaking for Sustainability (Young et al., 2020a)

cooperation and coordination among stakeholders, rightsholders and other actors within as well as between regions inclusively (Fig. 1.1). Inclusion is the biggest challenge, considering the temporal and spatial scope for sustainability from diverse perspectives that ultimately translate into actions. With contributions from the 2020 *Arctic Frontiers* conference in Tromsø, Norway (Arctic Frontiers 2020a, b; Steinveg 2020), this book seeks to be inclusive, exploring cooperation and coordination to achieve Arctic sustainability from diverse perspectives with global relevance.

Organization of this introductory chapter corresponds with phrases in the book title – Building Common Interests / In the Arctic Ocean / With Global Inclusion – to elaborate the theory, methods and skills that are intertwined across the contributions (please see the *Preface*). What do ecology, ecosystems and economics have in common (Table 1.1)? Practical answers to such questions emerge with science, which starts with curiosity and inquiry, elaborated into ways of knowing. With this objective, the natural sciences, social sciences and Indigenous knowledge all reveal patterns, trends and processes (albeit with different methodologies) that become the bases for decisions across our globally-interconnected civilization (Fig. 1.2a-d).

As an umbrella concept across knowledge systems, **science** can be characterized broadly as the 'study of change' (symbolized by the Greek letter delta Δ) to be holistic (Berkman et al., 2020; Berkman, 2020a, b), considering biophysical and socioeconomic factors as well as their intersections. This umbrella characterization of science builds on Socratic methods of learning that are stimulated by questions with the human quest for knowledge to understand our world and its relative motions

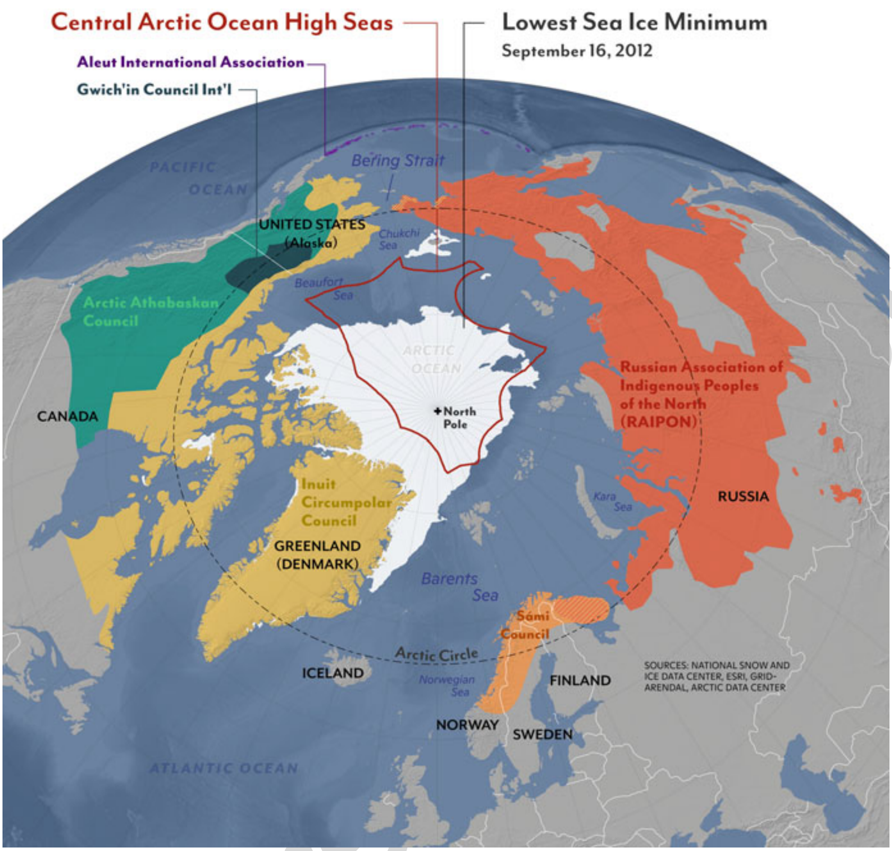

Fig. 1.1 The Arctic Ocean System with its holistic (international, interdisciplinary and inclusive) dimensions surrounding the North Pole is being transformed with climate warming as its surface boundary changes from permanent sea-ice cover to seasonally open water between the North Pacific and North Atlantic, as illustrated with the lowest sea-ice minimum observed during the satellite era (NASA 2012). The superimposed legal boundary of the high seas in the Central Arctic Ocean (CAO) illustrates connections between biogeophysical and socioeconomic dynamics with the maritime Arctic associated with *"sustainable development and environmental protection"* as *"common Arctic issues"* among all signatories of the *Ottawa Declaration* (1996) that established the Arctic Council. To be inclusive, the eight Arctic states (north of the Arctic Circle) and six Indigenous Peoples Organizations who established the Arctic Council are shown together. Mapping of the Indigenous Peoples Organizations has been co-produced iteratively with feedback from the Indigenous Peoples Secretariat (2021a, b) and in cooperation with GRID-Arendal (2021). The resulting polygon shape files have deposited with the Arctic Data Center for open access (Fiske 2021).

(Lucretius 55 BCE) with implications for societal development at all levels (Ruffert & Steinecke, 2011). In this book and in the series on INFORMED DECISIONMAKING FOR SUSTAINABILITY, science is illustrated as an unifying framework to operate with inclusion across time and space, especially in view of urgencies.

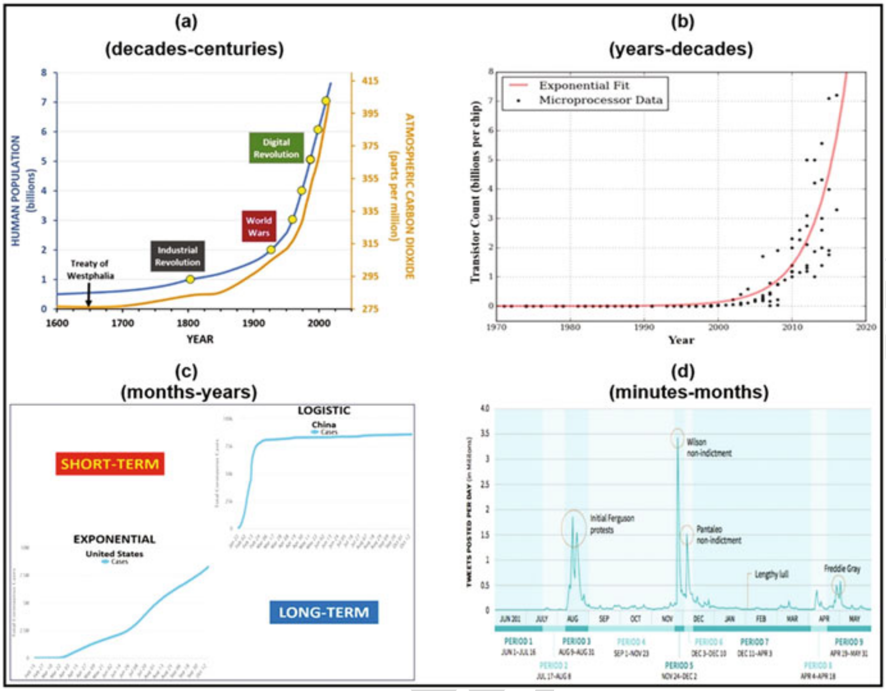

Fig. 1.2 Globally-Interconnected Civilization Times Scales revealed by exponential changes with: (**a**) Climate and human-population change over decades to centuries; (**b**) High-technology change over years to decades illustrated by "Moore's Law" with transistors on a chip; (**c**) Global pandemic change over months to years with COVID-19 cases accelerating across the Earth, illustrated by the United States (scale of 10,000,000–10^7) in contrast to China (scale of 100,000–10^5) through 12 October 2020, as recorded by *Worldometer*; and (**d**) Social-media change over minutes to months in relation to specific events, illustrated by 2014–2015 tweets about "Black Lives Matter", posted per day (in millions), as reported in *Mother Jones* on 13 March 2016. Adapted from Berkman et al. (2020) and Berkman (2020b).

Moreover, to be objective requires understanding about the dynamics of issues, impacts and resources in relation to defined systems, which is the reason the first volume in this book series focused on regional lessons. In this second volume, there is emphasis to further consider the temporal domain in view of the Arctic Ocean, especially to make **informed decisions**, operating across a **'continuum of urgencies'** (Vienna Dialogue Team, 2017; Berkman et al., 2017, 2020; Berkman, 2019, 2020a, b).

How can we study change to characterize a 'continuum of urgencies'? How can we place the present in context of the past and future? Answers to both of these questions are revealed with 'The Pandemic Lens' (Fig. 1.3), placing our world today in context across embedded time scales that all operate on a planetary scale with the common driver of our global human population (Fig. 1.2a-d). With science as the 'study of change,' we can describe as well as respond to the biophysical and socioeconomic dynamics that influence our home on Earth.

1.1.2 *Operating Across a 'Continuum of Urgencies'*

Working from first principles in view of humankind on a planetary scale, the shape of urgent change involves exponential rates at the time scales of minutes-months, month-years, years-decades and decades-centuries (Fig. 1.2a-d). Informed decisionmaking operates across these embedded time scales, addressing changes that impact our **sustainable development** (United Nations 1987, 2015), balancing environmental protection, economic prosperity and societal well-being at local-global levels with stability (Hardin 1968) as well as resilience (Berkes et al. 2000, 2008; Arctic Council 2016) in the face of change.

At the shortest global periods of minutes-months, the decisionmaking is largely reactive, especially when communications are contributed in view of self-interests without consideration of perspectives, drivers and consequences over time. The unfortunate outcomes of thinking short-term or long-term only are **uninformed decisions**, as illustrated in the United States during the global pandemic (Fig. 1.2c), pulling out of the World Health Organization with exponential change continuing unchecked in the absence of foresight and leadership (Berkman 2020a, b).

Operating across a 'continuum of urgencies' to produce informed decisions involves short-to-long term thinking, distinguishing **exponential** and **logistic** rates of change (Krebs 1972) bounded by an **inflection point** (Figs. 1.2c and 1.3) – when the past, present and future converge with clarity about common interests. We are living during such a moment with the global pandemic making survival a common interest at local-global levels.

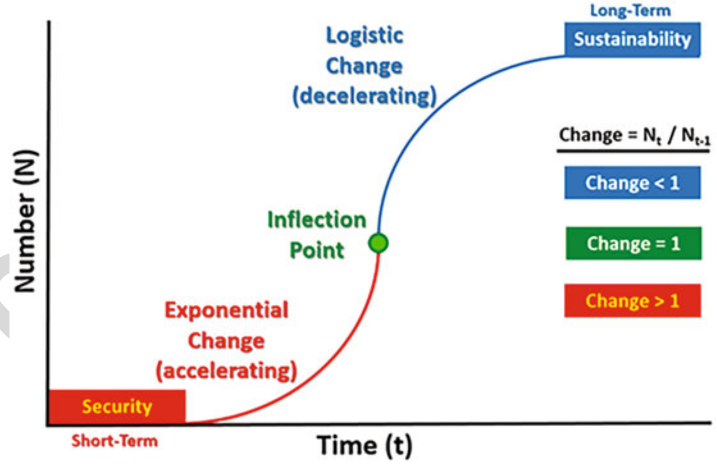

Fig. 1.3 'Pandemic Lens' for Sustainability, highlighting exponential change across an inflection point toward logistic (S-shaped, sigmoid) change, as described by numbers (N) changing per unit of time (t). Informed decisions operate across a "continuum of urgencies" (Fig. 1.4) – before-through-after inflection points to 'bend the curve' short-to-long term with scalability across embedded time scales of our globally-interconnected civilization (Figs. 1.2a-d). (Adapted from Berkman (2020a, b))

The relevance of an inflection point is immediate and long-term, noting there will be a global inflection point with the COVID-19 pandemic with certainty, either because the plague runs its course or because we have vaccines with effective distribution channels around the Earth. In this moment, leadership involves setting expectations correctly. Such intervention to 'bend the curve' – which is a source of hope – is exhibited today among some nations over months-years during the global pandemic (1.2c), underscoring the imagination and capacity of humanity to address issues and impacts over longer time scales: across years-decades with advanced technologies (Fig. 1.2b) as well as decades-centuries with our global human population and the Earth's climate (Fig. 1.2a).

The challenge is to recognize the inflection points, which are few and far between, and then to capitalize on those rare moments as levers for transformation. This application of informed decisionmaking is scalable, as there are inflection points in each of our lives, sometimes together at local-global levels across different time scales (Figs. 1.2a-d). The **theory** of informed decisionmaking scales from an individual to humanity, like driving a car constantly adjusting to the immediacies on the left and right while maneuvering in view of future urgencies with red lights ahead and circumstances to consider in the rear.

Speaking to humanity with lessons, the COVID-19 pandemic is the *"most challenging crisis we have faced since the Second World War,"* as stated in March 2020 by the Secretary-General of the United Nations (Guterres 2020). The end of the Second World War in August 1945 was another global inflection point, educating future generations about how to operate across a 'continuum of urgencies' (Fig. 1.4) from:

Security Time Scales (mitigating risks of political, economic, cultural and environmental instabilities that are immediate); to

Sustainability Time Scales (balancing economic prosperity, environmental protection and societal well-being across generations).

The *Bretton Woods Conference* in New Hampshire in July 1944 produced a vision of a stronger international governance regime that included establishment of the *International Monetary Fund* and the *International Bank for Reconstruction and Development* that became the *World Bank* (Steil, 2013). The *United Nations Conference on International Organization* in San Francisco from April to June 1945,

Fig. 1.4 Informed Decisionmaking as a scalable proposition operating across a 'continuum of urgencies,' illustrated for peoples, nations and our world from security to sustainability time scales. In parallel, there are negotiation strategies that contribute to the decisionmaking – short-term in view of conflicts to resolve and long-term in view of common interests to build – balancing issues, impacts and resources. (Adapted from Berkman et al. (2020) and Berkman (2020a, b))

produced the *Charter of the United Nations and Statute of the International Court of Justice* (United Nations, 1945), symbolised for the ages with the California redwoods, where Franklin Delano Roosevelt, the '*chief architect of the United Nations, and apostle of lasting peace for all mankind', was memorialised in May 1945 (National Park Service, 2020).* The new international architecture created in the post-War years and supplemented by a burgeoning array of international institutions in the decades that followed has manifestly reduced the risk of another global conflict on the scale of the two World Wars. That said, rising nationalism and political polarization combined with advanced technologies has generated new challenges to peace and security around the globe.

At the level of peoples, nations and our world, the 'continuum of urgencies' extends from security to sustainability time scales (Vienna Dialogue Team, 2017). However, knowing the time span of a 'continuum of urgencies' is a research exercise unless there are methods and skills to apply with decisions and actions that commonly involve negotiations (Fig. 1.4).

1.1.3 Science Diplomacy to Negotiate Transformation

With informed decisionmaking before-through-after inflection points (Figs. 1.2, 1.3 and 1.4), the opportunity is to turn science fiction into science reality with inspiration and hope for humanity as in the case of travelling from the Earth to the Moon across a century (Verne, 1865). In this quest, informed decisionmaking is the engine of **science diplomacy** as an holistic process to *"balance national interests and common interests for the benefit of all on Earth across generations"* (Berkman et al., 2011, 2017, 2020; Berkman, 2009, 2020a, b). However, balancing national interests first requires common interests, as reflected across the twentieth century, contrasting periods of conflict and cooperation (Fig. 1.5), which mirror the negotiation strategies applied (Fig. 1.4).

As a skill, common-interest building promotes cooperation among allies and adversaries alike, without the conflict that would persist otherwise. For example, throughout the Cold War, there was continuous cooperation between the United States and Soviet Union regarding both Antarctica and outer space. How was this continuous cooperation facilitated with these international spaces (Berkman, 2009) in the face of geopolitical confrontation among these superpowers everywhere else on Earth? What are the Cold War lessons of common-interest building in the Arctic today (Berkman, 2013, Nature, 2020)?

Both the Antarctic Treaty (1959) and Outer Space Treaty (1967) were built around the *"common interest of all mankind."* Asking what was the umbrella interest that enabled continuous cooperation between superpower adversaries in these international spaces during the Cold War, the answer is the same today: survival in the face of mutually assured destruction, which can happen quickly with global conflict or more slowly without planetary action, as required in the cases of Earth's climate (Fig. 1.2a) and human population (Erlich & Holdren, 1971;

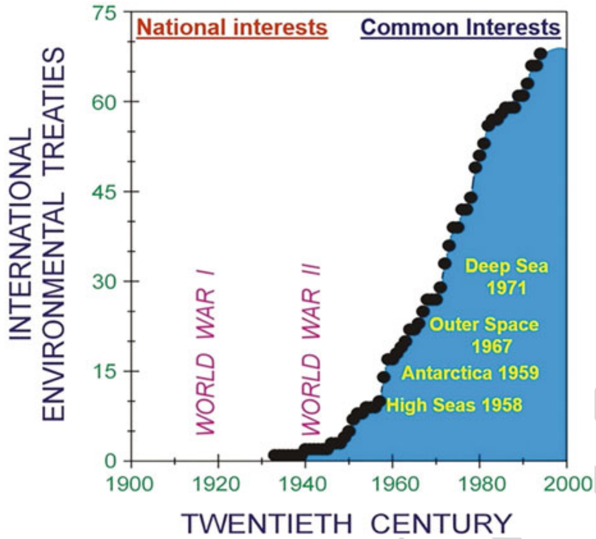

Fig. 1.5 Balancing National and Common Interests on a planetary scale during the twentieth century with international environmental treaties to address sustainability questions in our globally-interconnected civilization (Fig. 1.2a). (Adapted from Berkman (2002), including legal establishment of areas beyond national jurisdictions (yellow), which are international spaces (Kish, 1973, Berkman et al., 2011) to build common interests and minimize risks of conflict over jurisdictional boundaries on a planetary scale across the Earth (Berkman, 2009))

Holdren, 2008). Notably, the *Antarctic Treaty* (1959) – the first nuclear arms agreement (Berkman, 2011) – emphasizes *"facilitation of scientific research"* and *"international scientific cooperation."*

With science diplomacy in Antarctica, superpower adversaries and allies alike have been *"consulting together on matters of common interest"* across more than sixty years with continuous cooperation. As complementary negotiation strategies, conflict resolution and common-interest building (Fig. 1.4) both have the same end objectives to promote cooperation and prevent conflict, but the journeys are entirely different, depending on the starting point. The Cold War lesson with superpower adversaries in Antarctica as well as outer space is the starting point determines the journey with negotiations, continuously resolving conflicts or continuously cooperating based on common interests. Like with a glass half empty or half full, the starting point is a choice affecting the course of subsequent negotiations, emphasizing there is great scope in our world to increase capacities with common-interest building.

These ecopolitical lessons at the local-global scales of our home planet – "all mankind" – were carried from Antarctica to the Arctic before-through-after the end of the Cold War inflection point. Heralded with the Murmansk speech by Soviet President Mikhail Gorbachev (1987), an *"Arctic Research Council"* was conceived to *"let the North Pole be a pole of peace,"* leading to the formation of the Arctic

Council under the terms of the *Ottawa Declaration on the Establishment of the Arctic Council* (1996) to focus on *"common Arctic issues,"* particularly *"sustainable development and environmental protection."* The evolving international law of common interests (Berkman, 2012) is highlighted in the polar regions (Kish, 1973, Berkman, 2020c), underscoring theory, methods and skills with informed decisionmaking to apply, train and refine in a scalable manner. Moreover, the polar regions reveal science diplomacy as a process (Berkman et al., 2011), complementing science into policy as a product (Berkman, 2002), ultimately to develop **options** (without advocacy) that can be used or ignored explicitly, contributing to informed decisions beyond short-term political agendas.

As an example, the scalability of science diplomacy is reflected by two university professors convening the first formal dialogue between the North Atlantic Treaty Organization (NATO) and Russia regarding security in the Arctic (Berkman & Vylegzhanin, 2012a, b). Implications of this high-level dialogue among allies and adversaries alike continue to evolve, including with the Ambassadorial Panels (2015, 2016) on *"Building Common Interests in the Arctic Ocean"* (Berkman & Vylegzhanin, 2012b) that are the conceptual origin of this book. The underlying methods and skills that enable such dialogues are framed with the *Pyramid of Informed Decisionmaking* (Fig. 1.6), recognizing synergies exist between **research** and **action** like connections between *"the internal and the external"* realms of the human spirit (King, 1964).

With informed decisionmaking theory, methods and skills, it also becomes possible to train science diplomacy in a scalable manner, as reflected with the joint courses at universities in the United States and Russian Federation since 2017 (Berkman & Vylegzhanin, 2020), extending across the University of the Arctic with the *Science Diplomacy Thematic Network* (UArctic 2017). More broadly, science-diplomacy training is applicable across the diplomatic corps of foreign ministries and with the United Nations Institute for Training and Research (UNITAR, 2019a, b; 2020a, b; 2021). In all these venues, the objective is to enhance capacities with informed decisionmaking (Figs. 1.3, 1.4 and 1.6), involving both:

Governance Mechanisms (laws, agreements and policies as well as regulatory strategies, including insurance, at diverse jurisdictional levels); and

Built Infrastructure (fixed, mobile and other assets, including communication, research, observing, information and other systems that require technology plus investment).

Coupling governance mechanisms and built infrastructure underlies progress toward sustainable development, which will be elaborated in the third volume in the INFORMED DECISIONMAKING FOR SUSTAINABILITY book series, considering PAN-ARCTIC IMPLEMENTATION OF COUPLED GOVERNANCE AND INFRASTRUCTURE.

The underlying research that was translated into these education and leadership initiatives with science diplomacy emerged from the intertwined *Arctic Options / Pan-Arctic Options* projects from 2013–2021 with participants from Canada, China, France, Norway, Russian Federation and United States addressing *"Holistic Integration for Arctic Marine-Coastal Sustainability"* (Berkman et al., 2020a, b; Young

Fig. 1.6 Pyramid of Informed Decisionmaking as an holistic methodology with science diplomacy to apply, train and refine across a 'continuum of urgencies' (Fig. 1.4), characterizing the scope of an **informed decision**, as the apex goal with governance mechanisms and built infrastructure as well their coupling for sustainable development (Figs. 1.2a-d and 1.3). With holistic integration, **questions of common concern** reveal the methods of science to study change, generating the necessary **data** to produce answers in a transdisciplinary manner. These stages of research are transformed into action with **evidence** for decisions, involving institutions and their decisionmakers. Across the data-evidence interface, the diplomacy with science simply is in revealing **options** (without advocacy), which can be used or ignored explicitly, respecting the institutions. Starting with questions among allies and adversaries underlies the skill to build common interests. The engine of informed decisionmaking operates with common-interest building, enhancing research capacities as a positive feedback with individuals contributing as observers and participants inclusively

et al., 2020b). Holistic questions with science diplomacy (Table 1.2), at the base of the *Pyramid of Informed Decisionmaking,* emerged from the *Antarctic Treaty Summit* (2009) and were memorialised in the first book on Science Diplomacy (Berkman et al., 2011).

Holistic questions to build common interests and enhance research capacities (Fig. 1.6) also introduce a comparative framework to map the research and action chapters of this book (Table 1.2) beyond listing them in the Table of Contents (please also see the *Preface*). As an illustration, this mapping also provides an inclusive framework to introduce all of the book contributions in a balanced manner.

Striving to achieve balance, science diplomacy can be viewed as a **language of hope** because of its international and interdisciplinary inclusion with common-interest building. Like any language, there are definitions for words and phrases (which are bolded and defined above) with syntax to connect meanings from paper to

Table 1.2 Mapping of chapters in this book to categories of holistic (international, interdisciplinary and inclusive) questions with science diplomacy and its engine of informed decisionmaking

Categories of Questions for Decisionmaking[a,b] Involving Science as...?	Chapters in Volume 2 (see *Table of Contents and Preface*)[c,d]	
	Research	Action
An essential gauge of changes over time and space.	1, 5, 6, 8, 9, 10, 15, 16, 17, 23, 24, 25, 26, 29	2, 3, 4, 11, 22, 26, 32, 33, 34
An instrument for Earth system monitoring.	1, 6, 9, 15, 16, 24, 25, 29	2, 3, 11, 13, 22, 34
An early warning system.	1, 6, 9, 15, 16, 24, 25, 29	2, 3, 4, 11, 12, 14, 22, 30
A determinant of public policy agendas.	1, 5, 6, 8, 9, 16, 17, 18, 19, 23, 24, 25, 26, 27, 29	2, 3, 4, 13, 21, 22, 30, 31, 32, 33, 34
An element of international legal institutions.	1, 5, 6, 8, 15, 18, 23, 24, 25, 26	33, 34
A source of invention and commercial enterprise.	1, 7, 10, 15, 17, 18, 19, 24	11, 13, 14, 20, 22, 28, 33
An element of continuity in our global society.	1, 5, 6, 7, 8, 9, 15, 16, 19, 24, 26, 29	2, 3, 4, 11, 22, 28, 32, 33, 34
A tool of diplomacy to build common interests. (chapter mentions "common")[e]	1, 5, 6, 7, 8, 9, 15, 16, 18, 19, 23, 24, 25, 26, 29	3, 4, 11, 30

[a]Decisions involve governance mechanisms and built infrastructure, coupled for sustainability
[b]Elaborated from Berkman et al. (2011)
[c]Stages of research and action are elaborated in Fig. 1.6
[d]Appendix regarding the United Decades for Ocean Science and Sustainable Development (UNDOS) is included in all categories of questions
[e]Searched and integrated comprehensively with the KnoHow™ knowledge bank (https://knohow.co) for Volume 2. Building Common Interests in the Arctic Ocean with Global Inclusion, using the final drafts of PDF files for the research and action chapters as well as the Appendix

practice. As puzzle pieces, the language starts with science and diplomacy, empowering synergies with these processes to facilitate holistic integration with research and action that together enable informed decisionmaking with governance mechanisms and built infrastructure as well as their coupling for sustainable development in a scalable manner with the Arctic Ocean as a case-study (Figs. 1.1, 1.2, 1.3, 1.4, 1.5 and 1.6; Tables 1.1 and 1.2).

With holistic integration, the biggest challenge is to be inclusive, recognizing the prevalence and problems with systemic exclusion that exist worldwide. On our shared journey as a globally-interconnected civilization (Figs. 1.2a-d and 1.5), science diplomacy promotes informed decisions: not good or bad decisions, not right or wrong decisions, but decisions that optimize the available data in view of the underlying questions inclusively (Table 1.2). All the chapters in this book touch on science diplomacy and its engine of informed decisionmaking, providing open-ended starting points (Fig. 1.6) for readers to consider skills, methods and theory to build common interests with lifelong learning.

1.2 The Arctic Ocean

1.2.1 Interconnected Home Systems

The Arctic Ocean is a case study with global relevance, conceptually and in practice as an holistic system (Fig. 1.1). International and interdisciplinary questions operate inclusively (Table 1.2) in view of the Arctic Ocean at diverse time and space scales (Vörösmarty et al., 2010, Petrov et al., 2017), across regions and jurisdictions (Gad and Strandsbjerg, 2019), which are discussed throughout this book. Moreover, the diminishing sea-ice boundary of the Arctic Ocean is like removing the ceiling to your room, exposing all to the outside conditions with inherent risks of instabilities. Operating at this security time scale (Fig. 1.4) – especially considering the Arctic Ocean could become a $1 trillion arena for investment (Roston, 2016, World Economic Forum, 2016) – reflects the challenge to achieve progress with sustainable development as a "common" Arctic issue.

When **boundaries** change, so do the associated and dependent systems, which is why the world has been introduced to a "new" Arctic Ocean with the diminishing sea-ice boundary (Berkman & Vylegzhanin, 2012a, b; Carmack et al., 2015). Applications of bounded regions to characterize inflows and outflows as well as system dynamics in the Arctic Ocean are the focus of the first volume of this book series in view of Governing Arctic Seas: Regional Lessons from the Bering Strait and Barents Sea (Young et al., 2020b). The international, interdisciplinary and inclusive focus of this second volume is on a Pan-Arctic scale in view of diverse biogeophysical, socioeconomic and institutional boundaries associated the Arctic Ocean (Berkman, 2015), underscoring holistic considerations with science as the study of change that are necessary to generate knowledge for Arctic sustainability (Greybill and Petrov, 2020). AU2

In a general sense, progressing southward from the North Pole, the Arctic Ocean is bounded by the sea floor and sea surface with the surrounding continents (Jakobsson et al., 2004). Defining the southern boundary is where the ambiguities arise, underscoring the diverse interests of the associated stakeholders, rightsholders and other actors with this Pan-Arctic system. Nonetheless, while there is no fully agreed definition of the Arctic Ocean applicable in all situations, boundary characterizations of the Arctic Ocean system and its subsystems become essential to position the research and observations that are necessary to interpret change (Lee et al., 2019). These interconnections within the Earth system become especially important to manage the resulting data products in view of desired stakeholder outcomes (Eicken et al., 2016).

For some purposes, using the Arctic Circle as the southern limit of the Arctic Ocean has a number of advantages. The Arctic Circle boundary allows changes to be assessed in the Arctic Ocean with consistency over time, even back to the time when Indigenous peoples were able to walk across the Bering Strait with sea-level 120 meters lower than today more than 11,000 years ago (Hopkins, 1967, Jakobsson et al., 2017). Moreover, the Arctic Circle at 66.5° North latitude reflects the seasonality of the Arctic system in relation to the Sun as the primary external driver of Earth's climate, as with the climates of other planets in our Solar system (Kondratyev & Hunt, 1982), further highlighting the embedded and interacting nature of systems. In addition, the Arctic Circle demarcates the eight Arctic States, which established the Arctic Council, along with six Indigenous Peoples' Organizations (Ottawa Declaration, 1996), which highlight extensions of the Pan-Arctic region across lower latitudes (Fig. 1.1).

Dynamics of the Arctic Ocean system (Fig. 1.1) also can be characterized by diverse inflows and outflows across its boundaries, including from the North Pacific and North Atlantic as well as from adjacent land masses and across land-air-sea interfaces (Fig. 1.7). Among the many projects and programs, these diverse biogeophysical interactions are illustrated in view of sea-ice with research from the *Multidisciplinary drifting Observations for the Study of Arctic Climate* (MOSAiC) project (Shupe et al., 2020) and its complementary *Terrestrial Multidisciplinary distributed Observations for the Study of Arctic Connections* (T-MOSAiC) project (Vincent et al., 2019).

Amplified warming (Holland Bitz, 2003, Stuecker et al., 2018) and feedbacks with Earth's climate illustrate geophysical connections with the Arctic Ocean (Merideth et al., 2019), especially with reduced albedo from diminishing sea ice (Winton, 2006, Pistone et al., 2014) as well as with increased greenhouse gases in the atmosphere from devolving methane (Shakhova et al., 2010, Sultan et al., 2020, James et al., 2016). Additionally, melting from the Greenland Ice Sheet is raising global sea level (Briner et al., 2020). The biogeophysical dynamics of the Arctic Ocean system (Falardeau & Bennett, 2020) are represented further by species interactions across associated and dependent ecosystems, involving humans as the primary internal system driver of changes across the Earth during the Anthropocene (Ehlers & Krafft, 2006, National Research Council, 2014), beyond the external drivers associated with changes in Solar radiation and Earth's orbital geometries (Berger, 1988, Eddy, 2009). System perspectives that center on the Arctic Ocean are reflected in the organization of this book (please see the Preface) with mapping of the research and action chapters (Fig. 1.6 and Table 1.2) in each of the sections:

Section I. Introduction (Chapters 1–4);
Section II. The Arctic Ocean: Evolving Ecological and Sustainability Challenges (Chapters 5–14);
Section III. The Broader Arctic Setting (Chapters 15–22)
Section IV. Informed Decisionmaking Tools and Approaches for the Arctic (Chapters 23–32);
Section V. Conclusion (Chapters 33–35).

Like any natural system, the Arctic Ocean is represented by boundaries that depend on the eye of the beholder and the questions being addressed (Table 1.2). Boundaries also are conceptual features of learning systems widely considered in view of stages from **D**ata, **I**nformation and **K**nowledge to **W**isdom across the 'DIKW Pyramid' (Ackoff, 1989, 1999; Rowley, 2007). Although known since Socrates, an innovation with the Informed Decisionmaking for Sustainability

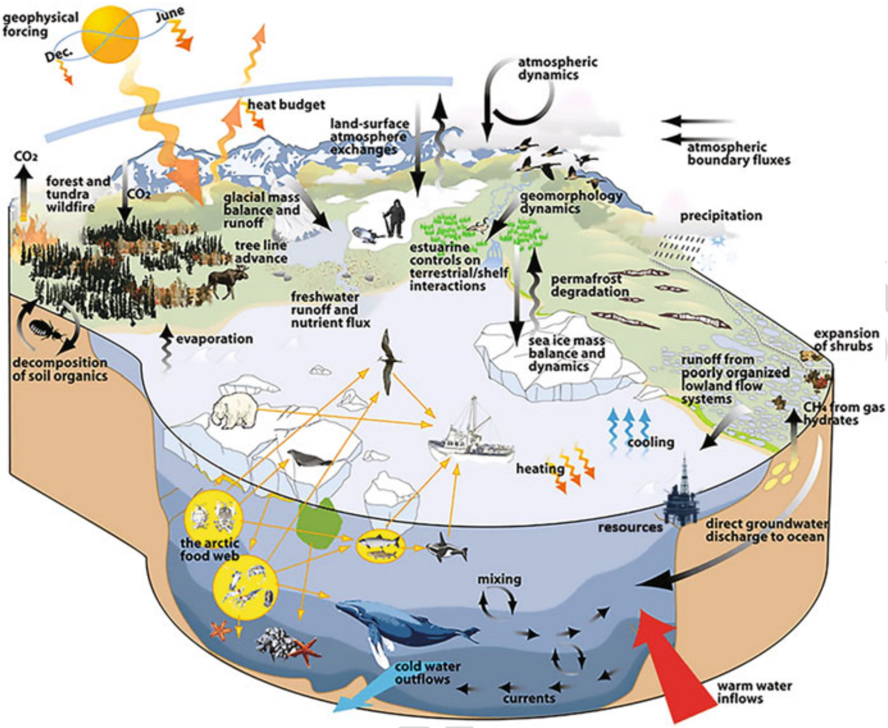

Fig. 1.7 Biogeophysical Dynamics of the Arctic System illustrated in view marine-terrestrial coupling with external and internal forcing. In the Arctic Ocean system (Fig. 1.1) – with its sea floor, sea surface and terrestrial boundaries – there are: (**a**) geophysical features with water masses, currents and sea ice with land-air-sea exchanges; (**b**) biological features with organisms, including humans, interacting with their dependent and associated ecosystems over diverse time and space scales; and (**c**) socioeconomic features with human uses of the maritime system along with its living and mineral resources, involving short-to-long term impacts (Fig. 1.3). (Modified from Roberts et al. (2010))

book series is that questions underlie data as a fundamental feature of learning systems, as evolving with the 'Pyramid of Informed Decisionmaking' (Fig. 1.6). Moreover, starting with questions inclusively is the essence of being transdisciplinary (beyond interdisciplinary, multidisciplinary or disciplinary) to achieve progress with knowledge democracy (Bunders et al., 2010), creating the opportunity to build common interests among allies and adversaries alike (Fig. 1.4).

The aspiration of this book is to be practical, helping readers to overlay ecopolitical regions (Table 1.1; Figs. 1.1 and 1.7) with the methodologies of science that contribute to informed decisions (Vörösmarty et al. 2018) with governance mechanisms and built infrastructure as well as their coupling for sustainable development in the Arctic Ocean (Pongrácz et al., 2020). This journey across the Pyramid of Informed Decisionmaking recognizes there are stages of research and action, which are distinguished across the data-evidence interface, where individuals can contribute as both observers and participants (Fig. 1.6).

1.2.2 Interconnected Governance Systems

In the Arctic Ocean, just as on a planetary scale, managing ecopolitical regions (Table 1.1; Figs. 1.1 and 1.7) involves common-interest building with research-action connections that operate short-to-long term (Figs. 1.3, 1.4, 1.5 and 1.6). In this local-global context, the "***Law of the Sea***" provides "*an extensive international legal framework*" to which the Arctic States and Indigenous Peoples' Organizations "*remained committed*" (Arctic Council Secretariat, 2013), including the five Arctic coastal states (Canada, Denmark, Norway, Russia and the United States) that have declared their "***sovereignty**, sovereign rights and jurisdiction in large areas of the Arctic Ocean*" (*Ilulissat Declaration* 2008).

Law of the sea and international environmental law (like other branches of international law) are applied universally, either as a binding system under the *Law of Treaties* (Vienna Convention, 1969) or as a matter of international customary law among nations. In both cases, areas within, across and beyond national jurisdictions are recognized to exist under international law. However, it is **international spaces** (Kish, 1973; Berkman et al., 2011; Berkman, 2020c) that best illustrate inclusive frameworks to build common interests (Figs. 1.4, 1.5 and 1.6), promoting peace (Berkman, 2009) with lessons of unity beyond sovereign jurisdictions.

Law of the sea provides lessons about international spaces that are different than with Antarctica and outer space (Fig. 1.5), considering the **jurisdictional zonation** from national boundaries into Areas Beyond National Jurisdiction (ABNJ), crossing a gradient of roles and responsibilities among nations (Fig. 1.8). The law of the sea also distinguishes ecopolitical regions that are bounded by the sea floor and superjacent waters, which are related to sovereign jurisdictions differently. As a prominent example (Berkman & Young, 2009), the deep sea floor to the North Pole still could be delineated as continental shelf attached to national jurisdictions, whereas the overlying high seas in the CAO (Fig. 1.1) are recognized universally as an international space (Fig. 1.5) where: *"No State may validly purport to subject any part of the high seas to its sovereignty"* (United Nations, 1982).

As the first ABNJ in human history (*Convention on the High Seas*, 1958), the high seas with its freedoms reflects the evolution of our globally-interconnected civilization since Grotius' crafting *Mare Liberum* in the early seventeenth century (Bull et al. 1995), when humankind was formulating the legal prerogatives of the nation-state with the *Treaty on Westphalia* (Fig. 1.2a). The journey ahead with international spaces includes the *"common heritage of mankind"* (United Nations, 1982) in the deep sea floor as a visionary concept with equitability for the benefit of humanity. As with all international spaces (Fig. 1.5), in the deep sea, complications to balance national interests and common interests are highlighted by accelerating commercial developments with short-term considerations only (Banet, 2020, Tunnicliffe et al., 2020), illustrating the precursors for uninformed decisions without formulation across a 'continuum of urgencies' (Fig. 1.4).

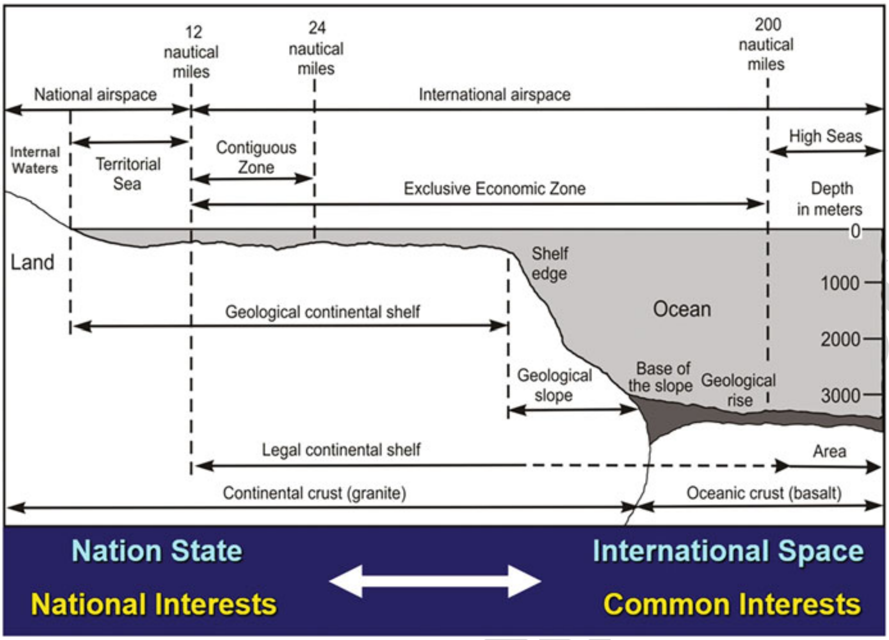

Fig. 1.8 Law of the Sea Zonation from boundary baselines of coastal nations into international spaces (Figs. 1.1 and 1.5), applied under customary international law (as by the United States) and through the 1982 *United Nations Convention on the Law of the Sea* (UNCLOS) with provisions for *"strengthening of peace, security, co-operation and friendly relations among all nations"* with keystone contributions from "*Marine Scientific Research*" (United Nations, 1982). The law of the sea illustrates the challenge of humanity forever after the Second World War – as long as there are nations – to balance national interests and common interests on a planetary scale. (Adapted from Berkman et al. (2020) as a core feature of the INFORMED DECISIONMAKING FOR SUSTAINABILITY book series)

With the 2018 *Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean* that entered into force on 25 June 2021, the high seas of the CAO (Fig. 1.1) have become a common interest of Arctic and non-Arctic states with Canada, China, Denmark (on behalf of the Faroe Islands and Greenland) Iceland, Japan, Norway, Russia, South Korea and the United States as well as the European Union (Vylegzhanin et al., 2020, Balton, 2020). Importantly, this binding Agreement brings home the point about the North Pole as a *"pole of peace"* (Gorbachev, 1987), considering especially the relations of superpowers who have signed this historic agreement.

The high seas of the CAO (Fig. 1.1.) also are a focal region to assess the interconnected biogeophysical and socioeconomic dynamics of associated and dependent ecosystems in the changing Arctic with **transboundary** governance considerations (Platjouw, 2019). Such assessment involves the cross-cutting features of science (Table 1.2), which are integrated across thematic, institutional and jurisdictional boundaries in a Pan-Arctic context (Figs. 1.1 and 1.7) with the 2017 *Agreement on Enhancing International Arctic Scientific Cooperation*.

Conceptually, the Arctic Science Agreement (2017) can be viewed as a key piece of the governance complex in the Arctic Ocean, complementing the *Marine Scientific Research* provisions of UNCLOS (United Nations 1982) that are central to informed decisionmaking (Figs. 1.3, 1.4 and 1.6) with law of the sea (Figs. 1.1 and 1.8). For example, the needs and applications of information are illustrated with the Polar Code (2017), which refers to: *"chart information;" "current information;" "hydrographic information;" "ice information;" "information available;" "information exchange;" land-based support information;" "meteorological information;" "positioning information;" "reference information;" "statistical information;" "sufficient information;" "supporting information;" "up-to-date information;"* and *"weather information."* Similarly, data and information needs are identified in other agreements that have come into force in the past decade (Arctic Search and Rescue Agreement, 2011; Arctic Marine Oil Pollution Preparedness Agreement, 2013) as well as earlier agreements (Berkman et al., 2019).

The process to produce these recent governance mechanisms are represented with the *Arctic Ocean Review* (PAME, 2013), implementing informed decisions from the *2005–2015 Arctic Marine Strategic Plan* (Arctic Council 2004), which is continuing with the *2015–2025 Arctic Marine Strategic Plan* (Arctic Council, 2015) across decadal time scales (Fig. 1.2a, b). Together, coupling of the scientific and governance products in the Arctic Ocean illustrates the pathway of science diplomacy from research to action, integrating data into evidence for informed decisionmaking (Figs. 1.3, 1.4 and 1.6).

1.3 With Global Inclusion

1.3.1 Local-Global Considerations

The premise of this book is that we live in a globally-interconnected civilization (Figs. 1.2a-d; 1.5 and 1.8), which includes all of us today and across generations (Table 1.1). What does it mean to be inclusive? How can we operate with inclusion, recognizing that institutions as well as systems have boundaries? Answering these questions is a matter of lifelong learning, which is the journey with informed decisionmaking (Figs. 1.3, 1.4 and 1.6; Table 1.2) that is illustrated with focus on the Arctic Ocean as a global case study (Figs. 1.1, 1.7, 1.8 and 1.9).

The dimensions of inclusion are local-global (Fig. 1.9), starting with questions (Fig. 1.6, Table 1.2) that involve transboundary perspectives and transdisciplinary capacities that apply across institutions and jurisdictions (Figs. 1.8 and 1.9) as well as across ecosystems that have dynamic geospatial dimensions (Figs. 1.7). The Arctic Ocean system (Figs. 1.1 and 1.7) illustrates the holistic integration to achieve progress with sustainable development (Table 1.3) as a Pan-Arctic issue, building common interests among allies and adversaries alike while enhancing research capacities (Fig. 1.6) to produce informed decisions (Figs. 1.3 and 1.4) that will operate across generations in the high north.

Fig. 1.9 **Holistic Integration** of interests in the Arctic Ocean with all humankind represented, recognizing there are concentric stewardship roles and responsibilities with respect to the Arctic residents who are most immediately impacted by changes in this region. At the center of the Arctic Ocean, surrounding the North Pole as a *"pole of peace"* (Gorbachev, 1987), is the CAO high seas (Figs. 1.1 and 1.8), which is an ABNJ that lends itself to building common interests with global relevance. (Adapted from Berkman and Vylegzhanin (2012b))

Table 1.3 Attributes and local-global characteristics of sustainability

Attributes	Local-Global Characteristics
Balance	Environmental Protection + Economic Prosperity + Societal Well-Being
	National Interests + Common Interests
Resilience	Present Generations + Future Generations
	Governance Mechanisms + Built Infrastructure
Stability	Promoting Cooperation + Preventing Conflict
	Peace + Survival

1.3.2 Precaution Across Generations

With the Arctic Ocean system (Figs. 1.1, 1.7, 1.8 and 1.9), how can we maintain the high north as region of low tension (Støre 2010), continuously promoting cooperation and preventing conflict (Table 1.3)? How can we balance economic prosperity, environmental protection and societal well-being at the heart of sustainable development in the Arctic as well as elsewhere on Earth across generations? Answers to these questions involve common-interest building (Fig. 1.4 and 1.6), which is reflected with the CAO high seas (Figs. 1.1 and 1.8) as an international space with inclusion among allies and adversaries alike.

The CAO High Seas Fisheries Agreement (2018) highlights informed decisionmaking (Figs. 1.3, 1.4 and 1.6) under international law with the principle of precaution (Pan & Huntington, 2016, Hoag, 2017, Schatz et al., 2019). In specific, the CAO High Seas Fisheries Agreement (2018) considers the "*application of precautionary conservation and management measures as part of a long-term strategy*" to address *"potential adverse impacts"* – safeguarding "*healthy marine ecosystems"* and ensuring *"sustainable use of fish stocks"* as the specific focus of this historic agreement among Arctic and non-Arctic states. With relevance inclusively, considering examples and lessons to manage activities short-to-long term (Figs. 1.3 and 1.4), related international legal instruments with the "precautionary" principle and approaches are compiled as an Appendix to this chapter.

Applying precaution underscores the challenge we face collectively to operate as a globally-interconnected civilization. The solutions we seek are not magic bullets, but processes that operate with scalability over time and space in the face of changing circumstances. With inclusion as the biggest challenge to achieve scalability, science diplomacy introduces an holistic process with informed decisionmaking to enhance integration skills in an unbounded fashion independent of language, location and culture, complementing the seventeen United Nations Sustainable Development Goals (United Nations, 2015) at local-global levels (Figs. 1.9 and 1.10). In view of international and interdisciplinary inclusion, the scalability with informed decisionmaking is a testable proposition, potentially with lifelong learning in an intergenerational context.

How can individuals, institutions and governments be inclusive? Part of the answer is to think beyond self-interests, which are most urgent now with greatest immediacy in the present. The future also is urgent, requiring present considerations to anticipate and prepare for eventualities, which are clearly evident in view of exponential change across diverse time scales (Figs. 1.2a-d). The notion of precaution places responsibility on present and future generations to inform the decisionmaking with governance mechanisms and built infrastructure as well as their coupled contributions to sustainable development. Importantly, thinking with precaution has the benefit of empowering diverse stakeholders, rightsholders, and other actors to contribute in an inclusive manner, building common interests with continuous iteration of questions, methods and capacities to address change.

Since the *Treaty of Westphalia* (Fig. 1.2a), nations have been the primary jurisdictional unit across the Earth. However, with "world" wars in the twentieth century, it became necessary for nations to create international institutions that also operate on a planetary scale. To be inclusive today involves subnational as another step in our evolution as a globally-interconnected civilization, noting the jurisdictional spectrum on Earth is like meters aggregated into kilometers and divided into centimeters (Fig. 1.10). How subnational fits into international legal frameworks with nations itself is a question to be resolved with informed decisionmaking.

Nonetheless, subnational jurisdictions do operate on planetary scale, as with the mayors of forty major cities considering their shared responses to climate change (World Mayors Summit, 2019) or with California as the fifth largest economy on Earth (CBS New 2018). Addressing the COVID-19 pandemic now over months to

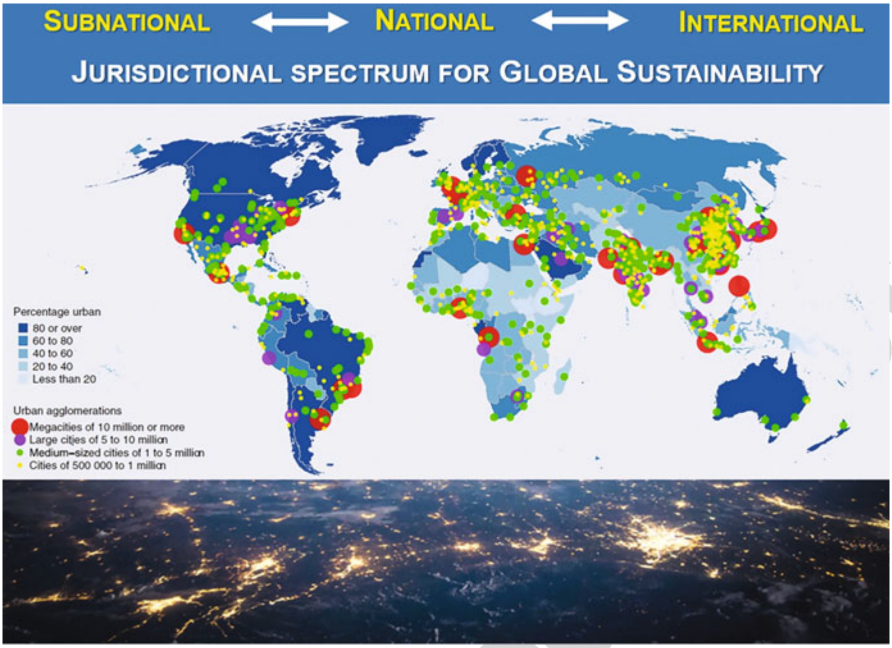

Fig. 1.10 Spectrum of Jurisdictions on Earth, representing an inclusive framework for humankind to address impacts, issues and resources with informed decisionmaking (Figs. 1.3, 1.4, 1.5 and 1.6; Tables 1.1, 1.2 and 1.3) across our globally-interconnected civilization (Figs. 1.2a-d) at subnational-national-international levels. With such integration, the Arctic Ocean system (Figs. 1.1, 1.7, 1.8 and 1.9) provides a global case-study with timeless lessons for humanity to operate on a planetary scale. (Modified from Berkman (2019))

years (Fig. 1.2c) – and with precaution for global pandemics to come in the future – requires informed decisionmaking across the jurisdictional spectrum (Fig. 1.10) with local-global implementation strategies before-through-after the inflection point (Fig. 1.3) that has yet to arrive.

All humans share a common interest in survival now with the COVID-19 pandemic, just as with "world" wars of the twentieth century, emerging over decades to centuries to come with the passion of our world entering each *Conference of the Parties* from the 1992 *United Nations Framework Convention on Climate Change* (United Nations, 1992). Earth's climate brings into renewed focus that our global human population has accelerated from 1 billion people living around 1800 to 8 billion alive within the next five years (Fig. 1.2a). **The challenge we collectively face is one of common-interest building on a planetary scale.**

The Arctic Ocean offers holistic lessons about decisionmaking, both informed and uninformed, involving governance mechanisms and built infrastructure as well as their coupling for sustainability. The Arctic Ocean also is part of the decisionmaking with global issues, especially climate, operating across decades and centuries to come. In this sense, it is important to note that young adults living today will be alive in the twenty-second century, which brings great responsibility of those reading this book to consider how each of us can enhance next-generation capacities. The perspectives about time – past, present and future – are what guide us individually and collectively throughout our lives inclusively.

Research connects the present, past and the future, which is the essence of science diplomacy to negotiate with time (Fig. 1.4), turning questions of common concern into informed decisions (Fig. 1.6). Stimulated by curiosity, research skills are the most basic feature to make an informed decision, operating short-to-long term before-through-after inflections points (Fig. 1.3). In this realm of imagination, children are innately curious, emphasizing responsibilities to develop skills that begin with questions across a lifetime.

With science fiction into reality (Verne, 1865), the synergies of informed decisionmaking will contribute to lifelong learning, triangulating education, research and leadership with common-interest building and compassion. Learning lessons of global inclusion from the Arctic Ocean and elsewhere with common-interest building to produce informed decisions underscores the opportunity to act *"for the benefit of all on Earth across generations."*

Acknowledgements This chapter and those that follow emerged with *Arctic Frontiers* 2020, building on the 2018 *Memorandum of Understanding* with the Science Diplomacy Center on behalf of the editors for the book series on Informed Decisionmaking for Sustainability. This chapter is a product of the Science Diplomacy Center through EvREsearch LTD, coordinating *Arctic Options/Pan-Arctic Options* and related projects with support from the United States National Science Foundation (Award Nos. NSF-OPP 1263819, NSF-ICER 1660449, NSF-OPP 1719540 and NSF-ICER 2103490) along with the Fulbright Arctic Chair 2021-2022 awarded to P.A. Berkman by the United States Department of State and Norwegian Ministry of Foreign Affairs with funding from the United States Congress. These international projects include support also from national science agencies in Canada, China, France, Norway, Russia from 2013 to 2022 in coordination with the Belmont Forum, gratefully acknowledging the collaboration with the University of California Santa Barbara, MGIMO University, Université Pierre et Marie Curie, Norwegian Polar Institute, University of Alaska Fairbanks, University of Colorado Boulder, Carleton University and the Ocean University of China among other institutions throughout this period. We also thank the Polar Institute with the Wilson Center for their leadership and support of this contribution.

Appendix

The Precautionary Principle or Approach

Possible Citation: Soto Sanchez, R. 2022. *Appendix to Chapter 1. Building Common Interests with Informed Decisionmaking for Sustainabilit*y. IN: Berkman, P.A., Young, O.R., Vylegzhanin, A.N., Balton, D.A. and Øvretveit, O. (eds). Building Common Interests in the Arctic Ocean with Global Inclusion. Volume 2. Informed Decisionmaking for Sustainability. Springer, Dordrecht.

Table 1 The precautionary principle or approach in the 1982 United Nations Convention on the Law of the Sea (LOSC)

The 1982 United Nations Convention on the Law of the Sea (LOSC) provides the widely agreed basic international law framework for balancing the rights and duties of coastal States, including protecting and preserving the marine environment in the different maritime zones, with the rights and duties of all States, including to freedom of navigation. The LOSC applies to the Arctic Ocean as it applies to other parts of the seas and oceans. Although the LOSC does not expressly refer to the precautionary principle or precautionary approach, a number of its provisions, highlighted in this table nevertheless give effect to the basic concept of precaution. The LOSC is not comprehensive in the sense of providing detailed rules for the regulation of all marine operations and shipping at sea, especially in areas beyond national jurisdiction (ABNJ). Other international instruments, included in Table 2*, build on or supplement the provisions of the LOSC relating to precaution an evolving concept that must be interpreted in accordance with the full complement of relevant international instruments.*[2]

Year adopted	Instrument	Type	Provision(s)	Textual quotation
1982	LOSC.[3]	Multilateral, International.	Articles 194 para(s). 1 to 3; and 195.	*Article 194* *Measures to prevent, reduce and control pollution of the marine environment* *"1. States shall take, individually or jointly as appropriate, all measures consistent with this Convention that are necessary to prevent, reduce and control pollution of the marine environment from any source, using for this purpose the best practicable means at their disposal and in accordance with their capabilities, and they shall endeavour to harmonize their policies in this connection.* *2. States shall take all measures necessary to ensure that activities under their jurisdiction or control are so conducted as not to cause damage by pollution to other States and their environment, and that pollution arising from incidents or activities under their jurisdiction or control does not spread beyond the areas where they exercise sovereign rights in accordance with this Convention.* *3. The measures taken pursuant to this Part shall deal with all sources of pollution of the marine environment. (. . .)"*

(continued)

[2] *1969 Vienna Convention on the Law of Treaties* (Vienna, 23 May 1969, in force 27 January 1980), Article 31, para. 3, lit. c. *1982 United Nations Convention on the Law of the Sea*, opened for signature 10 December 1982, (entered into forced 16 November 1994) Article 311, para. 2.

[3] United Nations Convention on the Law of the Sea (opened for signature 10 December 1982, entered into force 16 November 1994) 1833 UNTS 3 (LOSC).

				Article 195 *Duty not to transfer damage or hazards or transform one type of pollution into another* "In taking measures to prevent, reduce and control pollution of the marine environment, States shall act so as not to transfer, directly or indirectly, damage or hazards from one area to another or transform one type of pollution into another."
			Articles 207 to 211.	*Article 207* *Pollution from land-based sources* *"1. States shall adopt laws and regulations to prevent, reduce and control pollution of the marine environment from land-based sources, including rivers, estuaries, pipelines and outfall structures, taking into account internationally agreed rules, standards and recommended practices and procedures.* *2. States shall take other measures as may be necessary to prevent, reduce and control such pollution.* *3. States shall endeavour to harmonize their policies in this connection at the appropriate regional level.* *4. States, (. . .), shall endeavour to establish global and regional rules, standards and recommended practices and procedures to prevent, reduce and control pollution of the marine environment from land-based sources, (. . .). Such rules, standards and recommended practices and procedures shall be re-examined from time to time as necessary.* *5. Laws, regulations, measures, rules, standards and recommended practices and procedures referred to in paragraphs 1, 2 and 4 shall include those designed to minimize, to the fullest extent possible, the release of toxic, harmful or noxious substances, especially those which are persistent, into the marine environment."*

(continued)

				Article 208 *Pollution from seabed activities subject to national jurisdiction* *"1. Coastal States shall adopt laws and regulations to prevent, reduce and control pollution of the marine environment arising from or in connection with seabed activities subject to their jurisdiction and from artificial islands, installations and structures under their jurisdiction, (. . .).* *2. States shall take other measures as may be necessary to prevent, reduce and control such pollution.* *3. Such laws, regulations and measures shall be no less effective than international rules, standards and recommended practices and procedures.* *5. (. . .) Such rules, standards and recommended practices and procedures shall be re-examined from time to time as necessary."*
				Article 209 *Pollution from activities in the Area* *"1. International rules, regulations and procedures shall be established in accordance with Part XI to prevent, reduce and control pollution of the marine environment from activities in the Area. Such rules, regulations and procedures shall be re-examined from time to time as necessary.* *2. Subject to the relevant provisions of this section, States shall adopt laws and regulations to prevent, reduce and control pollution of the marine environment from activities in the Area undertaken by vessels, installations, structures and other devices flying their flag or of their registry or operating under their authority, as the case may be. The requirements of such laws and regulations shall be no less effective than the international rules, (. . .)."*
				Article 210 *Pollution by dumping* *"1. States shall adopt laws and regulations to prevent, reduce and control pollution of the marine environment by dumping.*

(continued)

				Article 211 *2. States shall take other measures as may be necessary to prevent, reduce and control such pollution.* *3. Such laws, regulations and measures shall ensure that dumping is not carried out without the permission of the competent authorities of States.* *4. (. . .) Such rules, standards and recommended practices and procedures shall be re-examined from time to time as necessary.* *5. Dumping within the territorial sea and the exclusive economic zone or onto the continental shelf shall not be carried out (. . .) after due consideration of the matter with other States which by reason of their geographical situation may be adversely affected thereby.* *6. National laws, regulations and measures shall be no less effective in preventing, reducing and controlling such pollution than the global rules and standards."*
				Pollution from vessels *"1. States, (. . .), shall establish international rules and standards to prevent, reduce and control pollution of the marine environment from vessels (. . .). Such rules and standards shall, in the same manner, be re-examined from time to time as necessary.* *2. States shall adopt laws and regulations for the prevention, reduction and control of pollution of the marine environment from vessels flying their flag or of their registry. Such laws and regulations shall at least have the same effect as that of generally accepted international rules and standards established through the competent international organization or general diplomatic conference. (. . .)"*
				Article 212 *Pollution from or through the atmosphere* *"1. States shall adopt laws and regulations to prevent, reduce and control pollution of the marine environment from or through the atmosphere,*

(continued)

				applicable to the air space under their sovereignty and to vessels flying their flag or vessels or aircraft of their registry, taking into account internationally agreed rules, standards and recommended practices and procedures and the safety of air navigation. 2. States shall take other measures as may be necessary to prevent, reduce and control such pollution. (. . .)"
			Article 234.	*Article 234 Ice-covered areas "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."*

Table 2 Existing instruments that embody the precautionary principle or approach

This table sets forth key provisions from international instruments that relate to the precautionary principle or precautionary approach, and that build on or supplement the provisions of the LOSC contained in Table 1.[4]

Year adopted	Instrument	Type	Provision(s)	Textual quotation
1969	OPRC Convention.[5]	Multilateral, International.	Article V.	*Article V.* *"1. Measures taken by the coastal State in accordance with Article I shall be proportionate to the damage actual or threatened to it.* *2. Such measures shall not go beyond what is reasonably necessary to achieve the end mentioned in Article I and shall cease as soon as that end has been achieved; they shall not unnecessarily interfere with the rights and interests of the flag State, third States and of any persons, physical or corporate, concerned.* *3. In considering whether the measures are proportionate to the damage, account shall be taken of:* *(a) the extent and probability of imminent damage if those measures are not taken; and* *(b) the likelihood of those measures being effective; and* *(c) the extent of the damage which may be caused by such measures."*

(continued)

[4] *1982 United Nations Convention on the Law of the Sea*, opened for signature 10 December 1982, (entered into forced 16 November 1994) Article 311, para.3.

[5] *1969 International Convention relating to intervention on the high seas in cases of oil pollution casualties*, opened for signature 29 November 1969, (entered into forced 06 May 1975) UNTS 970 (p.211).

1973	CITES.[6]	Multilateral, International.	Articles VIII, XIII and XIV.	*Article VIII* *Measures to be Taken by the Parties* *"1. The Parties shall take appropriate measures to enforce the provisions of the present Convention and to prohibit trade in specimens in violation thereof.* *(. . .)"* *Article XIII* *International Measures* "1. When the Secretariat in the light of information received is satisfied that any species included in Appendix I or II is being affected adversely by trade in specimens of that species or that the provisions of the present Convention are not being effectively implemented, it shall communicate such information to the authorized Management Authority of the Party or Parties concerned. 2. When any Party receives a communication as indicated in paragraph 1 of this Article, it shall, as soon as possible, inform the Secretariat of any relevant facts insofar as its laws permit and, where appropriate, propose remedial action. Where the Party considers that an inquiry is desirable, such inquiry may be carried out by one or more persons expressly authorized by the Party. (. . .)" *Article XIV* *Effect on Domestic Legislation and International Conventions*

(continued)

[6]Convention on International Trade in Endangered Species of Wild Fauna and Flora, 03 March 1973,, (entered into force 01 July 1975), 993 U.N.T.S. 243 (CITES).

				"1. The provisions of the present Convention shall in no way affect the right of Parties to adopt: (a) stricter domestic measures regarding the conditions for trade, taking, possession or transport of specimens of species included in Appendices I, II and III, or the complete prohibition thereof; or (b) domestic measures restricting or prohibiting trade, taking, possession or transport of species not included in Appendix I, II or III. (. . .) 6. Nothing in the present Convention shall prejudice the codification and development of the law of the sea by the United Nations Conference on the Law of the Sea convened pursuant to Resolution 2750 C (XXV) of the General Assembly of the United Nations nor the present or future claims and legal views of any State concerning the law of the sea and the nature and extent of coastal and flag State jurisdiction."
1980	CAMLR Convention.[7]	Multilateral, Regional.	Article II, para. 3, item c).	*Article II.* *"1. The objective of this Convention is the conservation of Antarctic marine living resources.* *(. . .)* *3. Any harvesting and associated activities in the area to which this Convention applies shall be conducted in accordance with the*

(continued)

[7] *1980 Convention for the Conservation of Antarctic Marine Living Resources*, opened for signature 20 May 1980, (entered into forced 7 April 1982) 1329 UNTS.

				provisions of this Convention and with the following principles of conservation: *(. . .)* *(c)revention of changes or minimisation of the risk of changes in the marine ecosystem which are not potentially reversible over two or three decades, taking into account the state of available knowledge of the direct and indirect impact of harvesting, the effect of the introduction of alien species, the effects of associated activities on the marine ecosystem and of the effects of environmental changes, with the aim of making possible the sustained conservation of Antarctic marine living resources."*
1982	World Charter for Nature.[8]	United Nations' General Assembly Resolution.		*GENERAL PRINCIPLES* *"1. Nature shall be respected and its essential processes shall not be impaired.* *2. (. . .) habitats shall be safeguard.* *3. All areas of the earth, both land and sea, shall be subject to these principles of conservation; special protection shall be given to unique areas, (. . .) to the habitats of rare or endangered species.* *(. . .)* *5. Nature shall be secured against degradation caused by (. . .) hostile activities."*

(continued)

[8]UN General Assembly, *World Charter for Nature.*, 28 October 1982, A/RES/37/7, available at: https://digitallibrary.un.org/record/39295?ln=es[accessed 06 September 2020]

1985	Vienna Convention.[9]	Multilateral.	Article 2, para.1.	*Article 2: General obligations* *"1. The Parties shall take appropriate measures in accordance with the provisions of this Convention and of those protocols in force to which they are party to protect human health and the environment against adverse effects resulting or likely to result from human activities which modify or are likely to modify the ozone layer.* *(...)"*
1987	Declaration on the Second International Conference on the Protection of the North Sea.[10]	Regional Declaration.	Articles VII; XV item(ii); and XVI para. (1).	*Ministerial Declaration* *"(...)* *VII. Accepting that, in order to protect the North Sea from possibly damaging effects of the most dangerous substances, a precautionary approach is necessary which may require action to control inputs of such substances even before a causal link has been established by absolutely clear scientific evidence;* *(...)* *XV. Decide to:* *(...)* *(ii) accept that by combining, simultaneously and complementarily, approaches based on emission standards and environmental quality objectives, a more precautionary approach to dangerous substances will be established;*

(continued)

[9] *1985 Vienna Convention for the Protection of the Ozone Layer*, opened for signature 22 march 1985, (entered into forced 22 September 1988) UNTS 1513, (p.293).

[10] Second International Conference on the Protection of the North Sea, London, 27 November 1987.

				(. . .) *XVI. Therefore agree to:* *(. . .)* *l. accept the principle of safeguarding the marine ecosystem of the North Sea by reducing polluting emissions of substances that are persistent, toxic and liable to bioaccumulate at source by the use of the best available technology and other appropriate measures. This applies especially when there is reason to assume that certain damage or harmful effects on the living resources of the sea are likely to be caused by such substances, even where there is no scientific evidence to prove a causal link between emissions and effects ("the principle of precautionary action"); (. . .)"*
1987	The Montreal Protocol.[11]	Protocol, Multilateral.	Preamble, para (s). 6 and 8.	*Preamble.* *"(. . .) Determined to protect the ozone layer by taking precautionary measures to control equitably total global emissions of substances that deplete it, with the ultimate objective of their elimination on the basis of developments in scientific knowledge, taking into account technical and economic considerations and bearing in mind the developmental needs of developing countries,* *(. . .)*

(continued)

[11] Montreal Protocol on substances that deplete the ozone layer, opened for signature 16 September 1987, (entered into forced 01 January 1989) UNTS 26369.

				Noting the precautionary measures for controlling emissions of certain chlorofluorocarbons that have already been taken at national and regional levels, (. . .)"
1992	United Nations Framework Convention on Climate Change.[12]	Multilateral.	Article 3.	*Article 3.* *PRINCIPLES.* *"(. . .)* *3. The Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures, taking into account that policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost. To achieve this, such policies and measures should take into account different socio-economic contexts, be comprehensive, cover all relevant sources, sinks and reservoirs of greenhouse gases and adaptation, and comprise all economic sectors. Efforts to address climate change may be carried out cooperatively by interested Parties. (. . .)"*

(continued)

[12] United Nations Framework Convention on Climate Change, opened for signature 09 May 1992, (entered into forced 21 March 1994) UNTS 1771 (p.107).

1992	The Water Convention.[13]	Regional.	Article 2, para. 5, item (a).	*Article 2. General Provisions. "(...)5. (. . .) the Parties shall be guided by the following principles: (a) The precautionary principle, by virtue of which action to avoid the potential transboundary impact of the release of hazardous substances shall not to be postponed on the ground that scientific research has not fully proved a causal link between those substances, on the one hand, and the potential transboundary impact, on the other hand; (. . .)"*
1992	Rio Declaration.[14]	International.	Principle 15.	*Principle 15. "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."*
1992	The Maastricht Treaty.[15]	Regional.	Article 130r, para. (2).	*Title XVI Environment Article 130r "(. . .) 2. Community policy on the environment shall aim at a high level of protection taking into account the diversity of*

(continued)

[13] *Convention on the Protection and Use of Transboundary Watercourses and International Lakes*, adopted on 17 March 1992, (entered into forced 06 October 1996).

[14] Rio Declaration on Environment and Development, 14 June 1992, UN Doc. A/CONF.151/26/ Rev.1 Report of the UNCED Vol.1 (New York).

[15] Treaty on European Union, adopted on 07 February 1992, (entered into forced 01 November 1993) UNTS 298, (p.11).

				situations in the various regions of the Community. It shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay. Environmental protection requirements must be integrated into the definition and implementation of other Community policies. (. . .)"
1992	Convention on the Transboundary Effects of Industrial Accidents.[16]	Regional.	Article 3, para. 1.	*Article 3 General provisions "1. The Parties shall, taking into account efforts already made at national and international levels, take appropriate measures and cooperate within the framework of this Convention, to protect human beings and the environment against industrial accidents by preventing such accidents as far as possible, by reducing their frequency and severity and by mitigating their effects. To this end, preventive, preparedness and response measures, including restoration measures, shall be applied. (. . .)"*
1992	Helsinki Convention.[17]	Regional.	Article 3, para. 2.	*Article 3. Fundamental principles and obligations. "(. . .)*

(continued)

[16]Convention on the Transboundary Effects of Industrial Accidents, adopted on 17 March 1992, (entered into forced 19 April 2000) UNTS 2105, (p. 457), with Amendments as Adopted in 2015.

[17]Convention on the Protection of the Marine Environment of the Baltic Sea Area, opened for signature 17 March 1992, (entered into force 17 January 2000) 1507 UNTS.

				2. The Contracting Parties shall apply the precautionary principle, i.e., to take preventive measures when there is reason to assume that substances or energy introduced, directly or indirectly, into the marine environment may create hazards to human health, harm living resources and marine ecosystems, damage amenities or interfere with other legitimate uses of the sea even when there is no conclusive evidence of a causal relationship between inputs and their alleged effects. (. . .)"
1992	OSPAR Convention.[18]	Multilateral, Regional.	Article 2, para. 2, item a).	*Article 2. "(. . .) The Contracting Parties shall apply: a) the precautionary principle, by virtue of which preventive measures are to be taken when there are reasonable grounds for concern that substances or energy introduced, directly or indirectly, into the marine environment may bring about hazards to human health, harm living resources and marine ecosystems, damage amenities or interfere with other legitimate uses of the sea, even when there is no conclusive evidence of a causal relationship between the inputs and the effects; (. . .)"*

(continued)

[18]Convention for the Protection of the Marine Environment of the North-East Atlantic (opened for signature 22 September 1992, entered into force 25 March 1998) 2354 UNTS.

1994	Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Further Reduction of Sulphur Emissions.[19]	Protocol, Multilateral.	Preamble.	*Preamble.* *"(. . .) Resolved to take precautionary measures to anticipate, prevent or minimize emissions of air pollutants and mitigate their adverse effects, Convinced that where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures, taking into account that such precautionary measures to deal with emissions of air pollutants should be cost-effective, (. . .)"*
1994	Energy Charter Treaty.	Multilateral.	Article 19, para. (1).	*Article 19: Environmental Aspects* *"(1) In pursuit of sustainable development and taking into account its obligations under those international agreements concerning the environment to which it is party, each Contracting Party shall strive to minimise in an economically efficient manner harmful Environmental Impacts occurring either within or outside its Area from all operations within the Energy Cycle in its Area, taking proper account of safety. In doing so each Contracting Party shall act in a Cost-Effective manner. In its policies and actions each Contracting Party shall strive to take precautionary measures to prevent or minimise environmental degradation.(. . .)"*

(continued)

[19]Protocol to the 1979 Convention on Long-Range Transboundary Air Pollution on Further Reduction of Sulphur Emissions, Oslo, 14 June 1994, in force 05 August 1998, UNTS 2030, (p. 122).

1995	UN Fish Stocks Agreement.[20]	Multilateral, Regional.	Article 6.	*Article 6. Application of the precautionary approach. "1. States shall apply the precautionary approach widely to conservation, management and exploitation of straddling fish stocks and highly migratory fish stocks in order to protect the living marine resources and preserve the marine environment. 2. States shall be more cautious when information is uncertain, unreliable or inadequate. The absence of adequate scientific information shall not be used as a reason for postponing or failing to take conservation and management measures. 3. In implementing the precautionary approach, States shall: (a) improve decision-making (. . .) by obtaining and sharing the best scientific information available and implementing improved techniques for dealing with risk and uncertainty; (. . .) (c) take into account, inter alia, uncertainties (. . .) and the impact of fishing activities on non-target and associated or dependent species, as well as existing and predicted oceanic, environmental and socio-economic conditions;*

(continued)

[20] Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (UN Fish Stocks Agreement), 2167 UNTS 3.

				(d) develop data collection and research programmes to assess the impact of fishing on non-target and associated or dependent species and their environment, and adopt plans which are necessary to ensure the conservation of such species and to protect habitats of special concern. *(. . .)* *6. For new or exploratory fisheries, States shall adopt as soon as possible cautious conservation and management measures, including, inter alia, catch limits and effort limits. Such measures shall remain in force until there are sufficient data to allow assessment of the impact of the fisheries on the long-term sustainability of the stocks, whereupon conservation and management measures based on that assessment shall be implemented. The latter measures shall, if appropriate, allow for the gradual development of the fisheries.* 7. If a natural phenomenon has a significant adverse impact on the status of straddling fish stocks or highly migratory fish stocks, States shall adopt conservation and management measures on an emergency basis to ensure that fishing activity does not exacerbate such adverse

(continued)

				impact. States shall also adopt such measures on an emergency basis where fishing activity presents a serious threat to the sustainability of such stocks. (. . .)"
1996	London Protocol.[21]	Protocol, Multilateral.	Article 3, para. 1.	*Article 3. General Obligations "1. In implementing this Protocol, Contracting Parties shall apply a precautionary approach to environmental protection from dumping of wastes or other matter whereby appropriate preventative measures are taken when there is reason to believe that wastes or other matter introduced into the marine environment are likely to cause harm even when there is no conclusive evidence to prove a causal relation between inputs and their effects. (. . .)"*
1999	Convention on the Protection of the Rhine.[22]	Regional.	Article 4, item (a).	*Article 4 Principles "To this end, the Contracting Parties shall be guided by the following principles: (a) precautionary principle; (. . .)"*
2000	Cartagena Protocol on Biosafety.[23]	Multilateral.	Preamble, and Articles 1; 10 para. 6; and 11 para. 8.	*Preamble "(. . .) Reaffirming the precautionary approach contained in Principle*

(continued)

[21] 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention), London, 7 November 1996, in force 24 March 2006, 2006 ATS 11 (London Protocol).

[22] Convention on the Protection of the Rhine, adopted on 12 April 1999, (entered into forced 01 January 2003).

[23] Protocol to the 1992 Convention on Biological Diversity (Cartagena Protocol on Biosafety), Cartagena de Indias, adopted on 29 January 2000, (entered into force on 11 September 2003) UNTS 2226, (p.208).

				15 of the Rio Declaration on Environment and Development,(. . .)" *Article 1* *OBJECTIVE* *In accordance with the precautionary approach contained in Principle 15 of the Rio Declaration on Environment and Development, the objective of this Protocol is to contribute to ensuring an adequate level of protection in the field of the safe transfer, handling and use of living modified organisms resulting from modern biotechnology that may have adverse effects on the conservation and sustainable use of biological diversity, taking also into account risks to human health, and specifically focusing on transboundary movements.* *Article 10* *DECISION PROCE DURE* *"(. . .) 6. Lack of scientific certainty due to insufficient relevant scientific information and knowledge regarding the extent of the potential adverse effects of a living modified organism on the conservation and sustainable use of biological diversity in the Party of import, taking also into account risks to human health, shall not prevent that Party from taking a decision, as appropriate, with regard to the import of the living modified organism in question as referred to in*

(continued)

				paragraph 3 above, in order to avoid or minimize such potential adverse effects. (...)" *Article 11* *PROCEDURE FOR LIVING MODIFIED ORGANISMS INTENDED FOR DIRECT USE AS FOOD OR FEED, OR FOR PROCESSING* *"(...) 8. Lack of scientific certainty due to insufficient relevant scientific information and knowledge regarding the extent of the potential adverse effects of a living modified organism on the conservation and sustainable use of biological diversity in the Party of import, taking also into account risks to human health, shall not prevent that Party from taking a decision, as appropriate, with regard to the import of that living modified organism intended for direct use as food or feed, or for processing, in order to avoid or minimize such potential adverse effects. (...)"*
2001	Stockholm Convention on Persistent Organic Pollutants.[24]	Multilateral.	Preamble para. 8; and Articles 1, and 8 para. 9.	*Preamble* *"(...) Acknowledging that precaution underlies the concerns of all the Parties and is embedded within this Convention, (...)"* *Article 1* *Objective* *Mindful of the precautionary approach as set forth in Principle 15 of*

(continued)

[24] Stockholm Convention on Persistent Organic Pollutants, adopted on 22 May 2001, (entered into force on 17 May 2004) UNTS 2256, (p.119).

				the Rio Declaration on Environment and Development, the objective of this Convention is to protect human health and the environment from persistent organic pollutants. *Article 8* *"(. . .)* *9. The Committee shall, based on the risk profile referred to in paragraph 6 and the risk management evaluation referred to in paragraph 7 (a) or paragraph 8, recommend whether the chemical should be considered by the Conference of the Parties for listing in Annexes A, B and/or C. The Conference of the Parties, taking due account of the recommendations of the Committee, including any scientific uncertainty, shall decide, in a precautionary manner, whether to list the chemical, and specify its related control measures, in Annexes A, B and/or C."*
2003	Framework Convention for the Protection of the Marine Environment of the Caspian Sea.[25]	Regional.	Article 5, para. (a).	*Article 5. Principles* *"In the actions for goal achievement of this Convention and accomplishment of its provisions Contracting Parties are guided, including:* *(a) the principle of taking measures of precaution according to which, in the presence of threat of serious or irreversible*

(continued)

[25]Framework Convention for the Protection of the Marine Environment of the Caspian Sea, adopted on 04 November 2003, (entered into force on 12 August 2006).

				damage for the marine environment of the Caspian Sea, references to lack of complete scientific confidence are not used as the reason for delay of cost-efficient measures for the prevention of similar damage; (. . .)"
2014	The Polar Code.[26]	Multilateral, Regional (Polar waters).	Part II-A and Part II-B Pollution Prevention Measures.	See the Chapter 1 text with reference to "information" needs and applications from the Polar Code (2017)
2018	The CAO Fisheries Agreement.[27]	Multilateral, Regional.	Article 5, para. 1, item c).	Article 5. Review and Further Implementation. "(. . .) c) on the basis of the scientific information derived from the Joint Program of Scientific Research and Monitoring, from the national scientific programs, and from other relevant sources, and taking into account relevant fisheries management and ecosystem considerations, including the precautionary approach and potential adverse impacts of fishing on the ecosystems, consider, inter alia, whether the distribution, migration and abundance of fish in the Agreement Area would support a sustainable commercial fishery and, (. . .)."

[26] International Code for Ships Operating in Polar Waters (Polar Code), adopted on 94th Session of IMO's Maritime Safety Committee (MSC) in November 2014, entered into force 01 January 2017.

[27] 'Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean', 12.6.2018, COM (2018) 454 final, available at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52018PC0453&from=EN; last accessed 05 May 2020.

References

Ackoff, R. L. (1989). From data to wisdom. Presidential address to ISGSR, June 1988. *Journal of Applied Systems Analysis, 16*, 3–9. http://www-public.imtbs-tsp.eu/~gibson/Teaching/Teaching-ReadingMaterial/Ackoff89.pdf

Ackoff, R. L. (1999). *Ackoff's best: his classic writings on management*. John Wiley.

Ambassadorial Panel. (2015). *Building common interests in the Arctic Ocean*. University of Reykjavik. https://en.ru.is/news/arctic-high-seas-oct15

Ambassadorial Panel. (2016). *Building common interests in the Arctic Ocean*. University of Reykjavik. https://en.ru.is/news/building-common-interests-in-the-arctic-ocean-1

Arctic Council. (2004). *2005–2015 Arctic marine strategic plan*. Protection of the Arctic Marine Environment (PAME) Working Group. https://www.pame.is/document-library/amsp-documents/173-amsp-2005-2015/file

Arctic Council. (2015). 2015–2025 Arctic marine strategic plan. 9th Arctic Council Ministerial Meeting, Iqaluit. https://www.pame.is/document-library/amsp-documents/174-amsp-2015-2025/file

Arctic Council. (2016). In M. Carson & G. Peterson (Eds.), *Arctic resilience report*. Stockholm Environment Institute and Stockholm Resilience Centre. https://oaarchive.arctic-council.org/handle/11374/1838

Arctic Council Secretariat (2013) Vision for the Arctic. Arctic Council Secretariat, Kiruna, Sweden 15 May 2013

Arctic Frontiers (2020a) Arctic Frontiers 2020. Annual Report*: The Power of Knowledge.* Tromsø, Norway. (https://www.arcticfrontiers.com/conference/2020-the-power-of-knowledge/)

Arctic Frontiers (2020b) Arctic Frontiers 2020. Conference Summary. *The Power of Knowledge*. Tromsø, Norway. (https://www.arcticfrontiers.com/wp-content/uploads/2020/10/plenaryreport2020.pdf)

Arctic Marine Oil Pollution Preparedness Agreement (2013) Agreement on cooperation on marine oil pollution preparedness and response in the Arctic. Signed: 15 May 2013, Kiruna, Sweden Entry into Force: 25 March 2016. https://oaarchive.arctic-council.org/handle/11374/529

Arctic Science Agreement (2017) *Agreement on Enhancing International Arctic Scientific Cooperation*. Signed Fairbanks, Alaska, United States, 11 May 2017. Entry into Force, 23 May 2018. (https://www.state.gov/e/oes/rls/other/2017/270809.htm)

Arctic Search and Rescue Agreement (2011) Agreement on cooperation on aeronautical and maritime search and rescue in the Arctic. Signed: 12 May 2011, Nuuk, Greenland Entry into Force: 19 January 2013. (https://oaarchive.arctic-council.org/handle/11374/531)

Balton, D. A. (2019). What will the BBNJ agreement mean for the Arctic fisheries agreement? *Marine Policy, 109*, 103745. https://www.sciencedirect.com/science/article/abs/pii/S0308597X1930449X

Balton, D. A. (2020). Chapter 21 implementing the new Arctic fisheries agreement. In T. Heidar (Ed.), *New knowledge and changing circumstances in the law of the sea* (pp. 429–445). Brill Nkjhoff. https://doi.org/10.1163/9789004437753_023

Banet, C. (Ed.). (2020). *The law of the seabed: access, uses, and protection of seabed resources*. Brill Nijhoff.

Berger, A. (1988). Milankovitch theory and climate. *Reviews of Geophysics, 26*(4), 624–657. https://www.researchgate.net/publication/230890888_Milankovitch_Theory_and_Climate

Berkes, F., Folke, C., & Colding, J. (Eds.). (2000). *Linking social and ecological systems: management practices and social mechanisms for building resilience*. University of Cambridge Press.

Berkes, F., Colding, J., & Folke, C. (2008). *Navigating social-ecological systems: building resilience for complexity and change*. Cambridge University Press.

Berkman, P. A. (2002). *Science into policy: global lessons from Antarctica*. Academic.

Berkman, P. A. (2009). International spaces promote peace. *Nature, 462*, 412–413. https://www.nature.com/articles/462412a

Berkman, P. A. (2011). President Eisenhower, the Antarctic treaty and origin of international spaces. In P. A. Berkman, M. A. Lang, D. W. H. Walton, & O. R. Young (Eds.), *Science diplomacy: antarctica, science and the governance of international spaces* (pp. 17–28). Smithsonian Institution Scholarly Press. https://repository.si.edu/handle/10088/16154

Berkman, P. A. (2012). 'Common interests' as an evolving body of international law: applications for Arctic Ocean stewardship. In R. Wolfrum (Ed.), *Arctic Marine Science, International Law and Climate Protection. Legal Aspects of Future Marine Science in the Arctic Ocean* (pp. 155–174). Springer.

Berkman, P. A. (2013) Preventing and Arctic Cold War. New York Times 12 March 2013. https://www.nytimes.com/2013/03/13/opinion/preventing-an-arctic-cold-war.html

Berkman, P. A. (2015). Institutional dimensions of sustaining Arctic observing networks (SAON). *Arctic, 68*(Suppl. 1). https://doi.org/10.14430/arctic4499

Berkman, P. A. (2019). Evolution of science diplomacy and its local-global applications. Special issue, 'broadening soft power in EU-US relations'. *European Foreign Affairs Review, 24*, 63–79. https://www.ingsa.org/wp-content/uploads/2019/09/Evolution-of-Science-Diplomacy-and-its-Local-Global-Applications_23JUL19.pdf

Berkman, P. A. (2020a). Science diplomacy and it engine of informed Decisionmaking: operating through our global pandemic with humanity. *The Hague Journal of Diplomacy, 15*, 435–450. https://brill.com/view/journals/hjd/15/3/article-p435_13.xml

Berkman, P. A. (2020b) 'The pandemic lens': focusing across time scales for local-global sustainability. *Patterns* 1(8): 13 November 2020. 4p. https://pubmed.ncbi.nlm.nih.gov/33294877/

Berkman, P. A. (2020c). Chapter 6. Polar science diplomacy. In K. N. Scott & D. VanderZwaag (Eds.), *Research Handbook on Polar Law* (pp. 105–123). Edward Elgar.

Berkman, P. A., & Vylegzhanin, A. N. (Eds.). (2012a). *Environmental security in the Arctic Ocean. NATO Science for Peace and Security Series* (p. 459p). Springer. https://www.springer.com/gp/book/9789400747128

Berkman, P. A., & Vylegzhanin, A. N. (2012b). Conclusion: building common interests in the Arctic Ocean. In P. A. Berkman & A. N. Vylegzhanin (Eds.), *Environmental security in the Arctic Ocean. NATO Science for Peace and Security Series* (pp. 371–404). Springer. https://www.springer.com/gp/book/9789400747128

Berkman, P. A., & Vylegzhanin, A. N. (2020). Training Skills with Common-Interest Building. *Science Diplomacy Action* 4:1–65. [Student-Ambassador Declarations (2016–2020) from the Joint Video-Conferencing Course on *Science Diplomacy: Environmental Security and Law in the Arctic Ocean* with the Fletcher School of Law and Diplomacy at Tufts University (United States) and International Law Programme at MGIMO University (Russian Federation)]. https://scidiplo.org/wp-content/uploads/2020/11/Synthesis_4.pdf

Berkman, P. A., & Young, O. R. (2009). Governance and environmental change in the Arctic Ocean. *Science, 324*, 339–340. https://science.sciencemag.org/content/324/5925/339

Berkman, P. A., Lang, M. A., Walton, D. W. H., & Young, O. R. (Eds.). (2011). *Science diplomacy: Antarctica, science and the governance of international spaces*. Smithsonian Institution Scholarly Press. https://repository.si.edu/handle/10088/16154

Berkman, P. A., Kullerud, L., Pope, A., Vylegzhanin, A. N., & Young, O. R. (2017). The Arctic science agreement propels science diplomacy. *Science, 358*, 596–598. https://science.sciencemag.org/content/358/6363/596

Berkman, P. A., Vylegzhanin, A. N., & Young, O. R. (2019). *Baseline of Russian Arctic Laws*. Springer. https://www.springer.com/gp/book/9783030062613

Berkman, P. A., Young, O. R., & Vylegzhanin, A. N. (2020). *Preface for the book series on informed Decisionmaking for sustainability. IN: Young, O.R., Berkman, P.A. and Vylegzhanin (eds.) Volume 1: Governing Arctic Seas: Regional Lessons from the Bering Strait and Barents Sea*. Springer. https://link.springer.com/content/pdf/bfm%3A978-3-030-25674-6%2F1.pdf

Briner, J. P., Cuzzone, J. K., Badgeley, J. A., Young, N. E., Steig, E. J., Morlighem, M., Schlegel, N.-J., Hakim, G. J., Schaefer, J. M., Johnson, J. V., Lesnek, A. J., Thomas, E. K., Allan, E., Bennike, O., Cluett, A. A., Csatho, B., de Vernal, A., Downs, J., Larour, E., & Nowicki,

S. (2020). Rate of mass loss from the Greenland ice sheet will exceed Holocene values this century. *Nature, 586*, 70–74. https://www.nature.com/articles/s41586-020-2742-6
Bull, H., Kingsbury, B., & Roberts, A. (1995). *Hugo Grotius and international relations*. Clarendon Press.
Bunders, J. F. G., Broerse, J. E. W., Keil, F., Pohl, C., Scholz, R. W., & Zweekhorst, M. B. M. (2010). *How can transdisciplinary research contribute to knowledge democracy? IN: in 't veld, Roel (Ed.) Knowledge Democracy: Consequences for Science, Politics, and Media* (pp. 125–152). Springer. https://www.researchgate.net/publication/274239011_Knowledge_Democracy
CAO High Seas Fisheries Agreement. (2018). Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean. Signed: Ilulissat, 3 October 2018. Entry into Force: pending remaining ratification by China. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2018:453:FIN
Carmack, E., Polyakov, I., Padman, L., Fer, I., Hunke, E., Hutchings, J., Jackson, J., Kelley, D., Kwok, R., Layton, C., Melling, H., Perovich, D., Persson, O., Ruddick, B., Timmermans, M.-L., Toole, J., Ross, T., Vavrus, S., & Winsor, P. (2015). Toward quantifying the increasing role of oceanic heat in sea ice loss in the new Arctic. *Bulletin of the American Meteorological Society, 96*(12), 2079–2105. https://journals.ametsoc.org/downloadpdf/journals/bams/96/12/bams-d-13-00177.1.xml
CBS News. (2018). California now has the world's 5th largest economy. CBS News, 4 May 2018. https://www.cbsnews.com/news/california-now-has-the-worlds-5th-largest-economy/
Convention on the High Seas. (1958). Convention on the high seas. Signed: Geneva, 29 April 1958 Entry into Force: 30 September 1962. https://treaties.un.org/pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXI-2&chapter=21
De Lucia, V. (2019). The BBNJ negotiations and ecosystem governance in the Arctic. *Marine Policy, 110*, 103756. http://refhub.elsevier.com/S0308-597X(20)30860-5/sref32)
DeEicken H., Lee OA, Lovecraft AL (2016) Evolving roles of observing systems and data co-management in Arctic Ocean governance. *OCEANS 2016, Marine Technology Societ*y. pp. 1-8 (https://ieeexplore.ieee.org/document/7761298)
Eddy, J. A. (2009). *The sun, the earth and the near-earth space: A guide to the sun-earth system*. National Aeronautics and Space Administration. https://lwstrt.gsfc.nasa.gov/images/pdf/john_eddy/SES_Book_Interactive.pdf
Ehlers, E., & Thomas Krafft, T. (Eds.). (2006). *Earth system science in the Anthropocene*. Springer.
Ehrlich, P. R., & Holdren, J. P. (1971). Impact of population growth. *Science, 171*, 1212–1217. https://science.sciencemag.org/content/171/3977/1212
Falardeau, M., & Bennett, E. M. (2020). Towards integrated knowledge of climate change in Arctic marine systems: a systematic literature review of multidisciplinary research. *Arctic Science, 6*, 1–23. https://cdnsciencepub.com/doi/10.1139/as-2019-0006
Fiske, G. (2021). Indigenous Peoples of the Arctic boundary polygons, 2021. *Arctic Data Center*. https://doi.org/10.18739/A24746S61
Freestone, D. (Ed.). (2019). *Conserving biodiversity in areas beyond National Jurisdiction*. Brill Nijhoff.
Gad, U. P., & Strandsbjerg, J. (Eds.). (2019). *The politics of sustainability in the Arctic. Reconfiguring identity, space, and time*. Routledge.
Graybill, J. K., & Petrov, A. N. (Eds.). (2020). *Arctic sustainability, key methodologies and knowledge domains. A Synthesis of Knowledge*. Routledge.
GRID-Arendal. (2021). Global Resource Information Database (GRID) Partner of the United Nations Environmental Programme in Arendal, Norway. https://www.grida.no/
Guterres, A. (2020). 'Transcript of UN Secretary-General's virtual press encounter to launch the report on the socio-economic impacts of COVID-19'. United Nations Secretary-General, 31 March 2020. https://www.un.org/sg/en/content/sg/press-encounter/2020-03-31/transcript-of-un-secretary-general%E2%80%99s-virtual-press-encounter-launch-the-report-the-socio-economic-impacts-of-covid-19

Hardin, G. (1968). The tragedy of the commons. *Science, 162*, 1243–1248. https://science.sciencemag.org/content/162/3859/1243

Hoag, H. (2017). Nations put science before fishing in the Arctic. *Science, 358*, 1235. https://science.sciencemag.org/content/sci/358/6368/1235.full.pdf

Holdren, J. P. (2008). Science and technology for sustainable well-being. *Science, 319*, 424–434. https://science.sciencemag.org/content/319/5862/424

Holland, M. M., & Bitz, C. M. (2003). Polar amplification of climate change in coupled models. *Climate Dynamics, 21*, 221–232. https://link.springer.com/article/10.1007/s00382-003-0332-6

Hopkins, D. M. (1967). *The Bering land bridge*. Stanford University Press.

Indigenous Peoples Secretariat. (2021a). Indigenous Peoples Secretariat of the Arctic Council. https://www.arcticpeoples.com/

Ilulissat Declaration. (2008). *Declaration from the Arctic Ocean Conference*. Declared by Canada, Denmark, Norway, Russian Federation and United States. Ilulissat, 28 May 2008

Indigenous Peoples Secretariat. (2021b). *Arctic indigenous languages and revitalization: an online educational resource*. Indigenous Peoples Secretariat. https://www.arcticpeoples.com/arctic-languages#feedback

Jakobsson, M., Grantz, A., Kristoffersen, Y., Macnab, R., MacDonald, R. W., Sakshaug, E., Stein, R., & Jokat, W. (2004). The Arctic Ocean: boundary conditions and background information. In R. Stein & R. W. MacDonald (Eds.), *The organic carbon cycle in the Arctic Ocean*. Springer. https://doi.org/10.1007/978-3-642-18912-8_1

Jakobsson, M., Pearce, C., Cronin, T. M., Backman, J., Anderson, L. G., Barrientos, N., Björk, G., Coxall, H., de Boer, A., Mayer, L. A., Mörth, C.-M., Nilsson, J., Rattray, J. E., Stranne, C., Semiletov, I., & O'Regan, M. (2017). Post-glacial flooding of the Bering land bridge dated to 11 cal ka BP based on new geophysical and sediment records. *Climate of the Past, 13*, 991–1005. https://doi.org/10.5194/cp-13-991-2017

James, R. H., Bousquet, P., Bussmann, I., Haeckel, M., Kipfer, R., Leifer, I., Niemann, H., Ostrovsky, I., Piskozub, J., Rehder, G., Treude, T., Vielstädte, L., & Greinert, J. (2016). Effects of climate change on methane emissions from seafloor sediments in the Arctic Ocean: A review. *Limnology and Oceanography, 61*, S283–S299. https://doi.org/10.1002/lno.10307

King, M. L. (1964). The quest for peace and justice. Nobel Peace Prize Lecture, 11 December 1964, Oslo. https://www.nobelprize.org/prizes/peace/1964/king/lecture/

Kish, J. (1973). *The law of international spaces*. A. W. Sijthoff.

Kondratyev, K. Y., & Hunt, G. E. (1982). *Weather and climate on planets*. Elsevier.

Krebs, C. J. (1972). *Ecology: the experimental analysis of distribution and abundance*. Harper & Row.

Lee, C.M., Starkweather, S., Eicken, H., Timmermans, M.L., Wilkinson, J., Sandven, S., Dukhovskoy, D., Gerland, S., Grebmeier, J., Intrieri, J.M., Kang, S.Hj., McCammon, M, Nguyen, A.T., Polyakov, I., Rabe, B., Sagen, H., Seeyave, S., Volkov, D., Beszczynska-Möller, A., Chafik, L., Dzieciuch, M., Goni, G., Hamre, T., King, A.L., Olsen, A., Raj, R.P, Rossby, T., Skagseth, Ø., Søiland, H., & Sørensen, K. (2019). A framework for the development, design and implementation of a sustained Arctic Ocean observing system. *Frontiers in Marine Science* 6: (19 August 2019):1–21. https://www.frontiersin.org/articles/10.3389/fmars.2019.00451/full

Lucretius, 55 BCE. On the Nature of Things (De Rerum Natura). Rome. [Translated by Stallings, A.E. 2007. Penguin Classics]

Meredith, M., Sommerkorn, M., Cassotta, S., Derksen, C., Ekaykin, A., Hollowed, A., Kofinas, G., Mackintosh, A., Melbourne-Thomas, J., Muelbert, M. M. C., Ottersen, G., Pritchard, H., & Schuur, E. A. G. (2019). Chapter 3. Polar regions. In H.-O. Pörtner, D. C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, & N. M. Weyer (Eds.), *IPCC special report on the ocean and cryosphere in a changing climate* (pp. 203–320) https://www.ipcc.ch/srocc/

NASA. (2012). *Arctic sea ice hits smallest extent in satellite era*. National Aeronautics and Space Administration. https://www.nasa.gov/topics/earth/features/2012-seaicemin.html

National Research Council. (2014). *The Arctic in the Anthropocene. Emerging research questions*. National Academies Press. http://nap.edu/18726
Nature. (2020). Editorial. Arctic Science Cannot Afford a New Cold War. *Nature* 30 September 2020. https://www.nature.com/articles/d41586-020-02739-x
Ottawa Declaration. (1996). *Declaration on the Establishment of the Arctic Council*. 19 September 1996, Ottawa: Foreign Affairs and International Trade Canada. https://oaarchive.arctic-council.org/handle/11374/85
PAME. (2013). The Arctic Ocean Review Project, Final Report, (Phase II 2011–2013). Protection of the Arctic Marine Environment (PAME) Secretariat, Akureyri. https://www.pame.is/projects/arctic-marine-shipping/the-arctic-ocean-review-aor
Platjouw, F. M. (2019). Dimensions of transboundary legal coherence needed to foster ecosystem-based governance in the Arctic. *Marine Policy, 110*, 103666. https://www.sciencedirect.com/science/article/pii/S0308597X19303185
Polar Code. (2017). *International Code for Ships Operating in Polar Waters (Polar Code). Marine Environmental Protection Committee, MEPC 68/21/Add. 1, Annex 10. International Maritime Organization*. Entry into Force 1 January 2017. http://www.imo.org/en/MediaCentre/HotTopics/polar/Pages/default.aspx
National Park Service. (2020). *The United Nations Memorial Service at Muir Woods*. United States National Park Service. https://www.nps.gov/articles/the-united-nations-memorial-service-at-muir-woods.htm
Pan, M., & Huntington, H. P. (2016). A precautionary approach to fisheries in the Central Arctic Ocean: policy, science, and China. *Marine Policy, 63*, 153–157. https://doi.org/10.1016/j.marpol.2015.10.015
Petrov, A. N., BurnSilver, S., Chapin, F. S., Fondahl, G., Graybill, J. K., Keil, K., Nilsson, A. E., Riedlsperger, R., & Schweitzer, P. (2017). *Arctic sustainability research past, present and future*. Routledge.
Pistone, K., Eisenman, I., & Ramanathan, V. (2014). Observational determination of albedo decrease caused by vanishing Arctic Sea ice. *Proceedings of the National Academy of Sciences, 111*(9), 3322–3326. https://doi.org/10.1073/pnas.1318201111
Pongrácz, E., Pavlov, V., & Hänninen, N. (Eds.). (2020). *Arctic marine sustainability Arctic maritime businesses and the resilience of the marine environment*. Springer.
Roberts, A., Hinzman, L., Walsh, J. E., Holland, M., Cassano, J., Döscher, R., Mitsudera, H., & Sumi, A. (2010). A science plan for regional Arctic system modeling. A report to the National Science Foundation from the International Arctic Science Community. International Arctic Research Center, University of Alaska Fairbanks
Roston, E. (2016). The world has discovered a $1 Trillion Ocean. *Bloomberg* 21 January 2016
Rowley, J. (2007). The wisdom hierarchy: representations of the DIKW hierarchy. *Journal of Information Science, 33*(2), 163–180. https://doi.org/10.1177/0165551506070706
Ruffert, M., & Steinecke, S. (2011). The global administrative law of science. In *Beiträge zum ausländischen öffentlichen Recht und Völkerrecht (Veröffentlichungen des Max-Planck-Instituts für ausländisches öffentliches Recht und Völkerrecht), Volume 228*. Springer. https://doi.org/10.1007/978-3-642-21359-5_2
Schatz, V. J., Proelss, A., & Liu, N. (2019). The 2018 Agreement to prevent unregulated high seas fisheries in the Central Arctic Ocean: A critical analysis. *International Journal of Marine and Coastal Law, 34*(2), 195–244. https://brill.com/view/journals/estu/34/2/article-p195_2.xml
Shakhova, N., Semiletov, I., Salyuk, A., Yusupov, V., Kosmach, D., & Gustafsson, Ö. (2010). Extensive methane venting to the atmosphere from sediments of the east Siberian Arctic shelf. *Science, 327*, 1246–1250. https://science.sciencemag.org/content/327/5970/1246
Shupe, M. D., Rex, M., Dethloff, K., Damm, E., Fong, A. A., Gradinger, R., Heuzé, C., Loose, B., Makarov, A., Maslowski, W., Nicolaus, M., Perovich, D., Rabe, B., Rinke, A., Sokolov, V., & Sommerfeld, A. (2020). The MOSAiC expedition: a year drifting with the Arctic sea ice. In *Arctic Report Card, Update for 2020*. National Oceanic and Atmospheric Administration. https://repository.library.noaa.gov/view/noaa/27898

Steil, B. (2013). *The Battle of Bretton woods: John Maynard Keynes, Harry Dexter white, and the making of a New World order*. Princeton University Press.

Steinveg, B. (2020). The role of conferences within Arctic governance. *Polar Geography, 43*. https://doi.org/10.1080/1088937X.2020.1798540

Støre, J. G. (2010). The Norwegian high north policy. *Foreign Minister* Speech, Norwegian Ministry of Foreign Affairs, Oslo 7 June 2010. https://www.regjeringen.no/en/aktuelt/m/id609025/

Stuecker, M. F., Bitz, C. M., Armour, K. C., Proistosescu, C., Kang, S. M., Xie, S. P., Kim, D., McGregor, S., Zhang, W., Zhao, S., Cai, W., Dong, Y., & Jin, F. F. (2018). Polar amplification dominated by local forcing and feedbacks. *Nature Climate Change, 8*, 1076–1081. https://doi.org/10.1038/s41558-018-0339-y

Sultan, N., Plaza-Faverola, A., Vadakkepuliyambatta, S., Buenz, S., & Knies, J. (2020). Impact of tides and sea-level on deep-sea Arctic methane emissions. *Nature Communications, 11*, 5087. (2020). https://doi.org/10.1038/s41467-020-18899-3

Tunnicliffe, V., Metaxas, A., Jennifer Le, J., Ramirez-Llodra, E., & Levin, L. A. (2020). Strategic environmental goals and objectives: setting the basis for environmental regulation of deep seabed mining. *Marine Policy, 114*, 103347. https://www.sciencedirect.com/science/article/pii/S0308597X1830321X

UArctic. (2017). *Science diplomacy thematic network*. University of the Arctic. https://www.uarctic.org/organization/thematic-networks/science-diplomacy/

UNITAR. (2019a). *Retreat for directors of Arab diplomatic academies and institutes*. United Nations Institute for Training and Research. https://www.unitar.org/event/full-catalog/retreat-directors-arab-diplomatic-academies-and-institutes

UNITAR. (2019b). *Diplomacy 4.0 training programme*. Geneva: United Nations Institute for Training and Research. https://unitar.org/about/news-stories/news/united-nations-diplomacy-40-training-programme

UNITAR. (2020a). *Science diplomacy and informed decision-making during our global pandemic*. United Nations Institute for Training and Research. https://www.unitar.org/event/full-catalog/science-diplomacy-and-informed-decision-making-during-our-global-pandemic

UNITAR. (2020b). *Executive diploma on international law*. United Nations Institute for Training and Research. https://www.unitar.org/event/full-catalog/executive-diploma-international-law-online

UNITAR. (2021). *Executive summer programme on innovations in science diplomacy*. United Nations Institute for Training and Research. https://www.unitar.org/event/full-catalog/unitar-executive-summer-programme-innovations-science-diplomacy

United Nations. (1945). *United Nations Archive: United Nations Conference on International Organization* (UNCIO) (1945) – AG-012. https://search.archives.un.org/united-nations-conference-on-international-organization-uncio-1945

United Nations. (1982). *United Nations Convention on the law of the sea.* (Signed: Montego Bay, 10 December 1982; entry into force: 16 November 1994). https://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf

United Nations. (1987). Our common future: from one earth to one world. Report Transmitted to the General Assembly as an Annex to Resolution A/RES/42/187. World Commission on Environment and Development, New York. https://sustainabledevelopment.un.org/content/documents/5987our-common-future.pdf

United Nations. (1992). *United Nations Framework Convention on Climate Change*. (Signed: Rio de Janeiro, 9 May 1992; Entry into Force: 21 March 1994). https://unfccc.int/sites/default/files/convention_text_with_annexes_english_for_posting.pdf

United Nations. (2015). *Transforming Our World: The 2030 Agenda for Sustainable Development.* Res. A/RES/70/1 (25 September 2015). United Nations General Assembly, New York. https://sustainabledevelopment.un.org/post2015/transformingourworld/publication

Verne, J. (1865). *De la Terre á la Lune*. Pierre-Jules Hetze.

Vienna Convention (1969) Vienna convention on the law of treaties. Signed: 23 May 1969, Vienna, Austria; Entry into Force: 27 January 1980

Vienna Dialogue Team. (2017). A global network of science and technology advice in foreign ministries. *Science Diplomacy Action, 1*, 1–20. https://scidiplo.org/wp-content/uploads/2020/11/Synthesis_1.pdf

Vincent, W. F., Canário, J., & Boike, J. (2019). Understanding the terrestrial effects of Arctic Sea ice decline. *Transactions of the American Geophysical Union (Eos)* 100, 17 July 2019. https://doi.org/10.1029/2019EO128471

Vörösmarty, C. J., McGuire, A, D., & Hobbie, J. E. (2010) Scaling studies in Arctic system science and policy support. *A Call-to-Research.* U.S. Arctic Research Commission. Anchorage. https://digital.library.unt.edu/ark:/67531/metadc949504/

Vörösmarty, C., Rawlins, M., Hinzman, L., Francis, J., Serreze, M., Liljedahl, A., McDonald, K., Piasecki, M., & Rich, R. (2018). *Opportunities and challenges in Arctic system synthesis: A consensus report from the Arctic research community*. City University of New York. https://www.arcus.org/publications/28459

Vylegzhanin, A. N., Young, O. R., & Berkman, P. A. (2020). The Central Arctic Ocean fisheries agreement as an element in the evolving Arctic Ocean governance complex. *Marine Policy, 118*, 1–10. https://www.sciencedirect.com/science/article/abs/pii/S0308597X20301780

Winton, M. (2006). Amplified Arctic climate change: what does surface albedo feedback have to do with it? *Geophysical Research Letters, 33*, *L03701*. https://doi.org/10.1029/2005GL025244

World Mayors Summit. (2019). C40 world mayors Summit. Copenhagen, 9–12 October 2019. https://c40summit2019.org/agenda/

World Economic Forum. (2016). *Arctic investment protocol. Guidelines for responsible investment in the Arctic*. World Economic Forum. http://www3.weforum.org/docs/WEF_Arctic_Investment_Protocol.pdf

Young, O. R., Berkman, P. A., & Vylegzhanin, A. N. (2020a). Chapter 15: conclusions. In O. R. Young, P. A. Berkman, & A. N. Vylegzhanin (Eds.), *Informed decisionmaking for sustainability. Volume 1. Governing Arctic Seas: Regional Lessons from the Bering Strait and Barents Sea* (pp. 341–353). Springer. https://link.springer.com/chapter/10.1007/978-3-030-25674-6_15

Young, O. R., Berkman, P. A., & Vylegzhanin, A. N. (Eds.). (2020b). *Informed decisionmaking for sustainability. Volume 1. Governing Arctic seas: regional lessons from the Bering Strait and Barents Sea*. Springer. https://link.springer.com/book/10.1007/978-3-030-25674-6

Author Queries

Chapter No.: 1	426463_1_En

Query Refs.	Details Required	Author's response
AU1	Please check and confirm, whether all author affiliations details are fine?	
AU2	"Greybill and Petrov 2020" is cited in text, but its detail is not provided in the list of references. Please provide.	