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**Institutional Dimensions of  
Sustaining Arctic Observing Networks  
(SAON)**

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## **ABSTRACT**

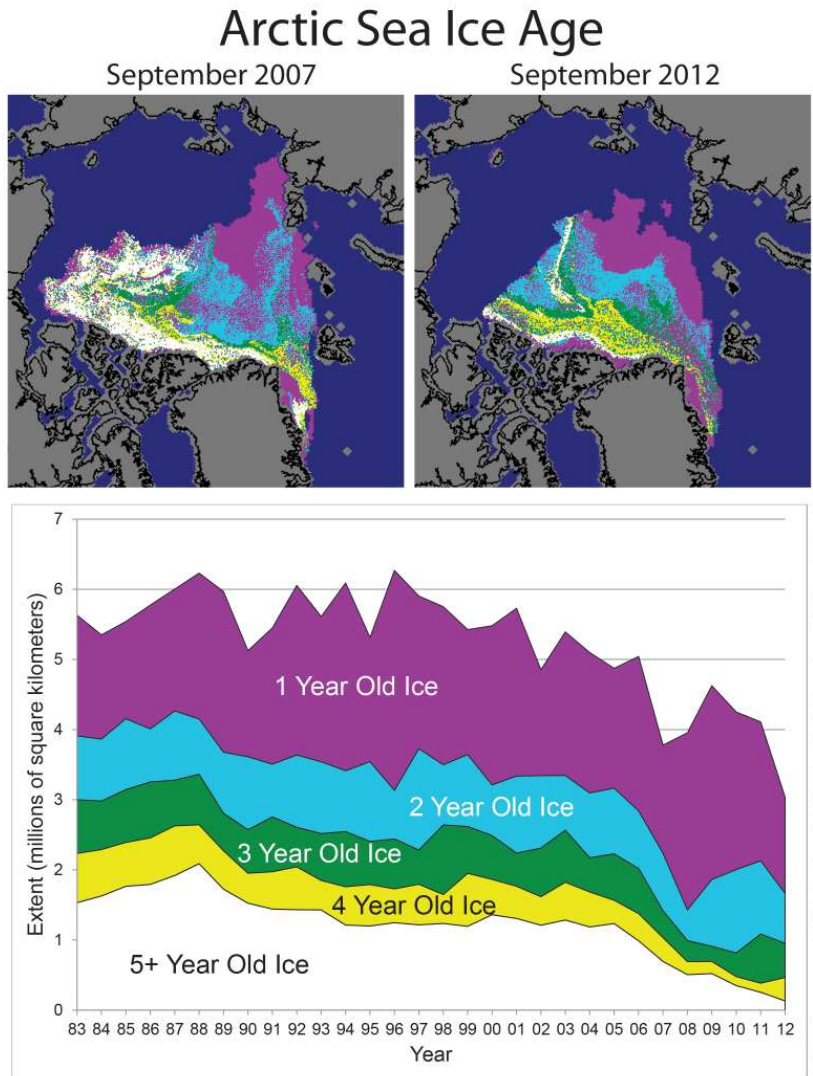
Sustaining Arctic Observing Networks (SAON) implies a system of different sensors that are generating data to be preserved, interpreted and applied in a continuous manner over a long period on a pan-Arctic scale. This paper neither defines the components of SAON nor the duration of its operation, other than to suggest that it will be operational as long as the majority of the Arctic Ocean is open water during the summer. This paper does, however, summarize the current institutional framework that relates to data generation and utilization as well as decision-making in the Arctic Ocean and surrounding coastal areas. Sustainable solutions will necessarily involve those institutions that have the financial, logistic, policy and legal capacity to support infrastructure in the Arctic Ocean region into the future. Three options are introduced in this paper to support SAON as a key element of the infrastructure that will be required in the Arctic Ocean into the future. Option 1 would be for the Arctic coastal states to mandate that a portion of lease-hold payments from energy companies pay be earmarked for general-purpose infrastructure development in the Arctic Ocean region with specific inclusion of SAON. Option 2 would be for the Arctic Council, as part of its remit for international cooperation, to spread the burden of supporting the SAON among the Arctic states and non-Arctic states as well as indigenous peoples. Option 3 would be coordination among the diverse organizations and institutions with Arctic remits to support SAON. In conclusion - beyond its origin and justification within the scientific community - SAON is necessary for operational decision-making with regard to all of the commercial activities that are emerging in the Arctic Ocean (involving search and rescue as well as emergency response and preparedness), which governments expect and hope to develop in a sustainable manner.

## **INTRODUCTION**

Historically, boundaries of the Arctic Ocean system have been the sea floor, surrounding land areas and its permanent sea-ice cap. With inflow and outflow from the North Pacific and North Atlantic, this marine system effectively turns on and off with seasonal solar forcing constrained by tilt of the Earth's axis, which is why the Arctic Circle is at 66.5 degrees North latitude (an unambiguous astronomical boundary to delimit the Arctic Ocean). The resulting oceanography and meteorology of the Arctic Ocean directly influences natural ecosystems and adjacent human populations of indigenous peoples and surrounding coastal states of Norway, Denmark, Canada, United States, Russian Federation and Iceland as well as non-coastal Arctic states of Sweden and Finland.

The Arctic Ocean had been characterized by sea ice accreting over many years and then persisting year-round as part of an environmental process repeated for millennia. In fact, until the 21<sup>st</sup> century, the Arctic Ocean was covered mostly by multi-year sea ice in contrast to the Southern Ocean around Antarctica, where first-year sea ice predominates. This has changed.

Within the past decade, the Arctic Ocean has transformed from a permanent sea-ice cap to a seasonally ice-free sea, which is now dominated by open water during the summer and first-year sea ice during the winter (Fig. 1). Each year, Arctic sea ice shrinks to its minimum extent in September and then grows to its maximum extent in March. Since satellite measurements of the Arctic Ocean began in 1979, the six lowest sea-ice minima have occurred in the past six years. Moreover, the absolute minimum extent of Arctic sea ice recorded during the satellite era was last year on 16 September 2012.



**FIGURE 1:** Environmental state-change in the Arctic Ocean system associated with the diminishing sea ice, as reflected by multi-year sea ice being replaced by first-year sea ice from 1983 to 2012 (NSIDC 2012). It is noteworthy that open water dominates during the summer with first-year sea ice in the Arctic Ocean, especially along the Russian coast from the Bering Strait to the Barents Sea. In contrast, most of the multi-year sea ice in the Arctic Ocean remains adjacent to the North American coast.

The diminishing sea-ice cap of the Arctic Ocean is analogous to removing your office ceiling, which would dramatically alter your inside behaviors. The fundamental change in the sea-surface boundary of the Arctic Ocean is creating a new natural system with different dynamics than anything previously experienced by humans in the region and it is happening on the time scale of years rather than decades.

Rather than projecting out to the mid-21<sup>st</sup> century when the Arctic Ocean may be open water across the North Pole, we can see that the system already has crossed a threshold with more than 50% of the sea ice newly forming each year (Fig. 1). Like a fertile land area

becoming a desert or a glacier becoming a mountain valley, the Arctic Ocean is experiencing an environmental state-change where the boundary conditions and dynamics of the system are fundamentally replaced.

Implications of the environmental state-change in the Arctic Ocean relate to all human activities and natural ecosystems in the region. **To both understand and respond to the impacts of the environmental state-change in the Arctic Ocean, it is essential to have accurate, timely and repeatable measurements of its geophysical, chemical and biological dynamics. Such measurements will require a stable and continuously operating network of instruments across the entire Arctic Ocean region, requiring the logistics and financial support especially from the Arctic states.**

## **SUSTAINABLE DEVELOPMENT IN THE ARCTIC OCEAN REGION**

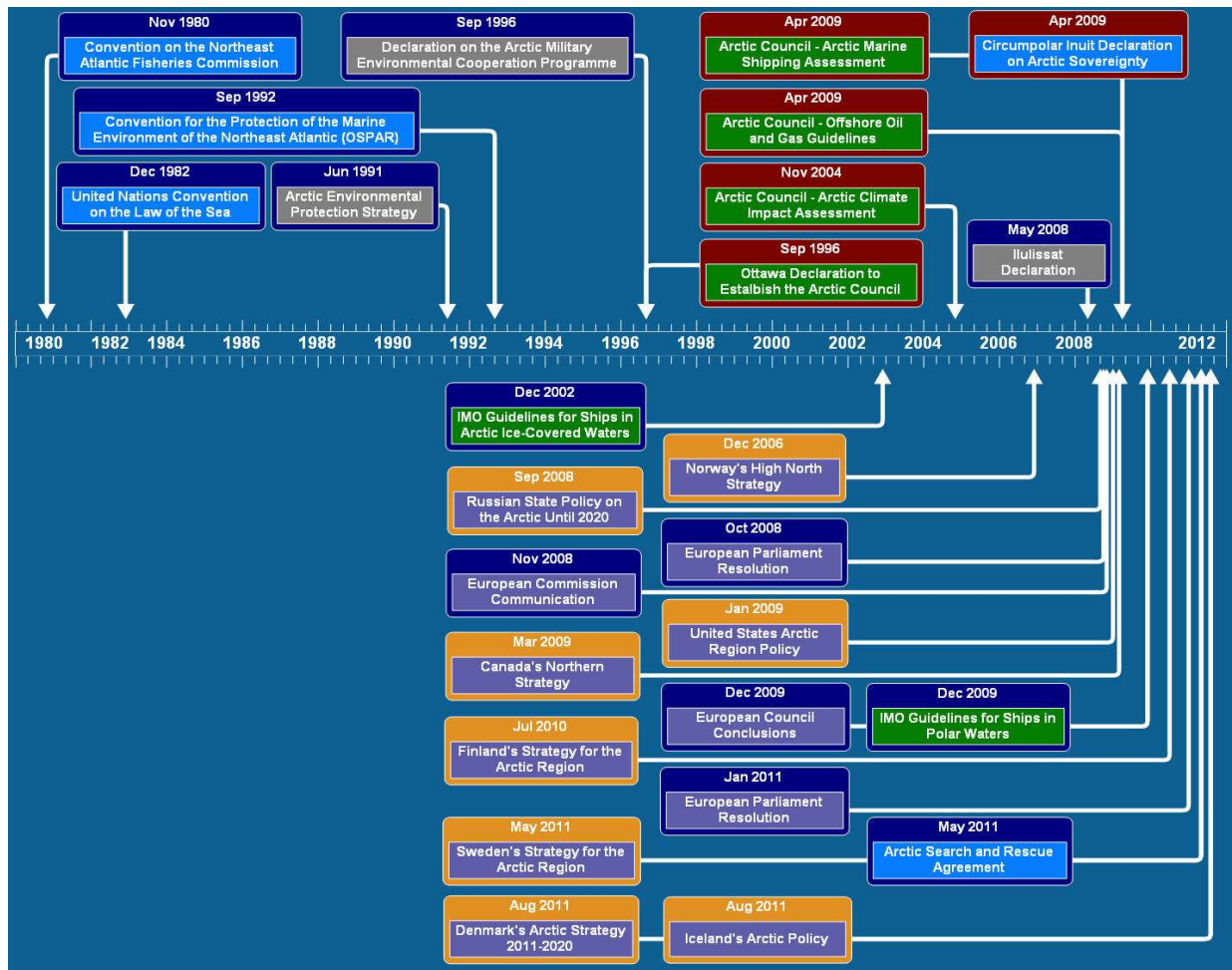
With diverse interests and the ongoing need to promote cooperation in the Arctic Ocean, in 1996, the Arctic Council established sustainable development and environmental protection as “*common arctic issues*” (Ottawa Declaration 1996). Achieving sustainable development requires balance, principally across three domains (Berkman and Vylegzhanin 2013):

- ❖ Environmental protection, economic prosperity and social equity;
- ❖ Urgencies of the moment and requirements of future generations; and
- ❖ National interests and common interests.

Balance also equates with stability, which is a fundamental requirement for human activities and infrastructures to be sustainable.

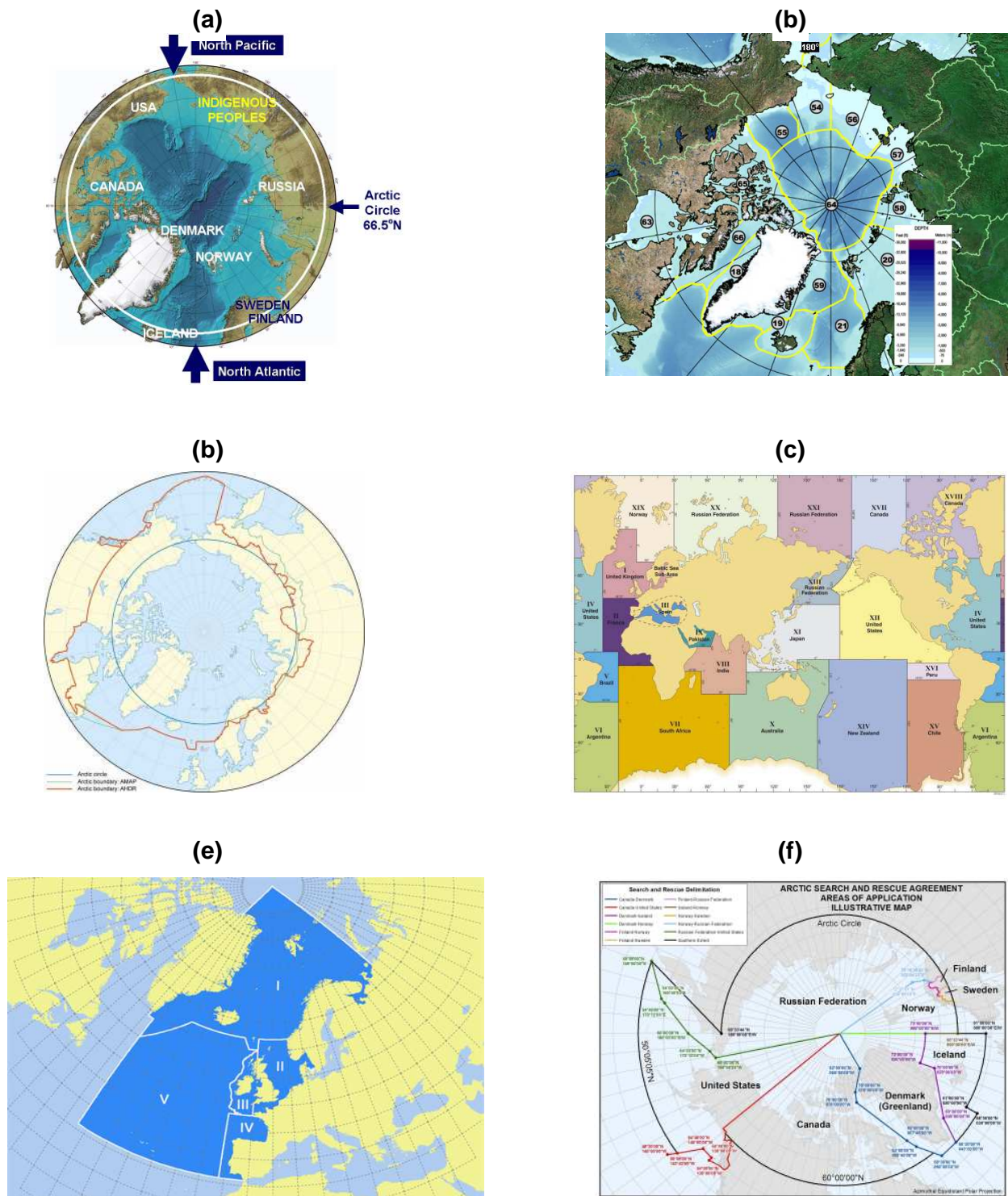
Whether the impacts are local or global, developing the Arctic in a sustainable manner will involve informed decision-making “*to understand the pressures and drivers of change, the current state of the system as well as identifying the key indicators that will mark systemic and potential detrimental changes, before the appropriate responses and actions are devised and implemented*” (Bock 2013). Measuring these drivers and indicators for informed decision-making and responding to the environmental state-change in the Arctic Ocean will require implementation of a system of Sustaining Arctic Observing Networks (SAON) on a pan-Arctic scale.

The diverse decisions that already have been made with regard to the Arctic Ocean are reflected in Figure 2, which further reveals that production of such decisions is accelerating. The decisions include the formation of institutions with remits in the Arctic Ocean, such as the *Convention on the Northeast Atlantic Fisheries* (NEAFC 1980), *Convention on the Prevention of the Marine Environment of the Northeast Atlantic* (OSPAR 1992) and the *Agreement on Cooperation on Aeronautical and Maritime Search and Rescue in the Arctic* (Arctic SAR 2011) as well as a host of policies, declarations, guidelines and reports that relate to this region, produced by many different stakeholders (Table 1).



**FIGURE 2:** Illustrative timeline of diverse types of policy documents for managing human activities and impacts in the Arctic Ocean. Color schemes simply represent agreements that are similar in jurisdiction, scope or concept. Production of policy documents that relate to the Arctic Ocean has been accelerating with interests increasingly expressed by Arctic states and indigenous peoples as well as non-Arctic states. From *ACCESS Newsletter No. 3* (ACCESS 2012).

A legacy of the policy development for the Arctic Ocean region (Fig. 2) is the diverse suite of boundary configurations that reflect perspectives of the natural system as well as jurisdictions of institutions that are in force. For example, the Arctic circle is an astronomical boundary based on the tilt of the Earth's axis that is independent of any geopolitical consideration (Fig. 3a), influencing the seasonal dynamics of the associated ecosystems (Fig. 3b). With relevance to potential policies and interpreting impacts, boundaries have been drawn to define the Arctic in terms of its human populations (Fig. 3c). Similarly, with regard to human operations in the Arctic Ocean, there are logistical boundaries framed by institutions with regard to meteorological and navigational areas (Fig. 3d). There are also regulatory boundaries framed by institutions that have limited legal remits in parts of the Arctic Ocean (Figs. 3e-f) for specific activities, such as fisheries and environmental protection. **The complex of boundary configurations (Fig. 3) and diversity of actors (Table 1) in the Arctic Ocean reflects the need for a coordinated observational system applied efficiently and cost-effectively on a pan-Arctic scale.**



**FIGURE 3:** Boundary configurations covering the Arctic Ocean. **(a)** Southern limit based on the astronomical boundary of the Arctic Circle at 66.5° North latitude (white circle); **(b)** Large Marine Ecosystem boundaries (AMSA 2009); **(c)** Arctic boundary drawn (red line) in relation to the dimensions of human development in the region (AHDR 2004); **(d)** Meteorological / Navigational Areas throughout the world ocean, including the Arctic Ocean (IHO 2009, IMO 2011); **(e)** Boundaries of the OSPAR (1992) convention, which coincides with the boundaries of the NEAFC (1982) convention in the North Atlantic and Arctic Ocean sector to the North Pole; and **(f)** Search and rescue areas of the Arctic states (Arctic SAR 2011). Redrawn from Berkman and Vylegzhanin (2013).

**TABLE 1: INTERNATIONAL PARTICIPATION IN ARCTIC ORGANIZATIONS**

STATES <sup>1</sup>	ARCTIC ORGANIZATION <sup>2,3</sup>															
	AC <sup>4</sup>	AMEC	BEAC <sup>5</sup>	FARO	IASC	NACG	NAFO <sup>6</sup>	NC	NEAF <sup>6</sup>	NF	OSPA	PB	SAR	SCAP	SPIT	NATO
Afghanistan															X	
Albania															X	X
Argentina															X	
Australia															X	
Austria															X	
Belgium <sup>7</sup>						X					X				X	X
Bulgaria <sup>7</sup>							X		X						X	X
Canada	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Chile															X	
China				X	X					X					X	
Croatia																X
Cuba							X		X							
Czech Republic <sup>7</sup>																
Denmark <sup>7,8</sup>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Dominican Republic															X	
Egypt															X	
Estonia <sup>7</sup>						X									X	X
Finland <sup>7</sup>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
France <sup>7</sup>	X	X	X	X	X	X				X					X	X
Germany <sup>7</sup>	X	X	X	X	X	X				X					X	X
Greece <sup>7</sup>															X	X
Hungary <sup>7</sup>															X	X
Iceland	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
India															X	
Ireland <sup>7</sup>						X					X				X	
Italy <sup>7</sup>		X	X	X	X										X	X

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Japan			X	X	X					X					X	
Latvia <sup>7</sup>						X										X
Lithuania						X										X
Luxembourg <sup>7</sup>											X					X
Monaco														X		
Netherlands <sup>7</sup>	X		X	X	X						X					X
New Zealand															X	
Norway	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Poland <sup>7</sup>	X		X	X		X									X	X
Portugal <sup>7</sup>						X			X						X	X
Republic of Korea				X	X		X			X						
Romania															X	X
Russian Federation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Saudi Arabia															X	
Serbia															X	
Slovakia																X
Slovenia																X
South Africa															X	
Spain <sup>7</sup>	X					X			X		X				X	X
Sweden <sup>1</sup>	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Switzerland										X	X				X	
Turkey																X
Ukraine							X									
United Kingdom <sup>7</sup>	X	X	X	X	X	X				X					X	X
United States	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Venezuela															X	



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	AC <sup>4</sup>	AMEC	BEAC <sup>5</sup>	FARO	IASC	NACG	NAFO <sup>6</sup>	NC	NEAF <sup>6</sup>	NF	OSPA	PB	SAR	SCAP	SPIT	NATO
Number of States	14	4	15	17	16	20	13	5	8	8	15	5	8	8	42	28

- 1 Among the 52 states in this table, the eight Arctic states are highlighted.
- 2 Highlighted organizations include all of the Arctic states.
- 3 **AC** (1996 Arctic Council); **AMEC** (1996 Arctic Military Environmental Cooperation Programme); **BEAC** (1993 Barents Euro-Arctic Council); **FARO** (1998 Forum of Arctic Research Operators); **IASC** (1990 International Arctic Science Committee); **NACG** (2007 North Atlantic Coast Guard Forum); **NAFO** (1978 *Convention on Future Multilateral Cooperation in the Northwest Atlantic Fisheries*); **NATO** (1949 *North Atlantic Treaty*); **NC** (1952 Nordic Council); **NEAF** (1980 *Convention on Future Multilateral Cooperation in North-East Atlantic Fisheries*); **NF** (1991 Northern Forum); **OSPA** (1992 *Convention for the Protection of the Marine Environment of the North-East Atlantic*); **PB** (1973 *Agreement on the Conservation of Polar Bears*); Arctic **SAR** (2011 *Agreement on Cooperation on Aeronautical and Maritime Search and Rescue in the Arctic*); **SCAP** (1994 Standing Committee of the Conference of Arctic Parliamentarians), **SPIT** (1920 *Treaty Concerning the Archipelago of Spitsbergen, and Protocol*)
- 4 Arctic Council – In addition to the eight Arctic Member States and the six non-Arctic Permanent Observer States listed in the table, there are six Permanent Participants from Arctic indigenous peoples organizations (Arctic Athabaskan Council, Aleut International Association, Gwich'in Council International, Inuit Circumpolar Council, Russian Arctic Indigenous Peoples of the North, and Saami Council). The Arctic Council also involves nine Intergovernmental and Inter-Parliamentary Organizations (International Federation of Red Cross & Red Crescent Societies, International Union for the Conservation of Nature, Nordic Council of Ministers, Nordic Environment Finance Corporation, North Atlantic Marine Mammal Commission, Standing Committee of the Parliamentarians of the Arctic Region, United Nations Economic Commission for Europe, United Nations Development Program, United Nations Environment Program) as well as eleven Non-Governmental Organizations (Advisory Committee on Protection of the Seas, Arctic Circumpolar Gateway, Association of World Reindeer Herders, Circumpolar Conservation Union, International Arctic Science Committee, International Arctic Social Sciences Association, International Union for Circumpolar Health, International Work Group for Indigenous Affairs, Northern Forum, University of the Arctic, World Wide Fund for Nature-Global Arctic Program). Non-Arctic states that include China, Japan and South Korea as well as the European Union have applied to the Arctic Council to become Permanent Observer States.
5. Barents Euro-Arctic Council – Permanent Members (Denmark, Finland, Iceland, Norway, Sweden and Russian Federation with the European Commission) and other states are observers.
6. Includes European Economic Community or European Union
- 7 Member of European Union.
- 8 Includes Greenland (which is not a member of the European Union) and the Faroe Islands as autonomous areas.

From Berkman and Vylegzhaniin (2013).

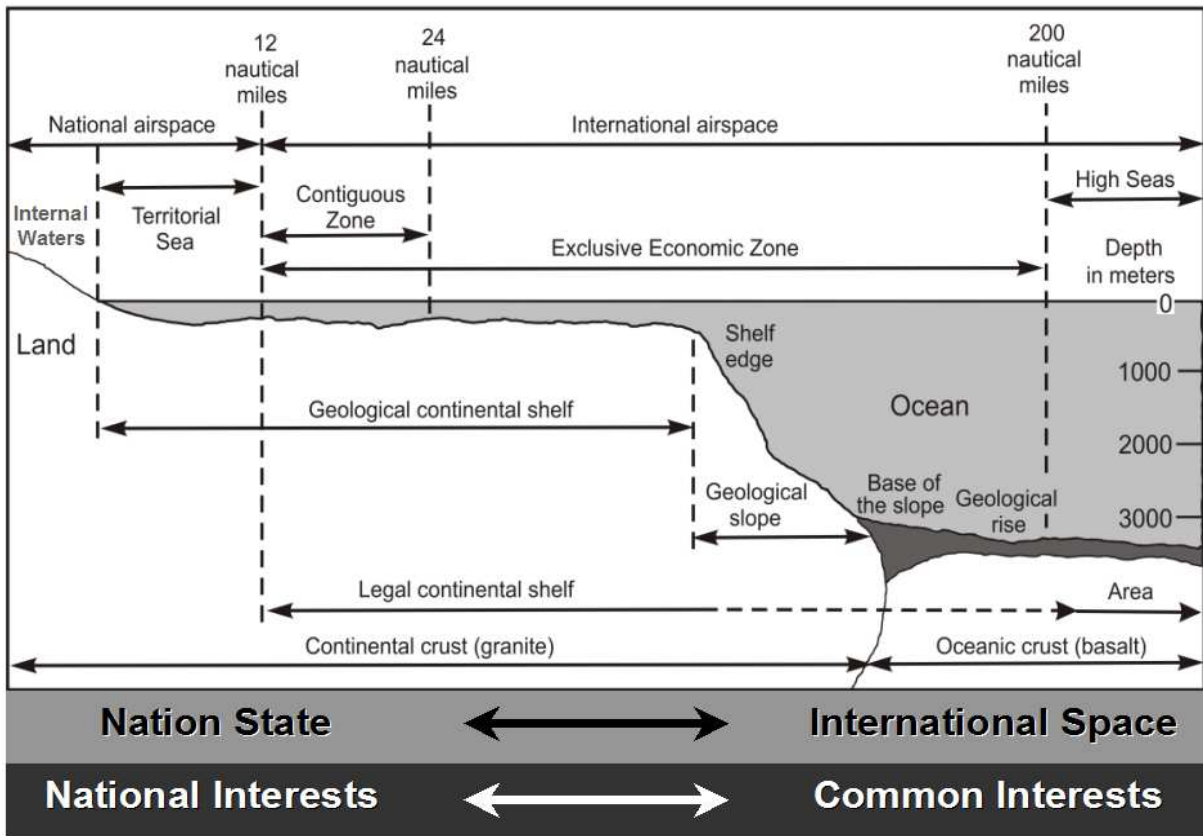
The diverse institutions and organizations that are involved with activities in the Arctic Ocean (Table 1) all have a role in the sustainable development of this maritime region. Among the institutions, the Arctic Council (Ottawa Declaration 1996) has a pivotal role as the high-level forum for this region with inclusion of all eight Arctic states and six indigenous peoples organizations. Other Arctic institutions that include all of the Arctic states are the: Barents Euro-Arctic Council (BEAC 1993); Forum of Arctic Research Operators (FARO 1998); International Arctic Science Committee (IASC 1990); North Atlantic Coast Guard Forum (NACGF 2007); *Agreement on Cooperation on Aeronautical and Maritime Search and Rescue in the Arctic* (Arctic SAR 2011); Standing Committee of the Conference of Arctic Parliamentarians (SCAP 1994); and the *Treaty Concerning the Archipelago of Spitsbergen, and Protocol* (SPITS 1920). Nearly 50 nations states are included among the Arctic institutions and organizations (Table 1), reflecting the holistic challenge of balancing the interests of Arctic and non-Arctic stakeholders.

A key to achieving this international balance region will be to involve the diverse stakeholders (Table 1) in sustainable infrastructure development of the Arctic Ocean. Arguably, the least intrusive infrastructure component to sustain for the surrounding Arctic states and indigenous peoples would be the pan-Arctic implementation of SAON, which has been promoted by the Arctic Council since 2007 (SAON 2011). **Moreover, SAON presumably would be the least expensive infrastructure element to sustain, compared to port facilities and ships, providing a low entry point for non-state actors to contribute to the sustainable development in the Arctic Ocean.**

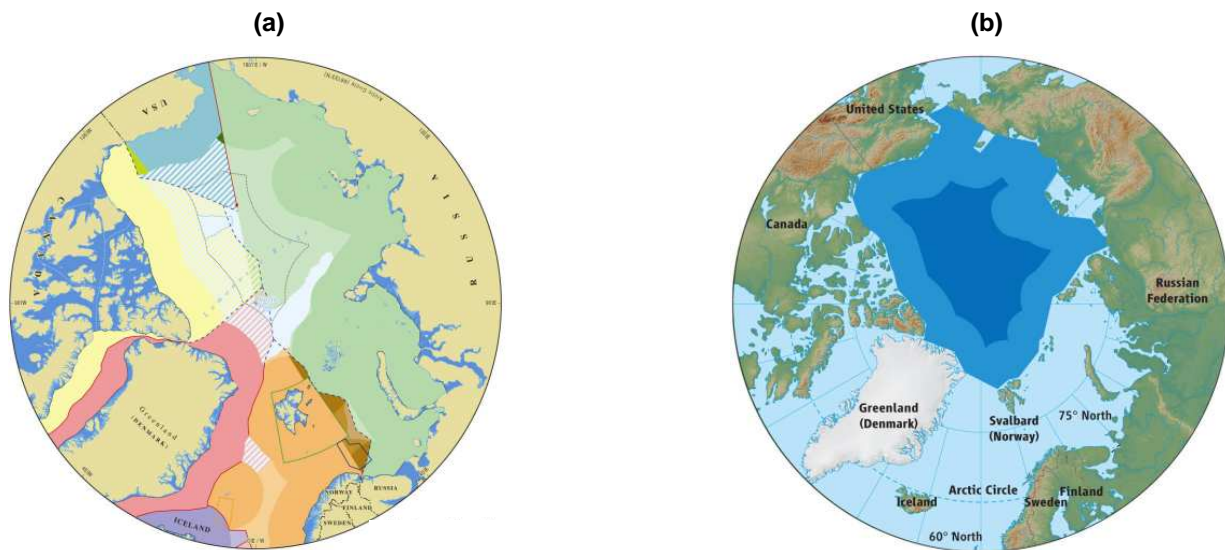
## SUSTAINABLE INFRASTRUCTURE IN THE ARCTIC OCEAN

The law of the sea is the umbrella boundary configuration to which the Arctic coastal states “*remain committed*” (Ilulissat Declaration 2008), providing a universal jurisdictional framework that is accepted by Arctic and non-Arctic states alike. The law of the sea zones, which are characterized by the *United Nations Convention on the Law of the Sea* (UNCLOS 1982), are accepted either because nations have ratified this convention or accepted the zones under customary international law, as is the case with the United States (Fig. 4).

The law of the sea zones apply throughout the world ocean without geographic emphasis, revealing a gradient of jurisdictions from land boundary to the edge of the exclusive economic zone in the water column and continental shelf on the sea floor, where the coastal state has sovereign jurisdictions, outward beyond sovereign jurisdictions into the international spaces of the high seas and the deep sea. An important feature of the law of the sea is that independent of any sovereign rights that coastal states may have on the sea floor, even to the North Pole, the high seas will still exist as an international space where the international community has rights and responsibilities under international law, independent of the coastal states (Figs. 5a-b). **Consequently, law of the sea provides justification for Arctic and non-Arctic states to coordinate and support infrastructure that will be required for sustainable development in the Arctic Ocean.**



**FIGURE 4:** Zones throughout the world ocean, from the baselines of coastal states into the international spaces beyond sovereign jurisdictions (i.e., the high seas and deep sea), reflecting the gradient from national interests into common interests. The zones are defined by customary international law and the *United Nations Convention on the Law of the Sea* (UNCLOS 1982) with provisions that “will contribute to the strengthening of peace, security, co-operation and friendly relations among all nations.” Adapted from United States (1985) with addition of zones for the area and internal waters.



**Figure 5:** Jurisdictional representations of the Arctic Ocean based on the law of the sea: **(a)** Boundaries based on the sea floor with sovereign areas and outer continental shelf claims of the surrounding coastal states (different colors) from IBRU (2008); and **(b)** Boundaries based on the overlying water column, emphasizing the High Seas (dark blue) as an international space in the central Arctic Ocean surrounded by Exclusive Economic Zones (light blue), showing the latitudes and longitudes. National and international contexts of these boundaries are shown in Figure 4. Adapted from Berkman and Young (2009).

The policy documents produced for the Arctic and Arctic Ocean region (Fig. 2) with the greatest sense of urgency are the national security policies adopted individually by the eight Arctic states to support their national interests (Table 2). These national Arctic policies, when mapped in relation to each other in terms of transboundary issues, reveal that the Arctic states have most national interests in common.

<b>ARCTIC COASTAL STATE</b>	<b>TERMS THAT REFLECT TRANSBOUNDARY ISSUES</b>					
	<i>Environment</i>	<i>Fisheries</i>	<i>Indigenous</i>	<i>Navigation / Shipping</i>	<i>Peace / Peaceful</i>	<i>Science / Scientific</i>
<b>Canada</b>						
<b>Denmark</b>						
<b>Finland</b>						
<b>Iceland</b>						
<b>Norway</b>						
<b>Russia</b>						
<b>Sweden</b>						
<b>United States</b>						

\* Based on full-text searching of terms in the following Arctic strategy documents: Canada (2009), Denmark (2011), Finland (2010), Iceland (2011), Norway (2006), Russian Federation (2008), Sweden (2011) and United States (2009).

**To address transboundary issues, however, requires information collected across national boundaries, which means that the Arctic nations will need to coordinate their observations cooperatively with the support of other Arctic states. Such coordination among the Arctic states will be both bilateral and multi-lateral on a pan-Arctic scale.**

The requirement to address transboundary issues further indicates that each Arctic state individually for its own national interests has a need to mitigate the inherent risks of political, economic and cultural instabilities associated with the environmental state-change in the Arctic Ocean (Berkman and Vylegzhnin 2013). Such risks of instabilities are real, underscoring the reason why each Arctic state has produced its own Arctic security policy since 2006. **Consequently, there is urgency for the Arctic states, individually and collectively, to support SAON in a manner that will enable them to make operational decisions as human activities and impacts accelerate in the Arctic Ocean.**

## OPTIONS TO SUPPORT SUSTAINABLE ARCTIC OBSERVING NETWORKS (SAON)

*“The Arctic is now experiencing some of the most rapid and severe climate change on Earth. Over the next 100 years, climate change is expected to accelerate, contributing to major physical, ecological, social and economic changes, many of which have already begun.”*

ACIA (2004)

There are many uncertainties about how to balance the diverse interests and capabilities for responding to the emerging opportunities and impacts in the Arctic Ocean. *“What is clear, however, is that changes in the region’s physical environment are likely to present policy planners and political decision-makers with a wide array of challenges that will require extraordinary measures at the national as well as at the regional and international levels”* (Åtland 2013). **Among the challenges is planning an integrated pan-Arctic infrastructure to accommodate global activities in the Arctic Ocean, not just for the Arctic states and indigenous peoples, but for the whole world.**

SAON represents an opportunity to initiate sustainable development in the Arctic Ocean, as a practical and cost-effective first step that can be inclusive on an international scale. The reality is, however, that SAON will require funding as well as technical expertise, as described in the plan for the implementation phase of SAON (2011):

*“Other than the Secretariat functions, which are provided by AMAP and by IASC, all other SAON activities are to be funded by the participants or by financial sponsors in response to proposals from the participants.”*

The above scope for funding SAON is vague and impractical at an integrated international and pan-Arctic scale. To effectively fund SAON, the following three options are introduced:

1. Arctic coastal states, as part of their leasehold agreements with major energy companies who seek to extract hydrocarbons from the sea floor within sovereign jurisdictions, should require funding from the energy companies to support SAON as a cost-of-business.
2. In addition to the Arctic states – with their “stewardship” roles in the Arctic Ocean (Ilulissat Declaration 2008) – non-Arctic states who are admitted as observers to the Arctic Council should commit funding to SAON. Support for SAON is necessary for ongoing interpretations through working groups of the Arctic Council (2013) as well as for operational decision-making about responses to impacts and activities in the Arctic Ocean. Such response capacity is a requirement for the Arctic states in binding agreements (e.g., Arctic SAR 2011) for:

- a. Point emergencies (e.g., rescue of persons from a sinking ship);
  - b. Transitory impacts (e.g., clean-up of an oil or gas spill); and
  - c. Global impacts (e.g., adaptation to marine ecosystem changes).
3. Some level of coordination should be developed among the diverse institutions and organizations (Table 1) to support SAON for informed decision-making about their activities in the Arctic Ocean.

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