The Arctic: Opportunities, Concerns and Challenges

Emmanuelle Quillérou
Mathilde Jacquot
Annie Cudennec
Denis Bailly
Anne Choquet
Laure Zakrewski

The Arctic is pictured in the collective mind as a white and frozen desert, with only a few polar bears, explorers and Eskimos sprinkled around. It is, however, inhabited by very diverse people, and several industries are well established in the Arctic, through the Arctic, or at the periphery of the Arctic Circle. Receding and thinning sea ice because of climate change opens up access to natural resources, shipping routes and touristic areas, thereby providing new opportunities for economic development in the Arctic. The potentially high rewards are extremely attractive, but at high financial, environmental and social costs in a high-risk environment. Some stakeholders have started securing access to Arctic resources, sowing the seeds for a 'cold rush'. Despite increased prominence in the media of Arctic bonanza, sometimes closer to myth than reality, such 'cold rush' does not seem to have fully materialised yet, slowed down by high investment costs and legal considerations, as well as high diplomatic, political and social sensitivity. The main political challenge ahead is for decision-makers to successfully reconcile highly contrasted perspectives and interests in the Arctic, from the local to the international levels, by building up existing institutional capacity at the pace of economic development. There is certainly strong potential for creating shared economic wealth and well-being, with a fair distribution of Arctic benefits. Choices for economic development, coordination and cooperation by Arctic countries and private actors in the next few years will shape the Arctic of tomorrow.

The Arctic refers to an oceanic area around the North Pole and Arctic Circle, partly covered in sea ice and surrounded by frozen lands. There is no agreed delineation of an 'Arctic Region' and population estimates vary from 4 to 10 million depending on the geographic extent considered (Ahlenius *et al.*, 2005, p.6 & 14; Duhaime and Caron, 2006; Norway Ministry for Foreign Affairs, 2015, p.5). The Arctic can refer to two zones: the Arctic Ocean and the Arctic region. The Arctic Ocean is bordered by five sovereign states (United States of America, Canada, Denmark, Norway, and the Russian Federation). The Arctic region is broader and encompasses all states with land in the Arctic Circle. The Arctic region includes all five states bordering the Arctic Ocean, with the addition of Iceland, Finland and Sweden.

The Arctic is part of the global climate system with heat redistribution through ocean currents between the North Pole and the equator, as well as heat and nutrient redistribution between surface waters and the deep abyssal plains (Ocean & Climate, 2015). Impacts from climate change in the Arctic are stronger and faster than any other areas of the globe. In addition to being sensitive to outside impacts, Arctic emissions and pollutions have a greater impact on the Arctic itself (Crate, 2012). The Arctic is therefore seen as the 'canary in the mine', an early warning sentinel of climate change impacts to come (The Arctic – The Canary in the Mine. Global implications of Arctic climate change. Norwegian-French conference in Paris, 17 March 2015; Dahl, 2015).

The Arctic sea ice is now shrinking and thinning because of rising concentrations of anthropogenic greenhouse gases in the atmosphere, leaving longer sea ice-free seasons (Serreze *et al.*, 2007; Boé *et al.*, 2009; Kwok and Rothrock, 2009; Parkinson, 2014; Speich *et al.*, 2015; US National Snow and Ice Data Center in Boulder Colorado, 03 March 2015). Scientific scenarios and models have shown that sea level could drop slightly in some areas of the Arctic and increase by more than 70 cm along the east coast of the United States (Ocean & Climate, 2015).

Such changes in the Arctic open up access to Arctic ocean-floor resources and sea routes, with new opportunities for economic development in the region, which could impact global trade patterns and trends (Valsson and Ulfarsson, 2011). However, infrastructures remain very costly, and sparse and isolated populations do not necessarily have the capacity to combine their strengths to overcome common weaknesses and threats (Heininen and Exner-Pirot, 2018).

If left open and uncoordinated, economic development of the Arctic could drive to a wild 'cold rush' driven by selfish interests rather than a concerted effort to make the most of these new opportunities for society as a whole, through win-win solutions that create shared wealth and well-being for all.

- What potential economic benefits would we derive from economic development of activities in the Arctic, and at what costs?
- What potential environmental and social consequences for such economic development?
- Have there been any signs of a 'cold rush' materialising yet?
- What are the political challenges ahead if we are to make the most of the economic opportunities opening up in the Arctic?

THE ARCTIC, A PLACE OF INTENSE ECONOMIC ACTIVITY BUT WITH WIDE VARIATIONS BETWEEN COUNTRIES AND INDUSTRIES

There are several industries already operating in the Arctic, through the Arctic, or at the periphery of the Arctic Circle. These include fishing and forestry, mining (oil, gas, minerals), shipping (sea transport), manufacturing (fish processing, electronics), Arctic tourism, and other services associated with human settlements such as education, health care, administration, postal services, shops and restaurants, hydro power and windmill parks, military activities (Ahlenius *et al.*, 2005; Duhaime and Caron, 2006; Glomsrød and Aslaksen, 2009; Dittmer *et al.*, 2011; Conley *et al.*, 2013).

Additionally, the Arctic supports subsistence activities outside the cash economy such as fishing, hunting,

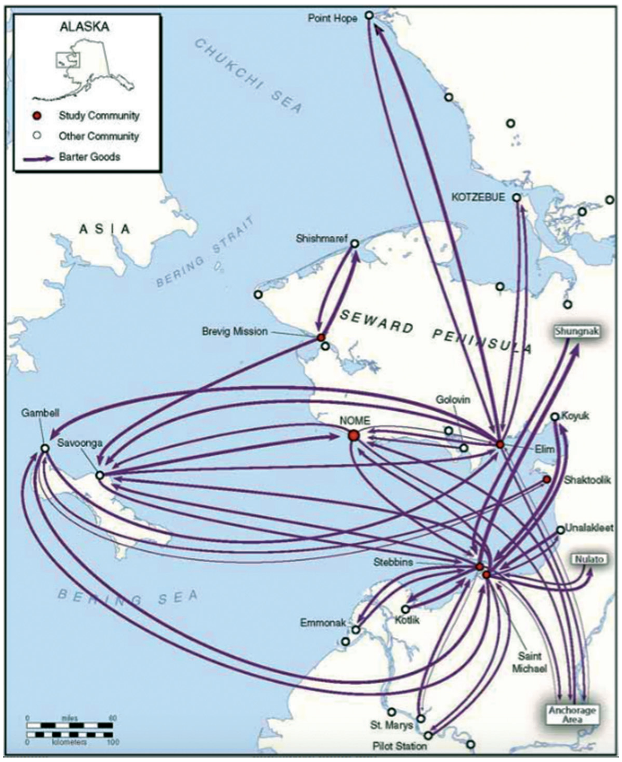

Fig.1 — Patterns of trade and barter between neighbouring human communities, regional hubs, and urban communities. Data collected between 2004-2006 in six western Alaska human communities. Source: Magdanz *et al.* (2007, p65).

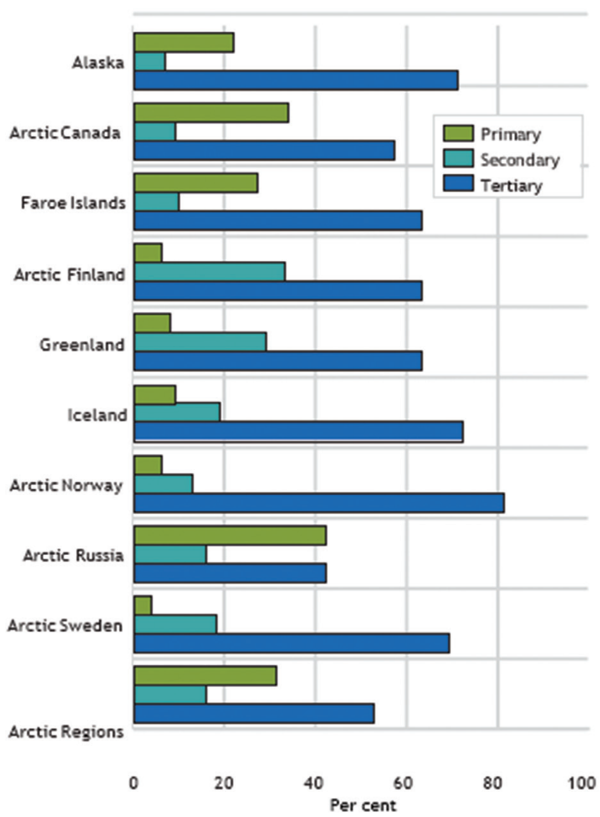

Fig.2 — GDP (%) by main industry in the different Arctic Regions (reference year: 2003) (Source: Duhaime and Caron, 2006, Figure 2.1 p.19). Primary sector: large-scale extraction of non-renewable resources, small-scale commercial fishing and forest exploitation; secondary sector: manufacturing and construction; tertiary sector: service industries.

caribou and reindeer herding, gathering, and traditional food processing (Ahlenius *et al.*, 2005, p.27; Glomsrød and Aslaksen, 2009). Subsistence activities are associated with significant traditional trading and bartering between different Arctic populations (Figure 1; Glomsrød and Aslaksen, 2009). Traditional activities are sometimes no longer enough to sustain families, with a push towards supplementing their income through the cash economy (Dana and Riseth, 2011).

The Arctic, at the macroeconomic level, displays intense economic activity linked to the exploitation of natural resources, and a very dominant service industry (Figure 2; Duhaime and Caron, 2006; Glomsrød and Aslaksen, 2009). Exploitation of natural resources includes geographically concentrated large-scale extraction of non-renewable resources such as hydrocarbons, nickel, diamonds and gold, as well as geographically widespread small-scale commercial fishing and forest exploitation. The public sector often accounts for 20-30% and the overall service industry for over 50% of all economic activity in the Arctic regions.

At the microeconomic level, the resource rent derived from production in the Norwegian oil and gas (offshore) sector has risen quite significantly in 2000-2004 compared to previous periods (Figure 3). Resource rents for renewable natural resources are much lower, with hydropower (green) and forestry (dark blue) associated with positive resource rents, commercial fisheries (orange) associated with negative but increasing rents, and aquaculture (turquoise) associated with positive and negative resources rents (Figure 4).

Local opportunities for development of economic activities arising with climate change in the arctic: potentially high economic benefits but for high economic costs in a high-risk environment. All industries operating in the Arctic region are faced with slightly different opportunities and constraints because of climate change, with potentially high economic benefits but for high economic costs. The receding ice sheet cover allows for increased duration and extent of physical access to natural resources such as fish and timber (renewable resources), oil, gas and minerals (non renewable resources). This increased access could translate into additional economic revenues for the fishing, timber, mining (oil & gas, minerals) industries. Numbers put forward more often than not fail to include costs and market price

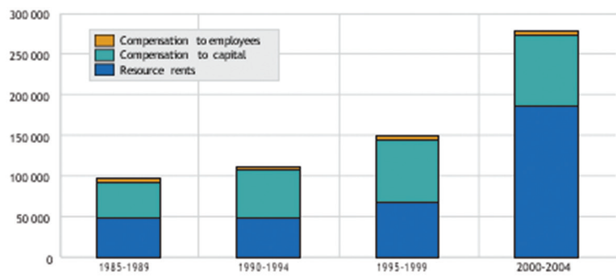

Fig.3 — Five-year average decomposition of gross production in the Norwegian oil and gas (offshore) sector (Source: Duhaime and Caron, 2006, Figure 1 p.24).

fluctuations which can influence profits greatly. The Arctic inherently remains a high-risk environment.

Most of the following descriptions and numbers rely on the use of models for predictions of future outcomes and are often subject to a high level of uncertainty. The quality of the outputs from such models depends on data quality, trends and understanding at the time the models were established. Estimations of potential gains are not always based on objectively measured data, with perceptions playing a big role. Predictions from such models should be considered with caution, especially when overly optimistic, as rewards may not fully materialise, or only in 2030-2050. It is not easy to determine whether actual gains will meet today's great expectations, nor how long it will be before they do.

The shipping (sea transport) industry would benefit from greater use of Arctic and circumpolar (sea transport) shipping routes such as the Northern Sea Route (the shipping lane along the Russian Arctic coast that connects Europe to the Asia-Pacific region), the Northwest passage (along the North American coastline), or the Bering Strait (53-mile strait between Siberia and Alaska) thanks to reduced ice cover extent and thickness and longer ice-free periods increasing seasonal access for maritime traffic (Peters *et al.*, 2011, Conley *et al.*, 2013, p.32-37). These routes cut down miles, shipping time and fuel costs, which combined with high fuel costs increase their appeal to the industry. Estimates of 40% shipping cost reduction and recent cost saving 'records' between Europe and Asia are widely quoted to illustrate the economic potential of these routes focusing on best possible outcomes only.

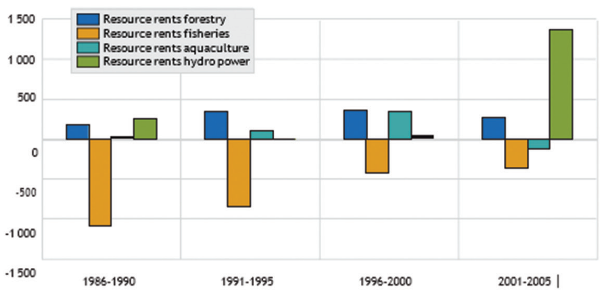

Fig.4 — Five-year average resource rents from the renewable natural resources in Norway (Source: Duhaime and Caron, 2006, Figure 2 p.25).

More recent studies accounting for ship performance in ice conditions are far less optimistic with only 5-16% cost saving now, and up to 29% in 2030 and 37% in 2050 (Liu and Kronbak, 2010; Peters *et al.*, 2011).

Actual cost savings need to offset higher costs of ice-graded vessels, non-regular and slower speeds, navigation difficulties and risks of accidents from poor visibility and ice conditions slowing ships down, as well as the need for ice breaker service (Liu and Kronbak, 2010). There are a limited number of public-use deep-water ports, re-fuelling stations, or reliable re-supply locations, limited communications and emergency response infrastructure including search and rescue capacity in the Russian Federation and Northern Europe and almost non-existent communications and emergency response infrastructure along the North American coastline (Valsson and Ulfarsson, 2011; Dawson *et al.*, 2014).

All these could reduce the appeal of using Arctic shipping routes compared to the Suez or Panama canals (Peters *et al.*, 2011). International shipping along the Northern Sea Route has decreased by half between 2011 (41 trips) and 2016 (19 trips) (Alexeeva and Lasserre, 2018). China however estimates that 1% of its freight could transit through the Northern Sea Route from 2020. Preparation includes a few publicised trials of transport along the Northern Sea Route and commissioning the construction of ice-grade vessels. Recent studies rather point to marginal and seasonal use of Arctic routes for international transport (Hugot and Umana Dajud, 2018; Theocharis *et al.*, 2018). At present, longer sea ice-free periods are not enough for transport companies, and these routes have so far remained excluded from their business strategies (Lasserre *et al.*, 2016).

The Arctic fishing and aquaculture industry would benefit from increased stock levels. Southern and pseudo-oceanic temperate fish species stocks are relocating North (Barents and Bering Seas), which could lead to unprecedented harvest levels most likely benefiting commercial fisheries (Hunt Jr. *et al.*, 2013; Christiansen *et al.*, 2014; Falk-Petersen *et al.*, 2015). The Barents Sea already displays higher levels of fish biomass density, with productivity at all trophic levels increasing with climate change and increased upwelling of nutrient-rich waters such as that of winter 2012. Actual streams of economic benefits depend on avoiding overfishing under yet insufficient Arctic fisheries biological data (Christiansen *et al.*, 2014).

Economic benefits are to be traded off with the negative impact of climate change and ocean acidification over calcareous shellfish (*e.g.* clams and oysters) and zooplankton (krill, pteropods consumed by salmons) (Ocean & Climate, 2015). It has been suggested that climate change could be directly or indirectly one of the causes of the disappearance of commercial species such as King Salmon off the coast of Alaska (Conley *et al.*, 2013).

Higher density of fish stocks would bring fishing effort down, but more difficult navigation in the Arctic generates extra costs (fuel, ice-grade vessels). Revenues from Arctic fishing would increase by 34% between 2000 and 2050 – less than 1% per year on average – with similar increase in costs (Lam *et al.*, 2016). Fishing is not profitable in itself but only through a multiplier effect, with an increase in household revenues by 32% over 50 years. At the local level, climate change can negatively impact subsistence fishing, for example in areas where it constitutes a major livelihood source (Himes-Cornell and Kasperski, 2015). In addition, overall costs also increase because of high monitoring and enforcement costs to mitigate illegal, unreported, and unregulated (IUU) fishing in the Arctic (WWF, 2008).

The oil and gas industry would benefit from increased physical access to oil and gas resources including offshore reserves in the Chukchi Sea. 400 oil and gas onshore fields north of the Arctic Circle account for approximately 240 billion barrels (BBOE) of oil and oil-equivalent natural gas – almost 10 percent of the world's known conventional resources (cumulative production and remaining proved reserves) (Bird *et al.*, 2008). The total undiscovered conventional oil and gas resources of the Arctic believed to be recoverable using existing technology are estimated to be approximately 90 billion barrels of oil, 1,669 trillion cubic feet of natural gas, and 44 billion barrels of natural gas liquids, with approximately 84% of the undiscovered oil and gas occurring offshore (Bird *et al.*, 2008). Oil and gas exploitation in the Arctic, however, comes with high costs for Arctic resistant infrastructure and operations, as well as capital costs for purchase of exploration licenses, leases, drilling permits, equipment and personnel (Conley *et al.*, 2013). Outdated infrastructure and lack of investment capacity are currently limiting the development of extraction activities in the Russian Arctic, despite gradual strategic convergence towards China since 2008 (Alexeeva and Lasserre, 2018).

Following a report by Lloyd's, a large UK-based insurance market, and Chatham House, a British think tank, in April 2012, not all insurers are happy to insure operations in the Arctic (*e.g.*, German bank West LB), partly `because of the logistical and operational challenges due to the harsh and unpredictable Arctic conditions (Conley *et al.*, 2013). The Dutch company Shell has pioneered efforts for offshore exploitation of oil and gas reserves in the Beaufort and Chukchi seas. The total investment cost for such operation is estimated to over US $4.5 billion for lease acquisition in 2005 and 2008, one sixth of its annual capital spending budget (Conley *et al.*, 2013). Total investment may exceed US $40-50 billion, which represents a significant financial risk for the company (Conley *et al.*, 2013). Shell suspended its Arctic operations in 2015.

The recent fluctuations in oil prices, combined with the exploitation of previously non-commercial natural reserves (*e.g.*, shale and other unconventional gas) have generally reduced incentives to operate in the Arctic (Conley *et al.*, 2013). There is still low competition from alternative energies – which have longer term potential – such as wind, waves, hydropower from the huge rivers that flow into the Arctic Ocean, and geothermal energy (Valsson and Ulfarsson, 2011).

The mineral extraction industry would benefit from increased physical access to mineral resources such as lead and zinc in Alaska, gold in Canada, rare earth elements in Greenland, diamonds and iron in Canada and Greenland, aluminium in Iceland, and nickel in the Russian Federation (Duhaime and Caron, 2006; Conley *et al.*, 2013). China is progressively building its strategy to defend its interests in the Arctic, positioning itself as a 'near Arctic state' (Lasserre *et al.*, 2015). In particular, Greenland could become a gateway for China's commercial entry into the Arctic region following recent discovery of large reserves of rare earth metals and increased Chinese strategic interest in these resources (Conley *et al.*, 2013; Gattolin, 2014). This is what seems to have motivated the United States of America to offer to buy Greenland, a topic prominent and hotly debated in the media in August 2019.

The GFMS index for base metals has increased by 300% between June 2002 and June 2007 (Conley *et al.*, 2013; Gattolin, 2014) whilst gold extraction has been put on hold in Alaska following low world market prices (Conley *et al.*, 2013). Mineral extraction in the Arctic comes at high infrastructure and operation costs to withstand the harsh weather conditions. Infrastructure development and maintenance (road or rail corridors) are often borne by government rather than industry. Infrastructure development could unlock exploitation of resources, *e.g.* copper exploitation in Alaska so far suspended for lack of infrastructure (Conley *et al.*, 2013; Melvin *et al.*, 2016).

Climate change in the Arctic seems to have extended access to areas of touristic value, benefiting the **Arctic tourism industry** directly. It has opened up previously inaccessible areas for exploration and use by expedition cruise ships as well as lengthened the shipping season (Dawson *et al.*, 2014). The Crystal Serenity, with her 1,200 passengers and a crew of 400, was the first cruise ship to go through the Northwest Passage in 2016, demonstrating that size is by no means restricted. There is globally increasing demand for 'remote' tourism experiences and for the unique and iconic landscapes and wildlife, driving an increase in Arctic tourism (Dawson *et al.*, 2014). Itineraries around Arctic Canada have more than doubled from 2005 to 2013, even if they remain limited to 30 itineraries a year (Dawson *et al.*, 2014).

Infrastructure and operation costs for Arctic tourism operators are decreasing with climate change (Dawson *et al.*, 2014). Transaction costs are however high for tourism in Arctic areas, with operation permits difficult to obtain in some countries or associated with a high opportunity cost for the country because of tax avoidance and lack of effective communication between government agencies (Dawson *et al.*, 2014). Information costs can be high for navigation in 'unchartered', 'wild' Arctic areas, because of incomplete or outdated maritime maps. Navigation accidents such as the grounding of the Clipper Adventurer in the summer of 2010 occurred because of nautical map inaccuracy (Supreme Court of Canada, 2018). Arctic tourism development can also generate resentment from local populations who may not wish their home to become a living museum (Antomarchi, 2017).

The small Arctic **manufacturing industry** would benefit from increased inputs availability such as fish for processing (Iceland, Greenland), rare earth minerals for electronics (Arctic Finland), and aluminium for smelting (Iceland) (Glomsrød and Aslaksen, 2009). As for other industries, high costs of capital, technology, qualified labour and transportation to consumption centres from manufacturing centres usually limit the development of the manufacturing industry in the Arctic (Conley *et al.*, 2013; Arctic.ru, March 2015). Changing and unpredictable climate conditions as well as thawing permafrost will likely weaken existing infrastructures and increase investment and repair costs.

The service industry serving local Arctic populations would indirectly benefit from increased economic activity in the region but also most likely incur additional costs for infrastructure development and maintenance not covered by the private sector – roads in particular (Conley *et al.*, 2013).

ENVIRONMENTAL CONCERNS

The main environmental concerns stem from the loss of pristine environment and unique Arctic ecosystems because of climate change, or from Arctic economic development pressures generating pollutions. One solution has been to create protected areas. For example, in the USA, the Alaska National Interest Lands Conservation Act established in 1980 the Arctic National Wildlife Refuge (ANWR), a 19 million acre protected wilderness area including caribou herds, polar bears, and mammals as well as numerous fish and bird species. The Russian Federation has also created several protected areas over its vast Arctic territory (Sevastyanov, 2018).

Arctic economic development is associated with a high risk of air and marine pollution, particularly from oil spills, Persistent Organic Pollutants (POP), heavy metals, radioactive substances, as well as the depletion of the ozone layer (Kao *et al.*, 2012; Conley *et al.*, 2013). Past experiences of soil rehabilitation after mining and clean ups of Cold War waste have led to high costs to human and environmental health: the 'develop now, fix later' strategy has incurred severe financial, social and political damage (Dance, 2015; Hird, 2016). Shell's operations in the Arctic had been slowed down before 2015 following damage to its oil spill barge, the Arctic Challenger, highlighting a lack of appropriate oil spill response measures in place (Conley *et al.*, 2013). Pollution generated by heavy diesel fuels of Arctic sea transport and tourism ships is a concern because of the accelerated sea ice decline it induces (Conley *et al.*, 2013). Concerns over pollution generated from mineral extraction have stalled gold mining in Alaska (Conley *et al.*, 2013). The high risk of oil spill and associated reputational damage this could cause, influential insurers such as Lloyd's getting 'cold feet' combined with the high financial costs and risks have led to Total and BP to back off from the Arctic earlier than Shell (Conley *et al.*, 2013).

Climate change externalities are a concern. Carbon emissions and pollutions cause more damage in the Arctic than elsewhere because of "polar amplification". Pollutions from Arctic shipping and tourism relying on heavy diesel fuels induce greater ice melting pack (Crate, 2012; Conley *et al.*, 2013; Whiteman *et al.*, 2013). Climate change induces thawing of permafrost, a normally permanently frozen soil found in high latitudes of the Arctic (Guiot, 2017). Whiteman *et al.* (2013) estimated that methane released only from Arctic offshore permafrost thawing would have a price tag of USD 60 trillion in the absence of mitigating action, representing about 15% of the average total predicted cost of climate-change impacts of USD 400 trillion. Mitigation could potentially halve the costs of methane releases (Whiteman *et al.*, 2013). Economic consequences are global, but about 80% impact the poorer economies of Africa, Asia and South America with increased frequency of extreme climate events (Whiteman *et al.*, 2013).

SOCIAL CONCERNS

The Arctic takes multiple forms, but with many internal tensions between industrial development and environmental protection, and with very different expectations over quality of life between traditional and westernised ways of life (Heininen and Exner-Pirot, 2018). Social and societal concerns arise with climate change itself or with economic development and industrialisation. Most of the social focus is on indigenous and resident populations of the Arctic who heavily depend on resources provided by their environment for their subsistence. With climate change, the receding ice sheet and unstable ice pack reduce game and sea mammal subsistence hunting and ice fishing opportunities (Ahlenius *et al.*, 2005 p.4; Himes-Cornell and Kasperski, 2015). Economic development generates increased competition within and between industries for access to resources across a three dimensional space. There is increased competition for fishing resources between coastal trawl and subsistence fishers in southern-based fisheries (Ahlenius *et al.*, 2005 p24). There is competition between subsistence fishing and offshore oil and gas extraction (Alaska) and between subsistence herders and oil and gas extraction (Russian Federation) (Duhaime and Caron, 2006; Conley *et al.*, 2013)

As illustrated by historical changes in Russian governance, heavy dependence of Arctic communities on the public sector makes Arctic population vulnerable to industry and government withdrawals, with dire social consequences for employment alternatives are extremely scarce at best (Glomsrød and Aslaksen, 2009; Amundsen, 2012). Small businesses and enterprises face adverse conditions to their own development, with wage inflation, high living costs and competition from public sector employment (Heininen and Exner-Pirot, 2018).

Increased Arctic tourism is supported by indigenous and resident populations so long as it is managed well and respects sensitive and culturally important shore locations, wildlife and other natural landscapes (Dawson *et al.*, 2014). This has occurred de facto in Arctic Canada following 'good will' and high ethical standards of expedition cruise operators, but may be prone to change with new comers entering the industry as there is no formal regulation safeguarding against 'bad' practices. The same applies to scientific research: concerns over impacts of scientific research vessels on subsistence activities have led to the development of a Community and Environmental Compliance Standard Operating Procedure (Konar *et al.*, 2017).

The Arctic displays worse-than-average health levels, the result of colonisation and marginalisation: lower life expectancy, higher frequency of psychological problems, drug additions, depression, domestic abuse and suicide (Heininen and Exner-Pirot, 2018; Zhuravel, 2018). Concerns from indigenous population health have in some places stalled mineral extraction (*e.g.*, uranium in Alaska, Conley *et al.*, 2013). Elsewhere, it is because of strong indigenous concerns and social contestation that mineral extraction was stopped (*e.g.*, gold and coal in Alaska, Conley *et al.*, 2013). Arctic populations are very sensitive to the boom-and-bust nature of mineral extraction: they depend on transfers from southern regions of their country even though they are yearning for more financial independence (Heininen and Exner-Pirot, 2018). It seems wealth created in the Arctic now would tend to stay there, thanks to diversification of activities, particularly services, reducing the economic dependence of the Arctic on other regions (Larsen, 2016).

Social problems are still very real in the Arctic, fueled by poverty, food insecurity, young people moving away from traditional lifestyles, marginalisation of women and traditional Arctic economies, and lack of access to information and knowledge for Arctic communities (Crate, 2012; Dalseg and Abele, 2015; Hodgkins and Weber, 2016; Mathisen *et al.*, 2017; Dalseg *et al.*, 2018; Malik and Melkaya, 2018). Forced displacement and family separation practised in Arctic Canada in the 1950s and 1960s have also left very deep and lasting social scars (Healey, 2016).

THE SEEDS ARE SOWN, BUT THE 'COLD RUSH' IS STILL DORMANT

The Arctic somehow seems to have come of age. All Arctic States seem to position themselves in the starting blocks by strategically securing access rights to Arctic resources and circumpolar routes, but without violating any international binding agreement. Industries in the Arctic could potentially reap very high economic rewards, but the overall high investment and operation costs keep it a financially high-risk environment to operate in, and reduce its competitiveness compared to other regions of the world. The 'cold rush' has not really started yet, as all stakeholders seem to be exercising relative caution in relation to the huge financial, reputational, diplomatic and political risks involved with economic development of the Arctic.

Political challenge ahead: reconciling different perspectives, including environmental and social concerns, to make the most of new opportunities in the arctic.

Very contrasted perspectives and social values coexist, with an Arctic between global common good and sovereign state property. The Arctic means: '**wilderness**' to environmental organisations for preservation or bequeath to future generations, a '**frontier**', source of energy and minerals, to industry, a '**home**' to over a million indigenous people, and a place of '**strategic and geopolitical interest**' to government for military, energy and environmental security (adapted from an original citation by Sheila Watt-Cloutier in Ahlenius *et al.*, 2005). The main political challenge ahead would seem to lie in the conciliation of such contrasted perspectives and ensuring they can live alongside one another peacefully, minimising conflicts whilst keeping up with the very fast pace of economic development associated with a 'cold rush'.

One possible way to achieve this would be through integration of science, economics and diplomacy for conflict resolution (Berkman and Young, 2009). Science can provide a 'neutral', mutually accepted and recognised basis for establishing trust, monitoring, reporting and objective verification by and between all parties. Economics can provide assessment tools that consider trade-offs and resource use conflicts.

Integration of science, economics, law and diplomacy could help bring together not only globally well-connected climate change winners in the Arctic but also losers from the local to the global level. Such integration and establishment of discussions at multiple levels, in turn, could lead to realise economic opportunities arising with climate change in the Arctic while taking environmental and social concerns into account. The exact pathway will most likely vary within countries, between countries and between the local and the global levels, with the choice and choice processes to determine such pathway the responsibility of local, national and international decision-makers.

Within countries, economic and human development can be identified along three models: the 'North American model' which is a neo-liberal regime at the last frontiers (highly concentrated around extraction of non renewable resources), the 'Scandinavian model' which follows the redistribution model of Northern Europe, and the 'Russian model' which is heavily shaped by its political and military history (Glomsrød and Aslaksen, 2009). New institutional approaches for improved natural resource management have been explored in some Arctic areas with promotion of co-management and joint stewardship. This restructuring of power and responsibilities among stakeholders requires strong political will to shift to decentralised and collaborative decision-making associated with improved coordination between indigenous populations and government (Glomsrød and Aslaksen, 2009).

Policies for promotion of external interests in the Arctic that recognise local populations combined to improved data over economic activities and distribution of benefits, social and environmental indicators have the potential to help minimise conflicts between stakeholders (Ahlenius *et al.*, 2005). Some Arctic countries have adopted measures to prevent pollution associated with legally recognised compensation mechanisms, and established national strategies for adaptation to climate change and energy security (Ahlenius *et al.*, 2005; Amundsen *et al.*, 2007). For instance, Canada has extended the reach of its Arctic Waters Pollution Prevention Act (Berkman and Young, 2009). Some Arctic countries have set up national research programmes with an objective to inform action in the Arctic for adaptation under climate change (The Arctic – The Canary in the Mine. Global implications of Arctic climate change. Norwegian-French conference in Paris, 17 March 2015). Such national initiatives, however, do not allow to resolve transboundary issues that rather call for supra-national approaches (Berkman and Young, 2009). Arctic research and exchanges going beyond national boundaries, for example facilitated by the Arctic University, could foster innovation focused on issues specific to polar environments (Hall *et al.*, 2017).

Between Arctic countries, there are a number of jurisdictional conflicts (Figure 5), increasingly severe clashes over the extraction of natural resources and transboundary security risks partly inherited from the Cold War era. A new 'great game' is emerging among the global powers with global security implications (Berkman and Young, 2009). Regional and international cooperation seems to be generally favoured in spite of States taking a stand over their sovereign rights, including through unilateral sovereignty extensions in disputed or international areas. The Russian Federation planted a flag under the North Pole while filing in an official extension request to the Commission on the Limits of the Continental Shelf of The United Nations Convention on the Law of the Sea, UNCLOS, of 10 December 1982. The status of the Northern Sea Route and Northwest Passage is disputed, some seeing them as international maritime routes under common international jurisdiction, whereas Canada is claiming sovereignty over the Northwest Passage and the Russian Federation over the Northern Sea Route (Lasserre, 2017).

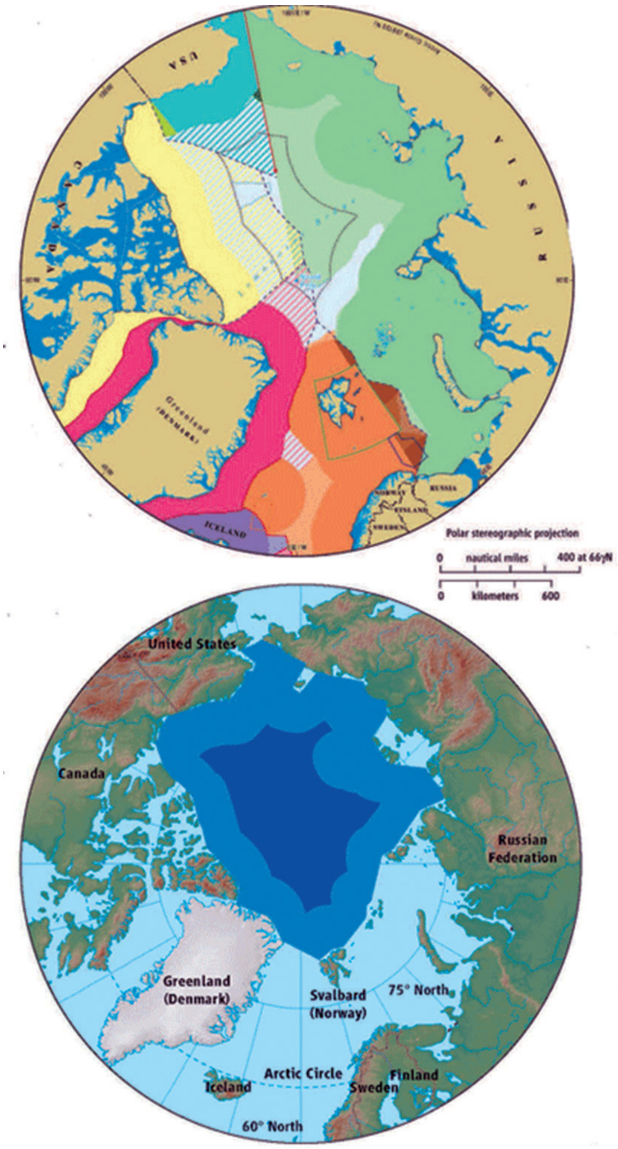

Fig.5 — Arctic sea ice Jurisdictional representations of the Arctic Ocean with boundaries based on (top) sea floor as a source of conflict among nations (different colours) and (bottom) overlying water column as a source of cooperation, with the high seas (dark blue) as an international space in the central Arctic Ocean surrounded by economic exclusive zones (EEZ, light blue). Source: Berkman and Young (2009).

The United Nations Convention on the Law of the Sea, UNCLOS, of 10 December 1982 (Montego Bay Convention) is considered one of the main binding agreements providing a legal framework for activities in the Arctic to this day. UNCLOS helps regulate access to Arctic resources, maritime traffic and pollution through clear identification of national jurisdictions and provision of a mechanism for dispute resolution (Berkman and Young, 2009). UNCLOS grants states bordering the Arctic Ocean sovereign rights for areas under their jurisdiction. In the Ilulissat Declaration of May 2008, countries part of the Arctic Council have reaffirmed their commitment to the legal framework provided by UNCLOS, and to the harmonious settlement of any competing claims that may arise.

In addition to UNCLOS, a number of other international conventions are relevant to the Arctic: the International Convention for Safety of Life at Sea (SOLAS) which focuses on safety requirements, the International Convention for the Prevention of Pollution from Ships (MARPOL 73-78) which focuses on environmental protection, the Convention on Standards of Training of Seafarers (STCW) which focuses on training and competency for personal safety at sea, and the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) which provides a guide for international cooperation and protection of the marine environment and applies to part of the Arctic.

More recently, a number of framework agreements have been established, in particular in relation to shipping in the Arctic, search and rescue operations and pollution management. They provide additional guidance and structure for international cooperation in the Arctic. The International Maritime Organization (IMO) has facilitated the adoption of a series of measures such as the International Code for Ships Operating in Polar Waters, better known as 'Polar Code' or 'Code for polar navigation'. The Polar Code includes amendments to the SOLAS Convention (adopted in 2014 and binding since 1st January 2017), to the MARPOL 73-78 Convention (adopted in 2015 and binding since 1st January 2017) and to the STCW Convention (adopted in 2016, binding since 1st July 2018).

An international agreement signed at Ilulissat on 3rd October 2018 aims to prevent unregulated commercial fishing on the high seas in the central Arctic Ocean. This agreement is signed by Canada, China, Denmark for Greenland and the Faroe Islands, Iceland, Japan, the Republic of Korea, Norway, the Russian Federation, the United States of America, and the European Union. Signatories commit to conducting commercial fishing only within the framework of regional fisheries organisations acting in accordance with recognised international standards. This agreement applies for 16 years and will be automatically extended every five years after that.

All these agreements have been possible thanks to exchanges at the international level in intergovernmental discussion platforms, leading to implementation of coordinated actions with benefits for all ("win-win"). Such platforms include intergovernmental organisations such as the United Nations and its agencies (including IMO), and international fora such as the Arctic Council.

The Arctic Council is formed by 8 states with land within the Arctic Circle: the United States of America (Alaska), Canada, Denmark (Greenland and the Faroe Islands), Iceland, Norway, Sweden, Finland, and the Russian Federation. The Council is a high level intergovernmental forum for Arctic governments and peoples (http://www.arctic-council.org). It is the main institution of the Arctic and was formally established by the Ottawa Declaration of 1996 to provide a means for promoting cooperation, coordination and interaction among the Arctic States, with the involvement of the Arctic Indigenous communities and other Arctic inhabitants on common Arctic issues, in particular issues of sustainable development and environmental protection in the Arctic. The Council is a "weak institution", with no regulatory authority (Chater, 2018), but has successfully facilitated the negotiation of binding agreements between the 8 Arctic countries. Examples include the Agreement on Cooperation on Aeronautical and Maritime Search and Rescue in the Arctic (2011), the Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic (2013) and the Agreement on Enhancing International Arctic Scientific Cooperation (adopted in Fairbanks, Alaska in May 2017, binding since May 2018).

The Arctic Council has been instrumental in the production of scientific assessments such as the Arctic Climate Impact Assessment (ACIA) by its Arctic Monitoring and Assessment Programme (AMAP) working group, Conservation of Arctic Flora and Fauna (CAFF) working group, along with the International Arctic Science Committee (IASC). The Arctic Council has also been the force behind the establishment of a report on human development in the Arctic (Larsen and Fondhal, 2014), and on Arctic environment resilience and ways to ensure its integrity (Arctic Council, 2016).

The Council has successfully brought Arctic issues to the attention of global fora. For example, the 2001 Stockholm Convention on Persistent Organic Pollutants was in part informed by the work of the Arctic Council. Adopted in Stockholm in May 2001 and implemented from May 2004, the Convention aims to reduce levels of persistent organic pollutants accumulating in the environment. It recognises that "Arctic ecosystems and indigenous communities are particularly at risk because of the biomagnification of persistent organic pollutants and that contamination of their traditional foods is a public health issue" (preamble of the Convention).

A number of international scientific monitoring and research bodies are setting up and participating to scientific initiatives and projects in the Arctic. Such international collaborative scientific projects could provide a basis to build trust and enhance Arctic state cooperation through establishing scientifically sound common baselines (Berkman and Young, 2009). These include (but are not limited to) the International Arctic Science Committee (iasc.info), and the European Polar Board (www.europeanpolarboard.org). Several non-Arctic states have become involved in Arctic scientific activities. China considers itself a "near-Arctic state" and is involved in scientific research there (Alexeeva and Lasserre, 2018). Japan has also developed its research activities in the Arctic following revival of interest for the place (Coates and Holroyd, 2015). There are a few training centres and universities in the Arctic itself or dedicated to Arctic issues, among which the University of the Arctic, a network of universities, colleges, research institutes and other organisations concerned with education and research in and about the North (www.uarctic.org). Several academic journals dedicated to polar environments, draw and share evidence from the natural sciences, social sciences and humanities alike (*e.g.*, The Northern Review, Arctic and North, The Polar Journal, Polar Record, and Advances in Polar Science). There is therefore ample grounds for scientific exchange and collaboration on the Arctic.

The Arctic captivates minds and enthrals imaginations as much as ever. There is real potential to harness and develop existing institutions (*i.e.* organisations, binding and non binding agreements) and build up existing institutional capacity based on current and emerging needs. New institutional needs have already emerged in the Arctic with current economic development. So far, the precautionary principle and constructive approaches for action have been aplied. The pace of economic development will be much faster when the cold rush is triggered. One of the challenges will be to build up existing capacity and develop safeguards fast enough to keep up with the fast pace of economic development and changes induced. There is certainly strong potential for creating shared economic wealth and well-being, with benefits for all. Actual choices made by Arctic countries and industries for economic development, coordination and cooperation within the coming years will significantly shape the Arctic of tomorrow.

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