Urban Planning in the Arctic: Historic Uses & the Potential for a Resilient Urban Future

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U*rbanization is not the most common concept associated with the Arctic. Nonetheless, climate change, growing industrial activity, and increased levels of accessibility all suggest that the region is likely to become more urbanized. As these significant changes, environmentally, socially and economically provide both opportunities and threats to the Arctic, there is a critical need to plan for and anticipate these changes to ensure that existing and developing Arctic cities are resilient to the future, both physically and as a social structure. Although Arctic cities exist as hubs of activity within the region, often acting as economic, governance and social centers, urban planners have yet to focus comprehensively on the region. Furthermore, the use of urban planning as a facilitator of urban resilience is a growing concept that is relatively new to the Arctic. Planning can be used to respond to and manage changes to the built environment, increasing the capacity of cities to absorb shocks and changes to the urban fabric. Urban planning as a form of resilience could become a key concept within the urbanization of the Arctic. This paper will take an analytical approach, firstly undertaking a brief investigation into the history of urban planning within the Arctic. In addition, case studies where urban planning has attempted to provide resilience will be discussed and finally the potential for urban planning to contribute to a resilient future in the Arctic in the future will be highlighted.*

Introduction

Norilsk, an industrial city in northern Siberia, is very slowly collapsing; buildings are cracking and disintegrating, creating a city trying to survive in a harsh climate while lacking basic foundational integrity. Thawing permafrost under Arctic towns and cities is a growing issue amongst a variety of concerns regarding the effects of climate change. Urban areas across the eight Arctic countries have long had to deal with unique challenges, most of which are now being exacerbated by climate change. As temperatures in the Arctic rise faster than in any other part of the world, the potential effects become complex and difficult to predict and may have negative impacts on human activities and development (Shur & Goening, 2009; Streletskiy et al., 2012). For the 'urban Arctic' such as the city of Norilsk, where industry and populations are centered, there is a strong need to develop a resilience towards the effects of climate change to ensure a sustainable future. For the purpose of this article, resilience in the urban sense can be understood as the capacity to plan for, anticipate and manage risk and change, while also taking advantage of new opportunities in a sustainable manner. The practice of urban planning is a key and currently underutilized device within the Arctic that has the potential to enhance resilience in the region.

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Although urban planning is not a concept that one would immediately associate with the Arctic in general, and its relating issues, planning is becoming a more prevalent and increasingly important tool in securing a sustainable Arctic future. Increased levels of accessibility due to climate change, as well as new opportunities for resource extraction, trade routes and rural-urban migration mean that urban development in the Arctic is becoming increasingly significant, economically, politically and socially. These opportunities also come with threats and consequences; remote regions are particularly environmentally vulnerable to human influence. These complex challenges need to be anticipated and consequently well planned for and managed to ensure that the almost inevitable urbanization of the Arctic is sustainable, resilient and inclusive at all scales. Urban planning is closely linked to urban design, architecture and engineering. Combined, these practices can be utilized to ensure that future economic development and human settlements in the Arctic can co-exist and become resilient towards the variety of challenges that the region faces. A comprehensive, forward-looking framework which integrates considerations of planning, development and climate change to create a resilient Arctic future could ultimately be the outcome to help urban Arctic societies develop the capacity to thrive in a changing climate (Linkov et al., 2014).

This article examines the progression of urban planning in the Arctic; firstly, a brief history of urban planning in the Arctic will be described, analyzing historic approaches and solutions to the challenges of development in the region. The study will then discuss the range of experimental and creative approaches to urban planning in the Arctic that have been attempted, before evaluating current planning practices in the region. Finally, the potential for a resilient urban Arctic future will be discussed followed by a discussion of future approaches to planning that seek to ensure a more resilient and sustainable future for all.

A Brief History of Urban Development and Planning in the Arctic

The Arctic is a vast region occupying the most northern part of the Earth; settlements within this region have developed and grown to have region and area specific identities. It is also widely accepted that there is a broader Arctic identity that encompasses the entire region, acknowledging shared challenges, threats and common interests, regardless of national borders (Schweitzer et al., 2015). Indigenous inhabitants across the Arctic have a long-standing history of coping with challenges unique to their own part of the region; changing their lifestyle, hunting practices and nomadic ways of life to adapt to the changing climate and environment. By developing a lifestyle which is flexible, with a deep understanding of the nature in which they live, and the diversity of food sources available, Inuit for example have lived a generally subsistent life, adjusting their lifestyles based on continual assessments of climatic conditions (Pearce et al., 2012). Nonetheless, modern development has greatly impacted these lifestyles. In Canada for example, particularly the Northwestern Territories, practices introduced to the region such as land management strategies and forced settlement have begun to erode this flexible and diverse way of life. More settlements began to appear in the Canadian Arctic in the late 19th century, mainly in coastal areas allowing for easy access for trading vessels, trading posts, religious missions and fishing villages, followed by larger settlements developing (Zrudlo, 2001). In the 1950's, government built housing for Inuit populations became more commonplace, again, particularly in Canada. Climate has impacted development in other Arctic nations; in Greenland, sea temperature fluctuations have impacted fish stocks which in turn affect development, prompting offshore fisheries and a less nomadic way of life (Rasmussen, 2009). As settlements and industrial practices continued to grow, it could

perhaps be suggested that the inherently adaptive nature of those who inhabit the Arctic began to erode, highlighting a need for resilience and sustainability (Arctic Council, 2013).

The planning and development of settlements in the Arctic has also relied and been heavily influenced by both the climate and the physical landscape, such as mountains and the coastline. This has shaped the growth of settlements but also restricted expansion, which has led to an often very adaptive and reactive approach to planning in the Arctic (Steinecke, 1999). A limited number of resources, such as building materials and a lack of large labour force, as well as a variety of traditions and social norms depending on location have also influenced and determined the form of the region's towns and cities (Bannova, 2014). Forms of planning have long been present in the Arctic, although not necessarily always in a formalized or strategic manner. It is suggested by Duhaime that "most Arctic settlements did not appear randomly, but have evolved as part of development that requires conscious planning and management processes; in some cases, involving the inhabitants of the settlements and in other situations based on top-down processes" (Duhaime, 1991: 45).

Planning for development in many northern countries was historically a very centralized, top-down practice, with plans and policies often being developed in far removed, more southern cities within the country. This disconnect between policy and practice has in some ways continued to exist in Arctic urban planning today and in (Farish & Lackenbauer, 2009). In addition, Arctic settlements have developed differently in different areas of the region, ranging from smaller, isolated settlements to much larger, heterogeneous urban cores. Arctic urban typology differs depending on the region or country. There has however been a recent and general trend in the Arctic towards people living in large settlements, particularly in Russia, where industrial cities can be found the Arctic region. Populations in national and regional capitals across the Arctic, such as Nuuk in Greenland and Whitehorse in Yukon, Canada are also steadily rising. It is likely that larger urban centers will become the dominant form of settlement structure across the Arctic as society transforms to have predominantly urban characteristics (Heleniak & Bogoyavlenksy, 2015; Hansen & Rasmussen, 2013).

Early Approaches to Urban Planning in the Arctic: Experimental and Industrial

Urban planning can be broadly defined as the organization of spatial structures to improve upon current or existing ones for the benefit of society and more recently, the environment. The practice of urban planning and its related professions is becoming increasingly prevalent in current climate change discourse; the relationship between the physical nature of climate change and the social and economic impacts it has are becoming increasingly interlinked (Davoudi, 2014). It is suggested by Alcoforado & Matzarakis that "urban planning's role is of paramount importance to inform, coordinate and implement measures to ameliorate climate quality…in the face of urban and global climate issues" (2010: 23). The Arctic is no exception to the importance of urban planning; in fact, its extreme nature and the challenges it faces with regards to climate change mean that urban and climate issues in the region are magnified. The remoteness of many Arctic settlements, along with the varying and challenging climate, provides a set of tough conditions in which to inhabit; therefore, planning has been, and can continue to be a useful tool to create and develop settlements, providing resilient towns and cities which can serve as a base from which to thrive in Arctic.

Planning practice in the Arctic is beginning to incorporate more strategic impact assessments of both social and environmental issues. It is recommended by Pressman that "one must learn from nature how to design climate-responsive urban space which has a powerful imprint on people's aesthetic sensibilities" and search for "naturally derived solutions" (Pressman, 1996: 527). In 1996, Pressman also argued that the profession of planning must focus on finding a balance between the exploitation and conservation of resources. Despite this being true across the world, it is perhaps particularly relevant to the Arctic, and its relevancy will continue to increase in the future as climate change effects more severe impacts on the region (Pressman, 1996).

Experimental Approaches to Urban Planning in the Arctic

Urban planners, designers and architects have often used the Arctic as an opportunity to develop unique, experimental and 'cutting-edge' solutions for Arctic development, developing ideas such as climate responsive buildings, utopian style winter cities and eco towns (Jull & Cho, 2013). Over the years, many ideas, designs and plans have been presented however few have come to fruition. Canadian 'Nordicicst' Louis-Edmond Hamelin commented on "the problem of the relationship between geographic realities and the world of the imagination" (Wynn, 2009: 19). The Arctic is a region of extremes and it presents a unique set of challenges to those who inhabit it. This also presents opportunities for planners, architects and urban designers to develop creative solutions and concepts such as below-ground protection, multi-use buildings, retractable roofs, winter tourism, indoor gardens, transport hubs and public art.

One of the most famous examples of the pursuit of a 'modern utopia' in the Arctic is British architect Ralph Erskine, known for socially inclusive and climate responsive architecture, and now often referred to as the 'Arctic Architect'. Erskine argued that both people and climate must be equally considered in Arctic, or northern, architecture. He first went to Scandinavia in the late 1930's, noting the lack of inventive architecture that provides pleasure and comfort as well as protection. Instead Erskine suggested that symbolic architecture was more prominent, despite the fact that this does not represent the idea of 'home' for most people. Overall, the architect believed that at the time, the towns, cities and built environment of the Arctic were failing to serve the needs of the residents. Erskine developed the 'ideal Arctic town' of Svappavaara in Sweden. The town is characterized by continuous runs of buildings connected by walkways. This urban form allows for a convenient and economically viable Arctic town layout, with a multitude of uses clustered for both practical and social benefits, in terms of protection against the harsh climate. Erskine argued that more highly concentrated northern towns were important as a more dispersed form would create inconvenience in terms of infrastructure and connectivity (Erskine, 1968; McGowan, 2008).

In addition to Erskine's work in Svappavaara, one of his more famous and potentially controversial designs was located in the small coastal town of Resolute Bay, Canada, as a response to oil revenue increases in the 1970s. His design, commissioned to help integrate Inuit communities and resolve social issues, resembled a fortified town, surrounded by a circular wall structure to protect from the elements and create a microclimate. The horseshoe shape of the planned town can be seen in Figure 1 below. The interior of the town would include apartments, shops and restaurants as well as a swimming pool and indoor garden. Despite the inventiveness and optimistic approach of the project, it was abandoned in the late 1970s, mainly due to the lack of proximity to the coast, which was essential for the livelihoods of the Inuit residents (Jull & Cho, 2013). Although Erskine attempted to create ideal Arctic towns, his designs were never undertaken in the mainstream; never

fully coming to fruition. He has been criticized for his designs being too 'placeless' and 'colonial' (Hemmersam, 2016).

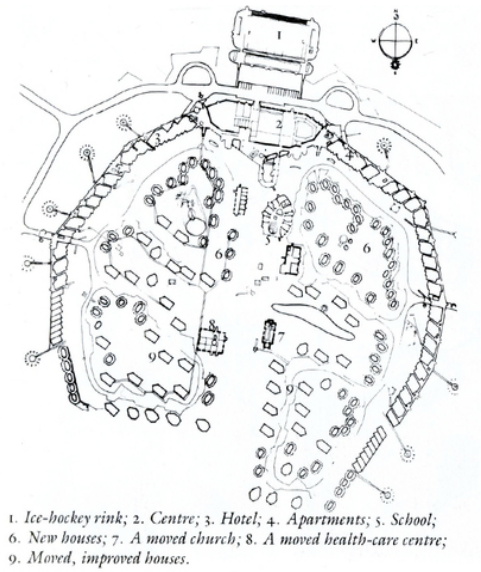

Figure 1. Plan for Resolute Bay (Erskine, c.1973)

Experimental approaches to urban design, architecture and planning in the Arctic have a tendency to lean heavily towards idealisation rather than practicality and therefore can often be a conflict between a romanticised idea of Arctic living and the realities (Løkken & Haggärde, 2016). The nomenclature of certain phrases or phenomena can have a negative, although somewhat inadvertent effect on development and the Arctic is oftentimes referred to as the 'final frontier'. This serves to romanticise the concept of Arctic settlements, deeming them a 'conquest', rather than a long-term, sustainable goal. Practical approaches to planning and design are paramount in these challenging and varying conditions, with local vernacular and traditions being equally important.

Industrial Development and Planning in the Arctic

Humans have been exploiting Arctic resources for hundreds of years, there are rich deposits of resources such as minerals, oil, natural gas and fish, with the potential, and perhaps the threat of being exploited at large scales. In the past, exploitation of resources in the Arctic occurred with little thought to sustainability (Keskitalo et al., 2011). One of the first industries to be established in the Arctic was whaling and walrus hunting. As far back as the 1500s whales and walruses were slaughtered by early explorers and settlers in the region. Despite whale and walrus hunting no longer existing as an industry in the Arctic, other industries have endured, shaping the industrial landscape of the region (Avango et al., 2014). Settlements emerged around industrial activity, following different trajectories based upon location and type of industry, from temporary barrack-style accommodation to house workers, to more permanent, imposing, industrial cities. Demand for energy and minerals has meant the global search for resources has expanded its reach to the

northernmost part of the world, and while large scale development projects in the Arctic have been few in numbers, they are likely to increase (Klein, 2000).

Mining in the Arctic began to take force more comprehensively in the 1950s, for example the Rankin Inlet Nickel Mine established in Canada, dubbed a 'grand experiment' in modernism in the Arctic (Keeling & Sandlos, 2015). Mining operations grew across the region, which holds a variety of deposits such as gold, nickel, lead and zinc. Resources in the Arctic also offer strategic opportunities; with resources comes economic growth and power and thus Arctic geopolitics began to intensify alongside industrial growth (Avango et al., 2014). In terms of resource extraction and power, Russia has emerged as the main player in the industrialization of the Arctic. At present the Russian Arctic accounts for over 60% of the region's Gross Domestic Product (GDP) and approximately two thirds of industrial activity in the entire circumpolar Arctic region. Furthermore, the GDP per capita of the Russian Arctic is almost double the size of the entire country's GDP per capita as a whole (Duhaime & Caron, 2008). The industrialization of the Russian Arctic was forceful and aggressive, occurring under the Soviet development policy and producing large-scale industrial cities. Russian Arctic cities are unlike any of their urban counterparts in the region. The industrial Siberian cities of Murmansk, Yakutsk and Norilsk, for example, are some of the largest cities in the Arctic. The city of Norilsk, in northern Siberia, developed around the nickel mining industry. Growing under Stalin's forced labor, Norilsk was initially set up in the 1930s as a Gulag camp. Despite a general plan for the city being developed in 1939, few considerations other than urban growth/industrial growth were taken into account. Norilsk's master plan can be seen in Figure 2 below; the repetitive, unsympathetic, nature of the urban form still defines the city today and the harsh character of the built environment continues to mirror the climatic conditions. The city has developed to become a heavily polluted urban landscape marked by high-rise, monolithic apartment blocks arranged in a uniform urban form, to protect against extreme weather conditions. Norilsk is built on permafrost; like many similar Russian Arctic cities, this is becoming an increasingly worrying issue as the permafrost begins to thaw and infrastructure becomes unstable and hazardous (Nelson et al., 2002).

Furthermore, social and economic issues, such as a lack of job opportunities for younger residents, mean that Norilsk, and similar northern Siberian cities, are in decline, with shrinking or plateauing populations. Many residents of cities in the Russian Arctic are leaving the region, if they have the means to do so, as industries have shut down, an issue caused mostly by these cities being based on a single industry (Parente et al., 2012; Heleniak, 2013). Initial waves of industrial activity in the Russian Arctic, particularly resource extraction, were not undertaken in a sustainable manner. As a result, although some industrial infrastructure has endured beyond the end of industrial operations, for example in the form of sites for scientific research, many sites and the surrounding built environment lie abandoned and depopulated or in physical, social and economic decline (Keeling & Sandlos, 2015; Milojevic, 2008; Heleniak, 2001).

Current Approaches to Urban Planning in the Arctic

There have been relatively few studies into the history, or current state of urban planning in the Arctic, and the concept does not exist at any comprehensive scale across the region, particularly in relation to the threat of climate change (Ghoneem, 2016).

Figure 2. Master plan for the city of Norilsk (c.1939)

For example, both the 2013 Arctic Resilience Interim Report and the following 2016 Arctic Resilience Report, make very little reference to urban areas. The reports, produced by the Arctic Council, despite focussing on resilience in the Arctic do not discuss in any depth the potential for urban growth and associated challenges in relation to climate change (Arctic Council, 2013; Arctic Council, 2016). Nonetheless, even today, planning and climate are not always inherently linked in the Arctic. In a key 2000 study entitled 'The Use of Climate in the Urban Planning Process', Eliasson commented that climate has a limited impact on the urban planning process. It is commented that urban planners currently lack climate knowledge due to a number of factors such as unclear policies, and a lack of time, money and resources (Eliasson, 2000). There is however a natural link between the climate and the built environment in the Arctic for example, decreasing permafrost temperatures are a key threat to human infrastructure, particularly in settlements in Russia and Alaska, where buildings and transport networks are all built on permafrost. There will be a need for increased mitigation and planning measures to address the potentially severe socio-economic consequences (Streletskiy et al., 2012). Furthermore, concerns are emerging regarding issues such as energy use and renewable energy, quality of public places, and indoor and outdoor comfort, all of which require a combined knowledge of planning and climate (Ebrahimabadi, 2015).

There are a variety of planning, design, engineering, architectural and technological concepts and solutions to provide resilience and to help Arctic settlements adapt to changes in climate and also support social and economic development. The concept of 'adaptation planning' has been borne out of the increasing levels of research on how humans can adapt to climate change, focussing especially on vulnerability and resilience. Whilst adaptation planning as a practical concept remains in its early stages, key ideas and concepts have been determined. Adaptation planning relates to acting in the face of uncertainty, and requires ongoing communication and public outreach (Ford & Pearce, 2012). Factors include committing resources, understanding vulnerabilities and determining options and stakeholders. Canada in particular has undertaken a number of these types of planning projects and Canadian Arctic planning has been, and is, arguably the most advanced in

the region and Canadian planners are also undertaking the idea of anticipatory planning. Anticipatory planning firstly assesses current strategies to planning, while simultaneously investigating the capacities for adaptation and change among stakeholders and communities (Hirvonen-Kantola, 2015). It is suggested that adaptation initiatives focussed on industry and town planning are underrepresented (Ford et al., 2014). It is common that long-term, strategic plans are not always present in these initiatives, despite cities and urban areas being home to the majority of Arctic inhabitants. Research and results relating to adaptation efforts are very poorly reported in these locations; instead there is a focus on remote and isolated settlements. Long-term strategic planning is vital to ensure that there is a solid framework from which anticipatory and adaptive practices can be implemented. Nonetheless, for many Inuit inhabitants of the Arctic, their flexible and reactive approach to dealing with climatic challenges conflicts long-term planning. Therefore, an amount of flexibility, perhaps even a somewhat 'ad hoc' approach to long-term planning will allow for dynamic plans to be made (Pearce et al., 2012). The concepts of adaptation and anticipatory planning focus heavily on producing resilient urban areas; though not yet widespread across the Arctic, there is a shift towards prioritising resilience in the region. Furthermore, with the increasing range of complexities faced by Arctic communities, it is crucial that resilience is integrated early on in the planning process, to allow for planning and adaptation in the short, medium and long-term (Linkov et al., 2014).

In terms of urban design and architecture in the Arctic, resilience towards the challenging climate is a priority. Utilizing technology and climate knowledge is imperative to developing practical and efficient approaches to maintain resilient and sustainable communities. First, creating, retaining and exploiting heat are important; for example, creating 'urban heat islands' can create warmer conditions in settlements. Furthermore, lowering the albedo effect assists with heat retention by using darker colors to maximize solar gain and minimize reflection. Additionally, developing dense urban fabrics will both minimize short-wave radiation and protect against strong winds, which can make the temperature feel even lower than it already is in the Arctic. Low-rise, compact and centrally arranged structures will also help protect against wind, and storms, also creating a sense of community. Wind however can also help to keep air quality high. The ultimate goal therefore, when using urban design, architectural and engineering techniques to protect against the climate, is not to completely eradicate it, but to exist, embrace, adapt and where possible, benefit from it (Alcoforado & Matzarakis, 2010). Furthermore, in the Arctic, some communities have begun to deploy adaptive co-management strategies and communications infrastructure, combining traditional and scientific knowledge. This is an emerging concept that presents a comprehensive approach to the planning and management of human activities (Berkes, 2007).

Towards a Resilient Urban Future in the Arctic

As the world is already caught up in the wave of urbanization and globalization, the need to develop a resilience towards the multiplicity of issues relating to these phenomena is paramount. A number of major international agreement have focused on urban issues. The United National Sustainable Development Goals (SDGs), adopted in 2015, devotes Goal 11 to urban areas, prioritizing resilience, sustainability, inclusivity and safety. While not specifically alluding to Arctic development, this goal fits well with the needs of the region in the future, and promotes the importance of urban areas on a global scale (Biermann et al., 2017). In addition, the Paris Agreement, known as COP21 attempts to provide a universal agreement to address climate change.

As we enter an age of 'mega-urbanization', even more remote, extreme and inhospitable regions of the earth will face development and growth. Climate change plays a central role, both positively and negatively in the urban future of these extreme regions. Therefore, planning for resilience and sustainability is an increasingly important task that planners, designers, architects, engineers, policy makers, governments and communities face (Bulkeley et al., 2009). In 1986, Pressman and Zepic argued that functions and activities located in more severe and extreme environments and climates require much higher levels of organization. They suggest that it is key to prioritize both planning policies and principals that moderate and manage the severity of, in this case, the Arctic climate, to create safe, protected spaces for human activity (Pressman & Zepic, 1986).

Urban planning must integrate climate change more thoroughly to achieve successful resilience. Climatic factors should be approached in an organized way, with engagement and not just awareness of the issues. It should be integrated into plans, and approached proactively; it could also be used as an opportunity, as well as a problem to be dealt with. Understanding the combined effects and consequences of climate change and urban growth, at varying spatial and temporal scales, is key to comprehensively identifying and planning for a resilient future (Ebrahimabadi, 2015; Arctic Council, 2013). Sharing knowledge between planners and climate scientists is crucial, although a great challenge, with both professions being required to understand the needs and capabilities of the other (Eliasson, 2000). It is however important to remember that it is impossible to completely accurately predict all changes to climate; this can be mitigated by incorporating and prioritizing resilience in the planning process. Urban resilience deals with uncertainty; planning for resilience therefore must avoid attempting to predict and regulate the future, instead remaining adjustable (Coaffee & Lee, 2016).

In the future, along with the need to plan for climate change and the subsequent physical and societal impacts, there is likely to be a need to incorporate larger scale political and economic issues. As the Arctic 'industrial revolution' evolves, it is important to ensure that proximity to natural resources is not the only planning consideration as urban settlements develop; social, economic, environmental and political aspects must all be considered. Furthermore, an avoidance of single-industry developments should be avoided (Heleniak, 2013). Political tensions may mount as climate change leads to better access to resources in the Arctic, and as the Northwest Passage begins to open, marine territory disputes may rise (Jull & Cho, 2013). Therefore, as well as physical planning, local, regional and even national governments may require reconfiguration in terms of systems of Arctic governance to ensure they are flexible and adaptable to future uncertainties. Furthermore, a key aspect of Goal 11 of the Sustainable Development Goals relates to global sustainability governance initiatives; it is suggested that the 'quest' for resilient and sustainable cities should begin with national policies and regional development plans (Biermann et al., 2017). Additionally, it is important to build the capacity of communities and regional governments in particular; progress could still be made in terms of prioritizing these sensitive regions. In Russia for example, there are challenges regarding achieving an equal standard of living across the country, with the lack of a comprehensive national regional policy in the Arctic creating challenges (Ghoneem, 2016; Hemmersam, 2016; Kinossian, 2013).

Though many aspects and impacts of climate change in the Arctic can be analysed and quantified, for example, sea ice extent or glacial melt, the impacts of climate change on the human, and in particular, social structure of the Arctic are much harder to measure; happiness and comfort, for

example, are subjective and cannot necessarily be easily monitored or quantified. People's happiness, comfort, and to a wider extent, their livelihoods, rely heavily on the surroundings in which they live. This means that not only ensuring resilient and sustainable urban development is important, but also that it positively impacts the people who reside in the settlements. Future Arctic development and planning must engage and co-exist with the outdoor environment, integrating the climate into daily life. Furthermore, the ideas of comfort and happiness must begin to be understood in greater depth to ensure they can be provided along with the more practical aspects of planning for resilience. Physical and social wellbeing should be prioritized and urban design, planning and architecture should be utilized to ameliorate rather than banish the climate. It is argued that in developing Arctic settlements, integration rather than isolation must be pursued. Arctic inhabitants must embrace living alongside the winter climate instead of living in spite of it. To pursue resilience and sustainability in the future, the relative disconnect between physical and social research regarding the impacts of climate change must be bridged. Research into urban development and the built environment in the Arctic is at present a relatively new field. Therefore, whilst a glaciologist, for example, could be researching the rate at which a glacier will melt over time, the outcome of that research does not help to understand the effects it may have on the lives of those who live near the glacier. It is of course crucial to understand how climate change effects the physical and biological systems, but without an equal and combined understanding of the social impacts, substantial efforts to mediate and adapt to develop resilient urban settlements cannot be made.

The recent rapid increase in levels of globalization, and subsequently urbanization, has meant that some isolated Arctic communities are now facing a more globally influenced spectrum of issues. Where once a settlement has relied mainly on a lifestyle of subsistence and reactionary planning, a heavier focus on minerals and energy resources in the region has led to larger scale commercial operations continuing to be established and grow, such as mining, fisheries and drilling. Along with these changes must come a modernization of planning and public administration; restructuring to allow for adaptation and resilience (Larsen & Fondahl, 2015). Furthermore, knowledge gaps must be filled and transferable skills, for both experts and local communities, must be developed so that there is a greater potential for adaptation and subsequently, resilience. Increased development and industrial activity, along with climate change, will bring new challenges and changes. It will be important to look towards local tradition and knowledge specific to the different communities across the Arctic to understand how they have historically coped with climatic issues. Combining these with modern and technological approaches may help to create sustainable, well-informed, context-specific, solutions that are appropriate to local communities and the environment. In a World Bank report entitled, 'Eurasian Cities: New Realities Along the Silk Road", improved planning and connectivity, as well as sustainability and increased funding are listed amongst key catalysts for sustainable urban growth. As suggested by Heleniak, these lessons could be applied to development in Arctic cities (Heleniak, 2013).

Conclusion

The cryosphere is changing and the challenges this presents to cities and communities are manifold. Although there are still a number of varying trajectories that the urban future of the Arctic can

take, it is wise to assume that climate change will shape and influence development. The impacts of climate change are as important and significant as the economic opportunities they may bring and planning for a resilient and sustainable urban future in the Arctic will require attention and cooperation at all scales (Ford et al., 2014). There is a need to develop a stronger Arctic identity and foster a sense of community and belonging; timescales must also be taken into account, as well as whether new strategies and ideas can be worked into existing planning practices. There is a need for comprehensive planning agendas for the Arctic that balance resilient and sustainable development with the challenges presented by climate change. Questions arise regarding how these agendas will take shape in differing parts of the Arctic, and how they will be implemented, as well as what we can learn from historic approaches to planning and development across the Arctic and what the future holds for Arctic development.

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Figures

Figure 1. Erskine. R., (c.1973). [Plan for Resolute Bay]. [Digital Image]. Available at:

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