

Cryosphere as infrastructure. Observations on open space in the Arctic city of Luleå

Stefano Tornieri

Jade University of Applied Science, Oldenburg (DE)

stefano.tornieri@jade-hs.de

01
2025

SECONDA SERIE

Abstract

This paper explores the role of the cryosphere as a dynamic element in Arctic urban design, with a focus on its implications for public space planning in winter cities. The cryosphere, encompassing snow, sea ice, permafrost, plays a dual role in Arctic urbanism: as a temporary, accessible open space enabling unique modes of public engagement and as a fragile ecosystem under threat from climate change. Using Luleå, Sweden, as a case study, the research highlights how Arctic cities creatively utilize frozen spaces such as sea ice for recreation, transportation, and social activities. Key features like Luleå's ice road exemplify the integration of seasonal infrastructure into urban life, offering a model for leveraging the cryosphere as "white infrastructure." The paper further examines the challenges posed by climate change, including the shortening ice season, which threatens both the ecological stability of sea ice and its cultural and functional roles.

Il contributo esplora il ruolo della criosfera come elemento dinamico nella progettazione urbana in ambienti artici, con un focus sulle sue implicazioni per la pianificazione degli spazi pubblici. La criosfera, che include neve, ghiaccio marino, permafrost, svolge un doppio ruolo nell'urbanismo artico: da un lato come spazio aperto che consente modalità uniche di interazione, dall'altro come ecosistema fragile minacciato dal cambiamento climatico. Utilizzando Luleå, in Svezia come caso di studio, si evidenzia come le città artiche utilizzino gli spazi ghiacciati per attività ricreative, trasporti e iniziative sociali. Spazi organizzati come la Ice Road di Luleå esemplificano l'integrazione di infrastrutture stagionali nella vita urbana, offrendo un modello per valorizzare la criosfera come "infrastruttura bianca". L'articolo esamina inoltre le sfide poste dal cambiamento climatico, che minacciano sia la stabilità ecologica del ghiaccio marino che i suoi ruoli culturali e funzionali.

Keywords

Arctic Urbanism, Iced Sea, Bothnia Gulf, Temporary Architecture.

Urbanismo artico, Mare ghiacciato, Golfo di Bothnia, Architettura temporanea.

Living in the Arctic

Designing urban environments in the Arctic presents unique challenges, particularly in terms of open space planning within a landscape dominated by snow and ice for much of the year. In these extreme latitudes, public life, outdoor activities, and soft mobility (Chapman et.al., 2017) are constrained by harsh winter conditions, often limited to brief summer months or confined to indoor settings. Winter defines Arctic cities, with temperatures frequently dropping below zero and the land blanketed in snow and ice for four to six months annually. In such conditions, traditional urban design principles must be innovatively reimagined and adapted to ensure the safety, comfort, and accessibility of residents throughout the year. Early pioneers – among others Ralph Erskine (1961), and more recently Norman Pressman (1987) have been instrumental in emphasizing the importance of climate-sensitive urban design for northern environments. Erskine's influential 1961 work *The Sub-Arctic Habitat* included in CIAM 1959 publication, introduced foundational guidelines for winter-specific urban planning, emphasizing the need to account for elements like extreme cold, snow, frost, light variation, wind, vegetation, and microclimate. Building upon Erskine's legacy, Pressman further refined these principles, advocating for design strategies that maximize solar exposure, reduce wind effects, and

manage snowfall to enhance livability in severe climates. Erskine and Pressman laid the groundwork for a range of studies and contributions reflecting on the living characteristics of the Arctic environment. Recent research has focused on a comprehensive analysis of settlement and urbanization in the Arctic (Shephard, White, 2016) and the Antarctic (Foscari, 2021), emphasizing the need for a more nuanced and region-specific approach to urbanism in these transnational territories. Taking a more sophisticated perspective, the Arctic Design Group interprets the Arctic territory as an 'intersection of many peripheries', conceptualizing it as a space that mediates multiple layers of complexity – spanning the physical and conceptual, the past and the future, and various spatial membranes (Cho, Jull, 2019). This perspective was explored in the exhibition *Domestic Territories* at the 17th Venice Architecture Biennale, where the Arctic Design Group examined deep connections between domestic interiors and the broader landscape. Similarly, the exhibition *The Arctic Hypothesis: Architecture in Transition for the Land of Tomorrow*, curated by S. Tornieri and A. Rizzo (Tornieri, 2024), focused on the European Arctic as a territory of opportunity for trans-scalar design solutions, linking domestic-scale interventions to regional planning strategies. In this context, the recent book *Planning and Urban Design for Attractive Arctic Cities* (Chapman et



Fig. 1 - The Iced Bothnia Gulf. (NASA image captured by the LANCE/EOSDIS Rapid Response Team. Data acquired on March 31, 2013).

al., 2024) explores ways to improve design quality to create more attractive Arctic cities. The book highlights established and classic principles of Arctic urban design, including considerations of microclimate, cultural heritage, urban morphology, and mobility. One of the main risks in designing for winter cities is an overemphasis on the technical performance of buildings, while issues of architectural composition and formal quality are relegated to a secondary level of consideration. This was evident in Soviet Arctic planning, where architecture primarily served ideological and industrial objectives. The result was a prevalence of standardized, monumental forms focused on controlling the extreme environment rather than adapting to it (Kalemeneva, 2018). In contrast, the notion of urban attractiveness has become central to the future of Arctic territories. This is often tied to strategies such as city branding (Hammersam, 2021; Pasgaard et al., 2020) or the use of conceptual narratives rooted in the socio-climatic experience of winter (Hamelin, 2000). From a Scandinavian perspective, qualities like aesthetic value and liveability are given greater importance compared to Russian contexts. Here, public spaces are actively designed to respond to the winter season through the use of light, colour, and programming – making the cold months more vibrant and socially engaging. Collectively, these approaches represent a shift from rigid, top-down planning models toward more human-centered, climate-responsive design strategies that recognize winter as an essential, enriching part of urban life (Legault, 2018).

A core concept in Arctic urban design is 'blue-green-white' planning, which seeks to integrate urban

spaces with surrounding ecological features such as green spaces, forests, rivers, lakes, and coastal areas. In the Arctic context, this approach introduces the concept of 'white infrastructure' – a term for the spaces dominated by seasonal snow and ice. Even though a precise scientific definition of White Infrastructure has yet to be established, the seminal work of Gällivare Municipality provides a clear reference to the use and management of ice and snow as integral components of large-scale urbanism (Gällivare Kommun, 2016). In this direction, recent urban planning theories advocate for a multicolored approach to urban thinking, emphasizing the interplay of diverse environmental and infrastructural elements (Sagrelus et al., 2022). The cryosphere, as defined by the World Meteorological Organization (WMO) and described as a "relational materiality" by L. Cho (2020), encompasses Earth's frozen elements, including snow cover, glaciers, sea ice, lake ice, river ice, permafrost, and seasonally frozen ground. In Arctic cities, the cryosphere often serves as an extension of public space; seasonally frozen lakes, rivers, and coastal areas transform into accessible urban expanses, enabling unique modes of winter activity and engagement.

While Arctic regions are not limited by a shortage of open space, the seasonal transformation of these frozen landscapes into vast, uniform, and accessible 'whiteboards' has fostered a distinctive approach to outdoor public life. Although recent years have seen a revival of interest in designing for cold climates, the topic remains underexplored in contemporary urban studies, despite the significant social and environmental implications of overlooking winter and

northern environments in urban planning. In scientific literature, ice sea is mainly studied in environmental engineering disciplines (Lépy, 2012), in chemistry (Geilfus et.al., 2021), or geophysics (Mäkynen, 2020; Vihma et.al., 2009). Sea ice has been studied as a dynamic and historically significant element, highlighting its essential role in driving societal and environmental transformations within the Arctic region (Sörlin, 2015), as well as its contribution to connectivity and soft mobility (Chapman et al., 2019), however a general lack of consideration can be detected in the field of urban studies.

This paper draws on direct observations from regular visits throughout the winter season of 2023/2024, enabling a qualitative analysis of the role of ice, or the cryosphere, as a temporary open space. Here, the cryosphere is explored not only as a public space but also as a fragile environment increasingly threatened by the impacts of climate change.

The fluid, volumetric, and contingent nature of sea ice presents unique challenges for both representation and planning. Unlike more stable landscapes, the ice is transient, constantly shaped by environmental conditions such as temperature, wind, and currents. These dynamic properties complicate traditional approaches to spatial organization, as conventional mapping and planning tools often fail to capture the ephemeral and fluctuating characteristics of the frozen sea. How we conceive of sea space direct-

ly influences how it is mapped, managed, and experienced.

Drawing inspiration from the narratives of polar explorers such as Ernest Shackleton, whose expeditions evoke both the awe and fear of ice, the cryosphere emerges as an environment of immense psychological and physical significance. Its vastness and volatility inspire both fascination and caution, symbolizing human vulnerability in the face of nature's extremes. A direct observation carried out between October 2023 and March 2024, combined with data provided by the municipality, enabled a comprehensive assessment of the current state of use and the positive factors associated with the ice in Luleå's harbour. This site was selected as a compelling case study, given Luleå's status as the largest city in Norrbotten County and its unique position facing the frozen Gulf of Bothnia.

The Ice Ring of Luleå

The Baltic Sea, an arm of the North Atlantic Ocean, serves as a natural boundary between the Scandinavian Peninsula and the rest of continental Europe. Spanning approximately 1,610 kilometers in length and 190 kilometers in width, with a surface area of around 377,000 square kilometers, it is the largest body of brackish water in the world due to the significant influx of freshwater from surrounding rivers. To the north, the Baltic Sea narrows into the Gulf of

Bothnia, which extends between Sweden, Finland, and the Åland Islands.

The Bay of Bothnia, is a highly indented region between 100 and 200 kilometers wide and around 600 kilometers long, bordered by rugged coastlines and scattered islands. Owing to its low salinity, the surface of the Gulf of Bothnia typically freezes over from early January until the end of March. Located less than 50 kilometers south of the Arctic Circle, Luleå experiences a dramatic range of temperatures, from summer highs of +30°C to winter lows of -30°C, with average temperatures typically staying below freezing from November through mid-March. According to Copernicus surveys (Ronkainen et al., 2018), ice thickness in Luleå's coastal areas can exceed 140 centimeters, and satellite images reveal ice extending as far as the Kvarken Archipelago, demonstrating the expansive reach of this frozen terrain. To support consistent shipping routes, icebreakers work continuously to keep ice channels open, enabling the flow of goods between Sweden and Finland even in the coldest months.

The sea surrounding Luleå's city center, encompassing the northern (*Norra Hamn*) and southern harbors (*Södra Hamn*), transforms in winter into a central recreational area due to its secure ice thickness, which is verified daily through perforation and drilling tests. This frozen expanse, maintained by the municipality, becomes a hub for winter sports and oth-

er seasonal activities. The primary attraction is the 'ice road', a 40-meter-wide, 10-11 kilometer-long ice path cleared of snow and open for ice skating, walking, and fat-biking. This route connects to nearby islands within the archipelago, making them accessible by foot and enhancing the city's winter connectivity. (Fig.2)

Along this path, simple amenities such as fireplaces shielded from the wind by wooden panels and benches offer rest points, while information panels and regular safety checks add to the accessibility and social quality of this unique open space. During Luleå's winter festival, the ice road becomes the scene for a diverse range of events, from ice hockey and curling matches to snowmobiling, fat biking, ice sculpting, and international racing competitions. Together, these activities create a dynamic, communal atmosphere, greatly expanding options for outdoor engagement and fostering social connections among residents and visitors. Access ramps to the ice road are located at both the northern and southern harbors, although individuals can enter and walk on the ice from various points along the shoreline. Beyond serving as a temporary infrastructure that enhances accessibility and well-being, the ice road offers a unique vantage point from which to view the city of Luleå. Extending into the Bothnian Archipelago, it reaches the small island of Gräsälören, which, during this season, functions as a rest area enhanced with



coffee shops, benches, restrooms, and local product vendors.

The ice road also prompts broader theoretical questions about the nature and function of open space in Arctic cities. As an 'abstract and liminal' environment, this temporary landscape challenges traditional notions of architecture and urban design, raising critical inquiries about the future role of public space in the context of climate change and how such spaces can adapt to shifting environmental conditions.

Expanding on this perspective, we should explore the potential of amphibious constructions – architectural solutions capable of both resting on ice and transforming into navigable vessels as conditions change. Additionally, an alternative approach could draw inspiration from Christo's *Floating Piers* installation on Lake Iseo in 2016, investigating how floating infrastructures can redefine the thresholds between land and water. Both directions challenge conventional

notions of permanence and impermanence, prompting architecture and urban design to critically engage with oscillation, amphibious adaptability, and the materiality of transient landscapes.

The plateau as performing esplanade

From a theoretical perspective, the concept of a blank space as a performative esplanade offers valuable insight into the design and compositional strategies behind the ice rink in Luleå. Designing on a white sheet can be seen as an archetypal gesture, the primal act of creation in architecture and planning. Make choices, drawing perimeters, define space through a simple line is enough to produce differences and hierarchies. The space in *Dogville* by Lars von Trier is undefined by material matter, it's only lines in a dark perimeter but still very powerful as Kurt Lewin's notion of 'hodological' space (Laine, 2006). Urban space extends beyond mere physical structures; it serves as the primary arena for human interaction (Makeham

Fig. 2 - Luleå, Sweden, The map of the ice track. (Photo: Stefano Tornieri, 2025)

2005). It is within this shared environment that we convey our identities, express our desires for transgression, and highlight our distinctiveness. These interactions and urban spaces are in constant interplay, generating 'urban scenes' – spaces that enable both collective and individual expressions to unfold. These scenes are closely tied to the concept of performance, as they provide the setting for cultural expressions within real time and space (Makeham 2005). In this sense, the city itself can be viewed as a performance: a representation of shared and personal values, aspirations, memories, and ambitions. When analyzing the qualities of public spaces in Arctic environments, it is crucial to emphasize the importance of integrating blue-green-white planning strategies. By doing so, cities can enhance the functionality and attractiveness of public areas year-round, despite the challenges posed by extreme climates. This approach includes considerations such as efficient snow removal, adequate lighting, and the maintenance of green and blue spaces, even when they are covered by snow and ice. The municipality of Luleå has made notable efforts in this regard by implementing daily maintenance of the ice road. This involves clearing snow and regularly testing ice thickness to ensure safety, thus transforming a natural seasonal feature into a secure and attractive public infrastructure. The attractiveness of a place is a critical issue in Arc-

tic regions, particularly in isolated and rural communities (Tornieri et.al., 2024). To address this, green and blue infrastructure (GBI) must be adapted to accommodate seasonal variations, ensuring continuity and complexity in how such spaces support public life throughout the year. The conceptualization of 'white infrastructures' which refers to the use of frozen landscapes such as snow and ice-covered spaces, builds upon prior research on green and blue infrastructures (Kazmierczak, Carter, 2010). This expanded framework acknowledges the unique role of the cryosphere in Arctic urbanism. However, the urbanization of ice remains an underexplored concept, with limited in-depth studies addressing its potential as a fully integrated component of urban planning (Hermersam, 2021).

The absence of reference in a uniform plateau is not an uncommon spatial condition in Arctic Regions. As G. Ligi observes, the theme of space and its vastness is almost impossible to overlook in any study about Lapland (Ligi, 2016). Ligi further introduces the concept of an 'ecology of vastness', suggesting that the enormity of the landscape has generated a need for symbolic shaping – a foundational act of measuring and defining the landscape (Ligi 2016, p. 174). In a manner similar to traditional native architecture, such as that of the Sámi and other Indigenous Lapland communities, the region's territory is charac-



Fig. 3 - Luleå, Sweden, People walking on the ice road. (Photo: Stefano Tornieri, 2024)

Fig. 4 - Luleå, Sweden, Festival on ice. (Photo: Stefano Tornieri, 2024)

terized by elementary spatial organizations: simple aggregations of dwellings and a form of urbanization like fishing villages that is largely unplanned and lacks deliberate design of open space as a social framework (Tornieri et al., 2024). Here, architecture holds value primarily as a positional element within the landscape, supporting social functions without extensive structural or aesthetic intervention. Similarly, the approach to urban design for the expansive ice-covered landscape in Luleå reflects this essential concept: architecture holds value not in and of itself but through its positional significance along the ice road. These structures act as 'pause points' within a connective infrastructure, serving as recognizable objects that stand out against the vast white expanse of ice through contrasting colours and forms. These structures, provided by the municipality, are currently not subject to advanced design proposals. They are simple and essential in form, yet highly functional for pedestrian users and ice skaters, as the ring is primarily intended for pedestrian use, with car and truck access permitted only for maintenance purposes such as ice cleaning and surface safety testing. Unlike the experimental approaches to water-based construction seen in countries addressing sea-level rise, Arctic infrastructure prioritizes reaching isolated areas, which are viewed as attractions for tourists seeking relaxation and escape from the noise and confusion of urban environments. The vastness of the frozen landscape, combined with the perception of isolation within an open and expansive space, is considered a key factor in enhancing both attractiveness and well-being. Enhancing pedestrian accessibility and creating alternative connections

contribute not only to the viability of the city but also extend benefits beyond the local resident population. Events such as sports festivals – comparable to international ice-based festivals like the Warming Huts Competition in Winnipeg, Luminothérapie in Montreal, the Winter Design Competition in Toronto, and the Harbin International Ice and Snow Festival – offer diverse experiences that attract international visitors. In these contexts, including Luleå, such events serve as platforms for engagement with Indigenous communities, notably the Sámi population. During the festival period, traditional Sámi huts are often installed along the ice track, offering visitors a glimpse into Indigenous ways of life, including traditional clothing and cuisine. In this sense, Indigenous nomadic traditions are adapted to enhance accessibility for all; the ice road facilitates inclusive access, enabling even individuals with mobility challenges to visit the huts and other installations.

Sea ice may appear lifeless, static, and unchanging, yet it serves as a foundational element for much of the life in the Arctic ecosystem. The scraping of ice against the shore creates growth conditions for plant species that would otherwise be unable to establish there. For the ringed seal, sea ice offers both a habitat and a secure location for rearing young. In February, female seals construct a 'cave' on the ice surface, where they give birth to a single pup. This pup develops on the ice, relying on it as a safe environment. Between April and May, adult seals undergo molting and depend on the ice both as a resting surface and a source of warmth. Underwater, fish species such as perch (*Perca fluviatilis*), pike (*Esox lucius*), and salmon (*Salmo salar*) continue their win-



Fig. 5 - Luleå, Sweden, Wind shelter protecting a fireplace on the ice road. (Photo: Luleå Municipality, 2022)

Fig. 6 - Luleå, Sweden, Free to use sledges. (Photo: Luleå Municipality, 2022)



Fig. 7 - Luleå, Sweden,
Ice fishing. (Photo:
Stefano Tornieri, 2024)



ter activities. Ice fishing, an important outdoor activity in this region, serves both as a source of entertainment and a means of obtaining food. This activity requires only basic tools, such as a manual drill and, often, a wind-blocking plastic curtain placed on the ice to shield fishers from cold breezes. This area is also an ideal spot for birdwatching, as the open landscape and wide sky offer excellent visibility for spotting Arctic eagles (*Aquila chrysaetos*). It is common to see groups of fishermen setting up their fishing rods along quieter sections beside the ice road, while birdwatchers often seek out more secluded spots nearby to observe wildlife in peace.

Design for the Transition

Climate change poses a profound threat to sea ice, a fragile habitat highly sensitive to temperature fluctuations. In Finland's recent assessment of threatened habitats (Kontula, Raunio, 2019), the ice of

the Baltic Sea was identified as a vulnerable environment, with decreasing extent, duration, and quality. This decline introduces significant challenges for the future of winter cities, where the cryosphere sustain part of the public life and outdoor activities. Key climate projections for the Baltic Sea region highlight air temperature as the critical factor influencing ice formation and melting. Local freezing and breakup dates show a sensitivity of 5–8 days' shift for every 1°C increase in temperature. Similarly, sea ice thickness fluctuates by 5–10 cm for the same degree of warming. Snow accumulation further complicates these dynamics, as increased snow can delay ice breakup but may either reduce ice thickness through insulation or enhance it by forming snow-ice layers (Leppäranta, 2023). While a substantial reduction in the ice season in the Gulf of Bothnia is not anticipated for another 10–15 years (Andersson, 2013), it is essential to prepare for the societal and spatial impli-

cations of this gradual change. A shorter ice season will inevitably reduce the availability of frozen surfaces for events, recreation, and public gatherings, fundamentally altering the structure of Arctic urban life. Addressing the transition period between winter and summer, often seen as a liminal and underutilized phase, is central to Arctic urban planning. Current spatial organization in Arctic cities primarily divides activities into winter and summer frameworks, leaving the 'in-between' seasons without specific programming or infrastructure. This transitional period, particularly during ice melt, presents an opportunity for innovative design interventions. Emerging concepts highlight how adaptive and resilient infrastructure can respond to these changing conditions. For example, the Research Infrastructure Greenland (RIG), a project by David Irwin (2019), even it's only

at the conceptual phase, envisions floating structures capable of adapting to diverse and shifting topographies, including melting ice. Similarly, more radical solutions like the Arctic Saver Tower by Yiyang Xu and Jingyi Ye from National Taiwan University of Science and Technology, propose mechanisms for actively managing ice (Designboom, 2019). This tower system rotates its outer frame in spring as ice begins to melt, freezing seawater into new ice layers while gradually releasing stored ice to absorb atmospheric heat and delay temperature rises. Such solutions offer forward-thinking strategies for maintaining Arctic ecosystems and the socio-cultural practices they support.

Although the anticipated changes to the Arctic ice season are not immediate, they provide a critical window for cities to strategize and design for the transition.

References

- Andersson L. 2013, *Baltadapt Strategy for Adaptation to Climate Change in the Baltic Sea Region: A proposal preparing the ground for political endorsement throughout the Baltic Sea Region*, Danish Meteorological Institute, Copenhagen.
- Chapman D., Nilsson K., Larsson A., Rizzo A. 2017, *Climatic barriers to soft-mobility in winter: Luleå, Sweden as case study*, «Sustainable Cities and Society», 35C. 574-580.
- Chapman D., Nilsson K.L., Rizzo A., Larsson A. 2019, *Winter City Urbanism: Enabling All Year Connectivity for Soft Mobility*, «International Journal of Environmental Research and Public Health», vol. 16, no. 10, p. 1820.
- Chapman D., Nilsson K.L., Sjöholm J., 2024, *Planning and Urban Design for Attractive Arctic Cities* (1st ed.). Routledge.
- Cho L., 2020, *Permafrost Politics: Toward a Relational Materiality and Design of Arctic Ground*, «Landscape Research», 46(1), 25-35.
- Couling N., Hein C., 2021, *The Urbanisation of the Sea: From Concepts and Analysis to Design*, Nai010 Publishers, TU Delft.
- Designboom. *Futuristic arctic saver tower sprays seawater to thicken melting ice* <<https://www.designboom.com/architecture/arctic-saver-tower-ice-antarctica-06-11-2019/>> (03/25)
- Erskine R., 1961, *The Sub-Arctic Habitat*, in Newman, O. (ed.), CIAM '59 in Otterlo: Group for the Research of Social and Visual Inter-Relationships, Alec Tiranti, London, pp. 160-168.
- Foscari G. (eds). 2021, *Antarctic Resolution*, Lars Müller Publishers, Zürich.
- Gällivare Kommun. 2016, *Grön-, blå- och vitstrukturplan Gällivare*. https://gallivare.se/download/18.4e20a890188bda337d16238c/1687718683989/GBV_slutlig_20160321.pdf

- Geilfus N.X., Munson K.M., Eronen-Rasmus E., Kaarto-kallio H., Lemes M., Wang F., Rysgaard S., Delille B., 2021, *Landfast Sea Ice in the Bothnian Bay (Baltic Sea) as a Temporary Storage Compartment for Greenhouse Gases*, «Elementa: Science of the Anthropocene», vol. 9, no. 1, p. 00028.
- Hamelin L.E., 2000, *Le Nord et l'hiver dans l'hémisphère boréal*, «Cahiers de géographie du Québec», 44(121), 5–25.
- Hammersam P., 2021, *Arcticness and the Urbanism of the North*, «Arctic Yearbook 2021: Defining & Mapping the Arctic: Sovereignties, Policies & Perceptions», pp. 452–468.
- Hammersam P., 2021, *Making the Arctic City: The History and Future of Circumpolar Urbanism*. London: Bloomsbury.
- Irwin D., Project rig <<https://www.youtube.com/watch?v=ayjvntxopP8>> (03/25)
- Kalmenova E., 2018, *Arctic Modernism: New Urbanisation Models for the Soviet Far North in the 1960s*.
- Kontula T., Raunio A., (eds.) 2019, *Threatened Habitat Types in Finland 2018: Red List of Habitats. Results and Basis for Assessment*, «The Finnish Environment», vol. 2, pp. 254.
- Laine T., 2006, *Lars von Trier, Dogville and the Hodological Space of Cinema*, *Studies in European Cinema*, vol. 3, no. 2, pp. 129–141.
- Lefebvre H., 1974, *The Production of Space*, Blackwell, England.
- Legault O., 2018, *Le design hivernal des espaces publics. Études de cas scandinaves*, «Le froid. Adaptation, production, effets, représentations, sous la dir. de Chartier, Daniel et Borm, Jan» Québec, Presses de l'Université du Québec, coll. Droit au Pôle, pp. 75–88.
- Leppäranta M., 2023, *History and Future of Snow and Sea Ice in the Baltic Sea*, Oxford Research Encyclopedia of Climate Science. Retrieved 14 November 2024, from <https://oxfordre.com/climatescience/view/10.1093/acrefore/9780190228620.001.0001/acrefore-9780190228620-e-891>.
- Lépy É., 2012, *Baltic Sea Ice and Environmental and Societal Implications from the Comparative Analysis of the Bay of Bothnia and the Gulf of Riga*, «Fennia», vol. 190.
- Ligi G., 2016, *Laponia. Antropologia e Storia di un Paesaggio*, Edizioni Unicopli, Varese.
- Makeham P., 2005, *Performing the City*, «Theatre Research International», vol. 30, no. 2.
- Mäkynen M., Karvonen J., Cheng B., Hiltunen M., Eriksson P., 2020, *Operational Service for Mapping the Baltic Sea Landfast Ice Properties*, «Remote Sensing», vol. 12, p. 4032.
- Pasgaard J.C., Hemmersam P., Nielsen T., 2020, *New Nordic stereotypes: In search of alternative design practices for tourism in peripheral landscapes*. «Journal of Landscape Architecture», 15(3).
- Pressman N., 1987, *Images of the North: Cultural Interpretations of Winter*, «Winter Communities Series», Institute of Urban Studies, University of Winnipeg. <https://winnspace.uwinnipeg.ca/bitstream/handle/10680/969/154-1987-Pressman-ImagesoftheNorth-WEB.pdf?sequence=1&isAllowed=y>.
- Ronkainen I., Lehtiranta J., Lensu M., Rinne E., Haapala J., Haas C., 2018, *Interannual Sea Ice Thickness Variability in the Bay of Bothnia*, «The Cryosphere», vol. 12, pp. 3459–3476.
- Sagrelus P., Lundy L., Blecken G., Rizzo A., Viklander M., 2022, *Blue-Green Infrastructure for All Seasons: The Need for Multicolored Thinking*. «Journal of Sustainable Water in the Built Environment».
- Sheppard L., White M., 2021, *Many Norths. Spatial Practice in a Polar Territory*. Actar D. Barcelona.
- Sörlin S., 2015, *Cryo-History: Narratives of Ice and the Emerging Arctic Humanities*, in Dodds, K., Nuttall, M. & Heffernan, M. (eds.), *The New Arctic*, Springer, Cham, pp. 327–339.
- Tornieri S., Ma J., Rizzo A., 2024, *Which Urban and Landscape Qualities Make Arctic Villages Attractive? The Torne River Villages in Sweden*, «European Planning Studies», pp. 1–21.
- Vihma T., Haapala J., 2009, *Geophysics of Sea Ice in the Baltic Sea: A Review*, «Progress in Oceanography», vol. 80, no. 3, pp. 129–148.