The short-term future of Arctic tourism: The complexity of seasonal uncertainties for nature-based tourism

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Abstract

This chapter explores the short-term future of Arctic tourism. The effects of climate change lead to intensified physical and ecological changes in the Arctic cryosphere, aggravating the loss of seasonal snow and ice. These changes are predicted to significantly affect communities where Arctic tourism, often nature- and cryospheric-based, plays a significant economic role. Short-term climate projections are characterized by increased unpredictability of seasonal patterns with growing variability of snow and river and ice cover extent: these being also the core elements of Arctic tourism. Some adaptation strategies exist to cope with momentary and brief snowless early winters like the storage of snow and artificial snowmaking. Nevertheless, these techniques have limitations in terms of sustainability. Therefore, it is crucial to develop other forms of adaptation strategies, based on new understandings of the Arctic, so that Arctic tourism does not become a burden for local communities.

Keywords

Arctic tourism, climate change adaptation, Finnish Lapland, sustainability, nature-based tourism.

26 **Introduction: adapting Arctic tourism to climate change**

27

28 The Arctic has become an infamous symbol of climate change in recent years, with images of
29 emaciated polar bears and melting cryosphere dominating media discourses. In general, the
30 transformation of the Arctic cryosphere and ecologies will have global impacts on regional
31 ecosystems, which are crucial for Arctic communities' food security and local economies (Dodds &
32 Woodward, 2021; Ford et al., 2006; Nuttall, 2007; Stepien et al., 2014; Markkula et al., 2019). This
33 includes the Arctic tourism industry, which is often nature-based, and whose attractiveness is based
34 on iconic wildlife (e.g., polar bears, seals, whales, reindeer) and landscapes (e.g., sea ice, glaciers,
35 white, and snowy vistas) (Hall, 2010; Palma et al., 2019). In line with this, Arctic tourism is
36 grounded in biased and historically constructed representations of the Arctic (Pedersen & Viken,
37 1996), perceived only as white, frozen, and empty, and thus overlooks other seasons and the reality
38 of the region in terms of climate, demography, and cultural diversity (Saarinen & Varnajot, 2019).

39

40 In this chapter, Arctic tourism is understood as tourism taking place in northern latitudes, where
41 tourists engage in experiences producing and reproducing cryospheric- and winter-based
42 imaginaries. However, it is worth noting that other forms of tourism exist in the Arctic, such as
43 second-home tourism, lake tourism, event tourism (e.g., festivals), or sports tourism (e.g., Arctic
44 Winter Games, Arctic Race of Norway). Thus, these other forms of tourism refer to 'tourism in the
45 Arctic' rather than 'Arctic tourism'. This distinction is critical. Indeed, as the latest IPCC reports
46 (Meredith et al., 2019; Constable et al., 2021) have highlighted, climate change is increasing
47 seasonal variability of Arctic cryospheric elements, such as snow cover, lake and river ice, and sea
48 ice. Consequently, this increasing variability leads to seasonal uncertainties in terms of snow and
49 ice reliability for tourism entrepreneurs in the Arctic (Steiger et al., 2019), and this specifically
50 affect Arctic tourism, and not tourism in the Arctic per se. In addition, this makes winter tourism-

dependent communities vulnerable to global climate change, reflecting future challenges related to cold climate and snow-dependent businesses and livelihoods (Kaján & Saarinen, 2013). This situation further raises issues for tourism entrepreneurs regarding seasonal workforce employment, destination image, and the inability to conduct outdoor nature-based activities due to the lack of cryosphere. Additionally, research has highlighted the influence of climate variables, such as temperature, precipitation, visibility, and cloudiness, on tourists' preferences and aversions towards Arctic tourism destinations, and it has been emphasized that destination's attractiveness is highly vulnerable to the impacts of climate change (Førland et al., 2013; Saarinen, 2014).

Strategies to adapt to global climate change have already been developed. These strategies are primarily reactive and technical; they involve, for example, the production of artificial snow, storage of snow over the summer (Damm et al., 2014; Varnajot, 2020), and even domed skiing slopes. Nevertheless, if these techniques might be enough to mitigate seasonal uncertainties from a short-term perspective, they all present limitations in terms of sustainability and environmental ethics in the long run (Varnajot & Saarinen, 2022). The negative impacts of such technological solutions include increasing energy and water consumption, loss of areal vegetation due to changing snow composition and density, and off-season aesthetic changes at ski resorts (Rixen et al., 2003; Rixen et al., 2011). Additionally, there are often sizeable economic costs related to artificial snowing (Scott et al., 2011) which in the long-term may become too costly for smaller ski resorts. Authors like Rantala et al. (2019) or Varnajot and Saarinen (2021) have suggested the need to rethink the narratives and policies associated with the Arctic to make Arctic tourism smarter, more responsible and sustainable in the future.

This chapter explores the short-term future of Arctic tourism in the context of climate change and global warming. The following section presents the current state of Arctic tourism and further

76 justifies the need to specifically focus on Arctic tourism, and not tourism in the Arctic. Focus then
77 shifts to the impacts of climate change on the Arctic cryosphere by shedding light on the challenges
78 the Arctic tourism industry will face in terms of climate variability and uncertainties, particularly in
79 the early winter season. The last section explores existing adaptation strategies and innovative road
80 maps for changing the narratives associated with the Arctic in tourism.
81
82 **The state of Arctic tourism and Arctification**
83
84 Tourism in the Arctic has existed for over two centuries, the first tourists consisting mainly of
85 scientists, explorers and wealthy adventurers (Hall & Johnston, 1995). At that time, large areas of
86 the Arctic remained unexplored and tourism in these northern regions was only a sporadic
87 phenomenon (Varnajot, 2020). Today, however, tourism in the Arctic "starts at the North Pole and
88 quite literally spreads out in all directions from there" (Maher et al., 2014, p. 1) to the southernmost
89 regions of the Arctic, both on land and by sea. Tourism in the Arctic is now operating year-round
90 and varies from exclusive icebreaker cruises to the North Pole (see Stewart & Draper, 2008) to
91 more accessible and affordable tourism hotspots with mass tourism practices (e.g., Reykjavik,
92 Iceland; Rovaniemi, Finland; or in places like Longyearbyen and Tromsø, Norway) (Saarinen &
93 Varnajot, 2019).
94
95 Some of the most visited Arctic destinations are in northern Fennoscandia, Iceland and Alaska (see
96 Hall & Saarinen, 2010; Maher, 2017), although accurate statistics would reflect the popularity of
97 tourism in the Arctic rather than of Arctic tourism (see Maher (2017) and Varnajot (2020) for
98 detailed statistics). Indeed, as Grenier (2011) recalled, Arctic tourism can be understood as a type of
99 experience; as such, it does not encompass all forms of tourism existing in the Arctic. Globally, the
100 highest tourist season for most Arctic destinations tends to be summer. One exception is Finnish

101 Lapland, experiencing its high tourist season in the winter (November to January), particularly due
102 to the well-developed Santa Claus and Christmas tourism industry in Rovaniemi (see Hall, 2008;
103 Tervo-Kankare et al., 2013; Varnajot, 2019). While tourism in the Arctic is not recent, Arctic
104 tourism has been significantly growing over the last two decades in various Arctic destinations,
105 partly due to two phenomena, namely last-chance tourism (LCT) and Arctification (Lundmark et
106 al., 2020). LCT refers to "the desire for tourists to witness vanishing landscapes or seascapes and
107 disappearing species" (Lemelin et al., 2010 p. 477). In other words, tourists want to experience the
108 snowy and icy Arctic, as we know it today, before it is irrevocably changed.
109
110 Arctification, however, is defined as the production of "particular representations of the North
111 among consumers as well as industry and political stakeholders" (Carson, 2020, p. 6). These
112 representations involve an intensification of stereotypical winter-based imaginaries and the
113 standardization of tourism products and experiences engaging with snow and ice (Lundén et al.,
114 forthcoming; Varnajot & Saarinen, 2022). Therefore, contrary to tourism in the Arctic, Arctic
115 tourism is poorly diversified and mostly occurs during the winter months. In line with this,
116 Arctification appears to be a direct driving force of Arctic tourism, and not of tourism in the Arctic.
117 Saarinen and Varnajot (2019) have identified in various Arctic destinations (Rovaniemi, Reykjavik,
118 Longyearbyen, Tromsø, Sisimiut, Iqaluit, Whitehorse, Fairbanks and Yakutsk) a strong core of
119 tourism activities (e.g., dog- and reindeer-sledding, viewing northern lights, snowmobiling and ice-
120 fishing), reflecting broader standardization and globalization of destinations and tourism products
121 (see also Simpson, 2016; Eriksen, 2021).
122
123 As observed by Saarinen and Varnajot (2019), these core activities are mostly dependent on the
124 presence of the cryosphere (snow cover and ice). Even northern lights that can be observed in late
125 summer and autumn in the southernmost parts of the Arctic, such as Lapland, are often associated

126 with snowy landscapes in promotional materials (Herva et al., 2020). More so, Arctification has
127 recently reached the tourism accommodation sector. Indeed, snow and ice castles, as well as fields
128 of glass igloos, have emerged in several Arctic destinations, particularly in the Nordic countries.
129 These glass igloos draw implicitly from the Inuit culture, while snow-castles were originally
130 developed from a Swedish tourism initiative and have spread to other Arctic and winter-based
131 destinations. Indeed, the IceHotel of Jukkasjärvi (in the vicinity of Kiruna) was the first of its kind
132 to have been developed as a tourist attraction where "the unique elements of the Arctic winter were
133 regarded as an asset" (Hall et al., 2008, p. 241). Ever since, these unique Arctic assets have been
134 reproduced for other snow castles such as in Kemi, Rovaniemi and Ylläs (Finland), in Alta
135 (Norway), in Yellowknife (Canada), but also outside the Arctic, like in Québec City (Canada) or,
136 Val Thorens (French Alps).
137
138 Arctic tourism, driven by the process of Arctification, does not merely seek to simplify the reality of
139 the Arctic in terms of its environmental, climatic, and cultural diversity. It also does so in relation to
140 the effects of climate change and seasonal uncertainties. The climate and seasonal weather
141 conditions are becoming potential liabilities for the industry in terms of providing commercially
142 necessary images of the Arctic. Two examples epitomize this shift between the seasonal climatic
143 variability and unreliability of the Arctic, on the one hand, and tourists' expectations and tourism
144 promotional materials on the other. First, in the early winter of 2018, Finnish Lapland faced a
145 delayed winter with a significant lack of snow and cold. For most of November and early
146 December, Finnish Lapland remained black to such an extent that British tabloids renamed the
147 region 'Crapland'. This reflected the 'betrayal' of Lapland in the eyes of the visitors, in the form of
148 missing wintery landscapes and snow that led to an obvious disappointment among tourists and to
149 cancelling of tours (Varnajot, 2020). Second, a typical activity around the Arctic is viewing
150 northern lights (Heimtun & Haug, 2022; Saarinen & Varnajot, 2019). Climate change forecasts for

151 most parts of the Arctic project rising temperatures which, in turn increase air humidity and
152 ultimately impact clouds conditions (Serreze et al., 2012). In parallel, northern lights safaris are
153 heavily promoted with edited photographs of auroras and do not consider increasing cloudiness
154 variability. The heightened expectations of tourists can sometimes conflict with the actual inability
155 to view the sought-after celestial lights, effectively emphasizing the gap between their expectations
156 and the dynamic reality of the Arctic. Therefore, as an Arctic tourism product, northern lights
157 safaris are often associated with extra activities, a kind of *planned distractions*, such as
158 snowmobiling, camping, or ice-diving. This combination of activities is meant to "enhance or
159 broaden the primary experience of the northern lights" (Mathisen, 2017, p. 68) in case of missing
160 them. Another response to northern light insecurities is the building of planetariums to secure the
161 experience, as the example of the Kakslauttanen resort (Finnish Lapland) shows.
162
163 As seasonal uncertainty is projected to increase in the short-term future, it becomes critical for
164 Arctic tourism entrepreneurs to adapt rapidly and to diversify their products. As the 'cryospheric
165 costs' of running winter-based tourism are likely to increase, opting for more flexible strategies and
166 products is necessary, although for particularly smaller tourism companies, these often mean extra
167 costs (see Kaján et al., 2015; Tervo-Kankare et al., 2018). Due to the projected impacts of climate
168 change on the phenomenon of Arctification, this chapter is therefore specifically concerned with
169 Arctic tourism.
170

171 **Climate change impacts on Arctic tourism**

172
173 Climate change and global warming impact all forms of ice in the Arctic (e.g., sea ice, glaciers, ice
174 sheets, snow cover, river and lake ice, and permafrost) (Meredith et al., 2019). Although thawing
175 permafrost has been analyzed as having tremendous impacts on infrastructures (e.g., roads,

176 buildings, or pipelines) (Hjort et al., 2018; Larsen et al., 2021), it does not affect the tourism
177 industry as much as other forms of cryosphere since the permafrost remains out of sight and is not
178 needed to support the majority of nature-based Arctic tourism activity and vista. However, it is
179 worth noting that permafrost degradation leads to significant challenges for tourism and other uses
180 in mountainous regions owing to increasing slope instability and mass movements (Pröbstl-Haider,
181 2016). Furthermore, although glaciers have become a prosperous resource for tourism, attracting
182 millions of tourists every year (Abrahams et al., 2021) and have been significantly affected by
183 climate change (Carey, 2007; Salim et al., 2021), their variations and modifications occur over a
184 much longer period and therefore do not have significant implications for seasonal variability and
185 uncertainty. Accordingly, this section focuses on sea ice, river and lake ice, and snow cover.
186
187 *Arctic sea ice*
188 Declining sea ice has gained significant interest due to the on-going and future growth of shipping
189 and cruise tourism in the Arctic Ocean (Pizzolato et al., 2014; Stewart et al., 2007). The observed
190 changes for 1979–2016 showed a 35% reduction in the Arctic summer sea ice extent and a 70%
191 reduction in the ice volume during the summer (Palma et al., 2019). Changes in sea ice can also be
192 observed through transitions from multi-year to first-year ice (Galley et al., 2016). As near-surface
193 Arctic air temperatures – emphasized by the Arctic amplification – continue to rise, the projected
194 future of Arctic sea ice shows a general decline of ice extent and thickness (Jung et al., 2016;
195 Massonnet et al., 2012; Stroeve & Notz, 2015), although sea ice dynamics can change at the local
196 scale and from one season to another. It is also predicted that on-going global warming could lead
197 to ice-free conditions in the summer months by the middle of the century (Notz & Stroeve, 2016)
198 and to further "Atlantification" of the Arctic Ocean (Ingvaldsen et al., 2021).
199

200 Seaborne Arctic tourism primarily occurs in the summer months, with increasing seaborne activities
201 during the June and November shoulder months (Pizzolato et al., 2014). Cruise tourism is even
202 regarded as the fastest-growing form of tourism in the polar regions (Bystrowska & Dawson, 2017;
203 Johnston et al., 2017). Nevertheless, declining sea ice raises uncertainty "in the timing of when the
204 Arctic may become ice-free in the summer, and for how long during the season" (Meredith et al.,
205 2019, p. 222; see also Overland & Wang, 2013), and that timing may substantially vary from a year
206 to another. For the cruise tourism industry, sea ice uncertainty is particularly problematic in June
207 since the cruising season does not extend all the way to November (yet). However, in the middle of
208 summer, sea ice conditions do not seem to be a significant problem for cruise ships in some areas of
209 the Arctic Ocean, such as around the Svalbard archipelago (Bystrowska, 2019).
210
211 Another significant implication of declining sea ice for cruise tourism is the projected increasing
212 mobility, and thus the uncertainty of ice floes in an area of the Arctic Ocean called the marginal ice
213 zone (MIZ) (Manucharyan & Thompson, 2017). The MIZ refers to the transition area between the
214 open ocean and inner and dense ice pack. The MIZ is not fixed in time and space; its width can
215 extend from 50 to 300 km depending on the season, and therefore its associated hazards vary in
216 time and space too (Dumont et al., 2011; Palma et al., 2019; Strong, 2012). In addition, due to
217 complex interactions between the ice, the sea and the air, the MIZ is also home to various iconic
218 wildlife species such as whales, seals and polar bears, which are the very reasons some operators
219 are planning cruise itineraries at the threshold of the sea ice (Palma et al., 2019). However, as the
220 Arctic warms up, the sea ice concentration in the MIZ decreases, resulting in drifting ice floes
221 driven by wind, waves, and tides (Dumont et al., 2011; Strong, 2012). Therefore, unpredictable ice
222 floes raise concerns regarding potential collisions, adding to the increasing seasonal navigation
223 variability and associated uncertainty (Bystrowska, 2019). Finally, a particular concern for some

224 parts of the Arctic is the limited search and rescue existing resources and infrastructure (Arctic
225 Council, 2009).
226
227 *River and lake ice*
228 Lake ice phenology (timing of seasonal ice formation and loss) has been observed and studied for
229 centuries for economic and recreational purposes. Frozen lakes and rivers are generally used for
230 winter transportation throughout the Arctic (Korhonen, 2006; Sharma et al., 2021). More recently,
231 lake and river ice phenology has been used as an indicator of climate change, particularly in the
232 Arctic, where freshwater systems are highly sensitive to changes induced by global warming
233 (Sharma et al., 2019).
234
235 Briefly, studies project a delay in the freeze-up and an earlier breakup for lakes around the
236 Circumpolar North (Benson et al., 2012; Magnuson et al., 2000; Meredith et al., 2019), although
237 there are regional differences (Šmejkalová et al., 2016). This represents a global trend but does not
238 reflect variability from one winter to another. In North America, for example, lake freeze-up is
239 projected to happen with a delay of up to 15 days by mid-century and an earlier breakup of between
240 10 to 25 days by 2050, both compared to the 1961-1990 reference period (Brown & Duguay, 2011;
241 Prowse et al., 2011). Korhonen (2006) and Šmejkalová et al. (2016) have observed similar trends
242 for the lakes of Finland and Siberia. The IPCC Special Report on the Ocean and the Cryosphere in a
243 Changing Climate (Meredith et al., 2019, p. 252) adds that "mean maximum ice thickness is
244 projected to decrease by 10-50 cm" compared to the 1961-1990 reference period (see also Brown &
245 Duguay, 2011) and that "high-latitude warming is projected to drive earlier river ice-breakup in
246 spring due to both decreasing ice strength, and earlier onset of peak discharge" (see also Cooley &
247 Pavelsky, 2016). It is worth noting that ice thickness is also dependent on snow precipitations which
248 can turn into snow ice (Korhonen, 2006).

249

250 Frozen lakes and rivers are essential features for contemporary Arctic tourism, local recreational
251 activities and subsistence resources by providing seasonal roads for reindeer herding, cross-country
252 skiing and vehicles (Landauer et al., 2015; Turunen et al., 2016; Knoll et al., 2019). Arctic tourism
253 activities requiring frozen freshwater systems include ice-fishing, ice-driving, and ice-floating
254 (dipping into a frozen lake and floating in special overalls), which are directly dependent on the
255 presence of ice to take place and for the tourist experience to be fulfilled. Snowmobile safaris also
256 need frozen freshwater systems because rivers and lakes can be used as corridors for group
257 snowmobile rides (Figure 1), although they can still ride on snow-covered lands if nearby lakes and
258 rivers are not yet frozen. Nevertheless, such a situation would considerably limit the variety of
259 available tours in terms of length and sites to visit. This is particularly the case in Rovaniemi, the
260 capital of tourism in Finnish Lapland, surrounded by several lakes and rivers, where snowmobile
261 trails can be overused. Northern lights viewing and photographing also benefit from frozen lakes
262 and rivers. Similarly, to snowmobiling, northern lights viewing can be done without frozen
263 freshwater systems around. Nevertheless, frozen lakes provide better access to viewpoints, and thus,
264 better opportunities to admire and photograph auroras. The increased variability of freezing-up
265 lakes and rivers in winter, therefore, leads to uncertainties regarding the (in)ability to conduct these
266 typical Arctic tourism activities and provide satisfactory experiences to tourists. In addition,
267 seasonal variability "can make planning of activities difficult" (Kaján et al., 2015, p. 315),
268 ultimately leading to extra costs and tour cancellations. This is problematic at destinations such as
269 Finnish Lapland, where the high tourist season is in early winter (November and December).

270

271

272 Figure 1. Snowmobile tracks on Norvajärvi, north of Rovaniemi. Photo: Alix Varnajot.

273

274 *Arctic snow cover*

275 Climate projections forecast a general reduction in Arctic snow cover duration for all regions of the
276 Arctic with later snow onset in the autumn and earlier snow melt in the spring (Brown et al., 2017;
277 Meredith et al., 2019). This reduction in snow cover extent and duration is driven by an increase in
278 surface temperature over Arctic lands (Hartmann et al., 2013; Mudryk et al., 2017). Overall, the
279 general trend reflects a constant decrease in snow cover duration by mid-century and reaching a 5-
280 25% reduction by 2100 – depending on the scenario – compared to the 1986-2005 reference period
281 (Brown et al., 2017; Meredith et al., 2019). Regional differences are also expected, with a greater
282 decline in snow cover duration in Alaska and northern Europe, compared to Siberia (Callaghan et
283 al., 2011).

284

285 In addition, with increasing temperatures, moisture availability also increases in the Arctic region
286 (Serreze et al., 2012), leading to increased snow precipitation and accumulation in the winter over
287 large regions of the Arctic (Brown & Derksen, 2013; Callaghan et al., 2011). Interviews with
288 tourism entrepreneurs and reindeer herders in Finnish Lapland have also revealed that these
289 observations have already been made by those directly dependent on snow conditions (Rees et al.,
290 2008). Also, increasing weather variability in the winter is projected to increase rain-on-snow
291 events (Hansen et al., 2014). In academia, a well-discussed consequence of these events is their
292 impact on reindeer husbandry. Indeed, the impacts of such events are "immediate […] [and]
293 accumulate, leading to massive starvation-induced die-offs of reindeer, caribou, and musk oxen"
294 (Serreze et al., 2021, p. 1). These events are also problematic for tourism. For example, as recalled
295 by Serreze et al. (2021, p. 7), "ice formation on the Svalbard airport runway forced the airport to
296 shut down" for a couple of days in January 2012; "[the] impacts […] ground ice had on
297 transportation, including transportation by snowmobile, dog-sled and pedestrian transport, resulted
298 in massive income losses for the local tourism industry". Thus, rain-on-snow events are
299 increasingly contributing to uncertainties for Arctic tourism.

300

301 Indeed, snow and its conditions are crucial for several Arctic tourism activities including
302 snowmobiling, dogsledding, and skiing (Gössling & Hall, 2005). Tourism activities involving
303 reindeer usually include visits to farms and reindeer-sledding (Saarinen & Varnajot, 2019), and
304 therefore, could be partly affected too. Snow cover is also necessary for the skiing industry (alpine
305 and cross-country). Nevertheless, in the short-term, snow reliability seems to be sufficient for the
306 middle of winter, particularly in northern Europe (Demiroglu et al., 2019), although snow
307 production will most likely be required (Rice et al., 2022). However, the decline in snow cover
308 duration inevitably raises issues for skiing conditions in the shoulder months. For example, due to a

309 substantial lack of snow and temperatures too warm for snow guns to work, the opening of the
310 World Cup for slalom skiing traditionally taking place in Levi, Finland, had to be cancelled both in
311 2011 and 2015. Snow cover is also important for the global aesthetics of Arctic destinations (Herva
312 et al., 2020). As demonstrated by Tervo-Kankare et al. (2013) in the case of Rovaniemi, 77% of
313 tourists would not have travelled to Rovaniemi if there had been no snow during the high tourist
314 season and Christmas. Furthermore, 63% of tourists would not have visited Rovaniemi if the
315 snowfall reliability was poor
316
317 However, climate change is not affecting all regions of the Arctic homogeneously. Therefore,
318 Arctic destinations will not be affected simultaneously and in the same way in terms of snow
319 variability and reliability. Such situations would ultimately become problematic for destinations
320 facing a substantial lack of snow from a competitive perspective (Varnajot & Saarinen, 2022).
321
322 **Existing and future tourism adaptation strategies to seasonal variability**
323
324 Studies on tourism adaptation to climate change have a relatively long history (Dubois & Ceron,
325 2006; Kaján & Saarinen, 2013; Weir, 2017). According to Tervo-Kankare et al. (2018) and Kájan et
326 al. (2015), studies on adaptation have mainly focused on small-scale actors, products, or
327 destinations and on reactive and practical adaptation strategies (e.g., snowmaking and storing).
328 However, more recently, some studies have suggested the need to also focus on the anticipatory
329 aspects, namely changing the narratives and imaginaries associated with the Arctic (see Lundén et
330 al., forthcoming; Rantala et al., 2019; Varnajot & Saarinen, 2021, 2022). Furthermore, beyond
331 issues related to operational costs and sustainability, reactive adaptation strategies are limited to
332 specific types of snow-based activities and therefore do not provide a comprehensive solution to all
333 primary offerings of Arctic tourism.

334

335 Indeed, in the Arctic – and in mountainous regions, a widely used adaptation strategy is artificial
336 snowmaking, allowing the mitigation of natural snow variability and uncertainty, particularly in the
337 early winter season (Rixen et al., 2011). Snowmaking induces costs related to the maintenance of
338 machines (e.g., snow guns), but also in terms of water and electricity consumptions (Rixen et al.,
339 2011; Steiger & Mayer, 2008) although "the exact net benefits are difficult to measure" (Tervo-
340 Kankare et al., 2018, p. 205) due to the variety of actors involved in this business (e.g., local
341 governments, small to medium-sized businesses, and large corporate chains). Nevertheless,
342 according to Dawson and Scott (2013), from the mid-century onwards, climate change and
343 increasing seasonal variability and uncertainty will lead to several ski resorts not being
344 economically viable, even with snowmaking facilities. As a result, the "remaining viable could take
345 advantage of a reduction in marketplace competition" (Dawson & Scott, 2013, p. 244). This
346 challenge for the most threatened ski resorts can also be understood as an opportunity to reinvent
347 themselves as Arctic destinations by proactively focusing on anticipatory strategies.
348

349 A second adaptation strategy is the storage of snow over the summer, followed by spreading efforts
350 on ski slopes early in autumn (Figure 2). This technique has been particularly used in northern
351 Europe, such as in Ruka or Levi, in Finland, or Vålådalen and Idre Fjäll, in Sweden. Usually, the
352 method consists of storing the snow on the slopes, covering them with white gauze and sawdust
353 (Varnajot, 2020). This allows some slopes to open as early as October regardless of the presence of
354 natural snow. Contrary to snowmaking techniques found in ski resorts, such an adaptation strategy
355 could be relevant in non-skiing resorts providing Arctic tourism experiences. Nevertheless,
356 temperatures need to remain low enough to maintain snow on the ground. Therefore, the increasing
357 temperature variability and rain-on-snow events induced by climate change are problematic. Both

358 snowmaking and storing provide a sense of security for resorts and aim to avoid potential crises
359 generated by increasing seasonal uncertainties.
360
361 In line with this, the will of municipalities and ski resorts to open slopes as early as possible in the
362 autumn shows how the tourism industry, particularly the skiing business, is unwilling to wait for
363 winter and snow to fall naturally. This unwillingness demonstrates the shift between the climate
364 reality of the Arctic (shortening winters) and local businesses driven by the economic pressure to
365 open the ski season as early as possible.
366

367
368 Figure 2. Snow stored under 'blankets' on the slopes of Ruka ski resort, Finland. Photo: Aapo
369 Lundén.
370

371 A third strategy for coping with seasonal variability is the construction of ski domes to overcome
372 climatic risks by moving snow products indoors. Although these are often associated with
373 extravagant construction projects in the Middle East (e.g., Dubai Snowdome in the UAE) and Egypt
374 (SkiEgypt in Giza), they also exist in the Nordic countries. For example, in Rovaniemi, two projects
375 plan the construction of such domes. The first one belongs to a tourist resort mega-project called
376 "The Republic of Santa Claus", where snow would fall all year-round (Varnajot, 2020). The second
377 is an initiative developed by the city of Rovaniemi, called "Arctic Central Park", and providing
378 year-round domed skiing opportunities (see Ounasvaara, 2022). However, more than coping with
379 snow variability and reliability in the shoulder months, such projects primarily aim to offer winter
380 experiences all year-round.
381
382 Finally, the fourth reactive strategy is to adapt tourism products to the lack of snow rather than
383 adapting the environment to tourism products. Indeed, sleighs can, for example, be turned into carts
384 with wheels for some activities such as dog- or reindeer-sledding. This technique has already been
385 used in Lapland in summer and early autumn to train and prepare dogs for the winter season or in
386 Svalbard, where tourists can hop in a wheeled cart pulled by husky dogs during the summer
387 months. Nevertheless, although such technical adaptations allow these Arctic activities to be
388 conducted, this raises the question of authenticity and fulfilment of the tourism experience. For
389 example, can a dog-sled ride on wheels in a snowless environment still be considered 'Arctic' from
390 a tourism perspective? In the short-term future, this potential lack of authenticity in these activities
391 could also favor tourism entrepreneurs where the paucity of the cryosphere is not (yet) a problem
392 (Varnajot & Saarinen, 2022).
393
394 These reactive adaptation strategies leave out several Arctic tourism experiences and products,
395 particularly ice-based activities. As a result, this also leads to a shrinking (of an already small)

396 diversity of Arctic tourism products and experiences. Therefore, this calls for more profound
397 adaptation strategies that go beyond short-term reactive solutions. Hence, Rantala et al. (2019, p.
398 63) suggested the need to reconsider the narratives and imaginaries associated with the Arctic in
399 tourism, and to increase the role of local communities in "[developing] […] diverse images
400 representing a variety of Arctic meanings and experiences". This strategy recommends that the
401 Arctic in tourism should not be solely grounded in images of snowy and deserted landscapes
402 (Varnajot & Saarinen, 2021, 2022). Indeed, it has been argued that more diverse Arctic meanings
403 could mitigate issues caused by the potential lack of snow and ice during the early winter season
404 especially. As opposed to the process of Arctification that emphasizes purely winter-based
405 representations, these new perspectives focusing on reinventing narratives, have been termed 'de-
406 Arctification strategies' by Cooper et al. (2020).
407
408 In practice, de-Arctification strategies would entail the support of destination marketing
409 organizations (DMOs) or larger tourism companies to withstand the transition and potential
410 temporal economic losses following such de-Arctification actions. Indeed, an isolated tourism
411 entrepreneur cannot change the whole vision of Arctic tourism. Therefore, to be successful,
412 changing broader narratives and images of the Arctic must be jointly conducted by DMOs and other
413 main tourism actors. Typically, this includes significant changes in tourism marketing and regional
414 branding strategies (see Bohn & Varnajot, 2021; Rantala et al., 2019) to end the production and
415 reproduction of winter- and cryospheric-based Arctic representations. The focus on narratives and
416 representations of the Arctic (and therefore of Arctification) is critical since, as recalled by Medby
417 (2019, p. 124) "denominations, definitions, and metaphors are all part of conditioning spatial
418 understanding" and can ultimately create new geographical representations of the Arctic. Indeed, by
419 formulating and conveying ideas, narratives used in marketing and promotional materials are
420 directly as the basis of Arctic place-making (Varnajot & Saarinen, 2022; see also Tuan, 1991).

421

422 Changing narratives associated with the Arctic could also benefit cruise tourism. As iconic
423 landscapes continue to disappear and wildlife migrate under the threat of climate change, there will
424 be a need for cruise operators to adapt their itineraries. Following this, Stewart et al. (2007) and
425 Palma et al. (2019) raised a critical question: what will happen to the destinations that used to attract
426 thousands of tourists looking for polar bears or glaciers when those will be gone? Short-term
427 reactive strategies already exist for cruise tourism too, such as the development of flexible
428 itineraries, planning and organization (Bystrowska, 2019). Nevertheless, these benefit the cruise
429 operators more than local communities that might be left behind. Conversely, anticipatory strategies
430 for changing Arctic meanings might become relevant for local cruise destinations to reinvent
431 themselves. This also suggests a need to breakdown the standardization of Arctic tourism meanings
432 and products and instead, to favor the myriad of cultures, landscapes and biomes that can make a
433 destination 'Arctic' (Varnajot, 2020).
434

435 **Conclusion**

436

437 This chapter explored the various challenges brought about by climate change in both contemporary
438 and future Arctic tourism. Due to the phenomenon of Arctification, Arctic tourism is particularly
439 affected by climate change and its associated impacts on the cryosphere (contrary to tourism in the
440 Arctic). Indeed, Arctic tourism as we know it today has been produced and reproduced by and for
441 outsiders (Saarinen & Varnajot, 2019), involving nature-based products and experiences engaging
442 with the cryosphere in snowy and empty landscapes (Pedersen & Viken, 1996). In addition, it is
443 important to note that climate change also affects Arctic summers (e.g., increased wildfires and fish
444 diseases) (Rees et al., 2008; Constable et al., 2022), but this goes beyond the scope of Arctic
445 tourism.

446

447 Arctic tourism is directly affected by the effects of climate change on the cryosphere, including
448 increasing variability and uncertainties. The global trend is leaning towards a reduction in the extent
449 and duration of snow cover, the duration of frozen freshwater systems, and an overall disappearance
450 of sea ice, especially in the summer. Nevertheless, this global trend is also characterized by seasonal
451 and regional differences. To cope with these significant changes, reactive strategies, including
452 artificial snow production or technical improvements, have been mainly used in the Arctic so far.
453 Although they might be useful in coping with seasonal uncertainties induced by increasing climate
454 variability and mitigating economic drawbacks in the short-term future, they all have long-term
455 limitations. For example, the production of artificial snow leaves out many Arctic tourism products
456 and, perhaps more importantly, will become anachronistic in a future without a cryosphere, leading
457 to concerns related to environmental sustainability and ethics. Conversely, it is argued that
458 anticipatory strategies such as adapting the global perception of what the Arctic is in Arctic tourism
459 may be an important strategy to sustain providers and communities dependent on the Arctic tourism
460 economy. By inviting tourism actors (e.g., academics, policymakers, entrepreneurs, DMOs) to
461 rethink the idea of the Arctic collectively, this would allow Arctic tourism to become smarter, more
462 resilient and responsible in the future.

463

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