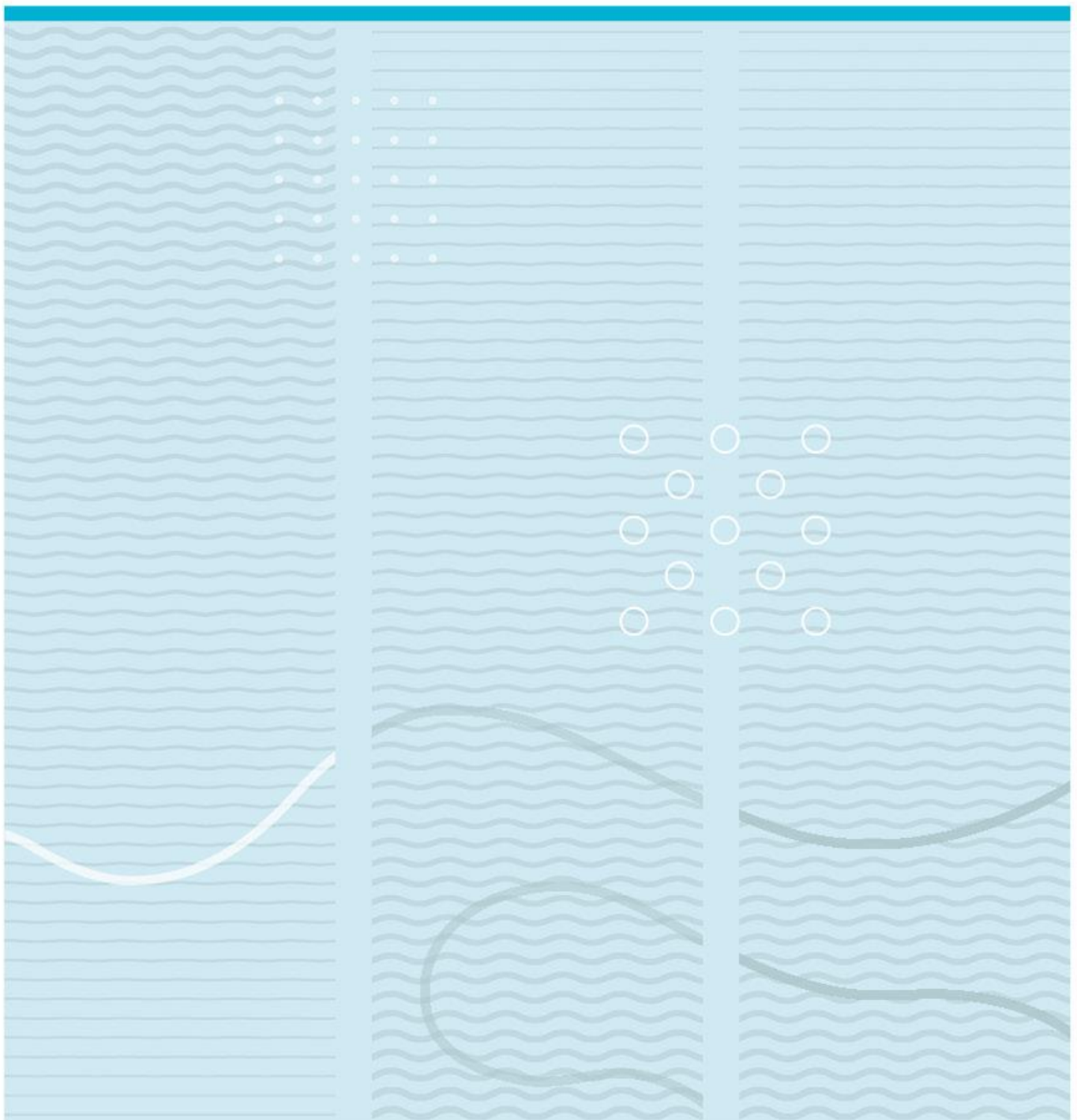


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# A tale of two glaciers from the Jostedal Ice Cap:

Impacts, challenges, and outlook for tourism and beyond



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This thesis is worth 30 study points.



## Summary

Norway is famous for its glaciers which are often utilized for recreational and tourist activities. The companies that run tourist activities on glaciers, therefore, must deal with the consequences of glacial retreat from climate change. Companies may have to contend with changing tourism patterns such as new hazards, increased risk during activities, fewer tourists, and decreasing revenue. This master's thesis considers the societal impacts of glacial retreat by comparing two glacial arms situated on each side of the Jostedal Ice Cap. The two glacial outlets, Briksdalsbreen and Nigardsbreen, have considerable importance in local tourism systems. Briksdalsbreen was popular for glacier hiking and tourist activities until glacial decline drastically changed conditions. Briksdalsbreen became unsuitable for guiding due to unsafe access and a dangerously steep frontal slope. However, the changes that occurred in Briksdalsbreen in tourism systems have not yet been quantified and explored. Changes are occurring in Nigardsbreen, with the continued retreat of the glacier for the last decades. A comparative case study approach is used to better understand tourist activities in Briksdalsbreen compared with Nigardsbreen. Qualitative interviews have been conducted with existing guiding companies and those who have gone out of business, to analyze past experiences and understand potential future challenges in adaptation. Quantitative data is presented to understand patterns of visitation, revenue, and tourist demand. Main findings show that steepness was a tipping point in which coping capacities were surpassed. Adaptive thresholds and capacities considered different aspects of adaptation. Social capital factors may intensify experiences of glacial change but may expand potential of adaptive capacity within community members. Glacial tourism systems are on a resilient path but may need to transition or transform in the future as glaciers continue to change and recede.



# Contents

<b>1</b>	<b>General Background</b> .....	<b>10</b>
1.1	Introduction .....	10
1.2	Thesis objective.....	10
1.3	Structure of Thesis .....	11
<b>2</b>	<b>Research problem and background</b> .....	<b>13</b>
2.1	Glaciers in a changing climate.....	13
2.1.1	Research Area: Southwest Norway and Jostedalbreen .....	16
2.1.2	Briksdalsbreen & West Valley .....	17
2.1.3	Nigardsbreen & East Valley.....	18
2.2	Tourism .....	19
2.2.1	Tourism in Norway .....	19
2.2.2	Employment in Norwegian tourism.....	20
2.2.3	Adaptation strategies in tourism .....	20
2.3	Glacier Tourism .....	21
2.3.1	Challenges of glacial tourism .....	22
<b>3</b>	<b>Theoretical Framework</b> .....	<b>24</b>
3.1	Adaptation in tourism systems .....	26
3.1.1	Definitions and Measurement of Adaptation .....	27
3.1.2	When does adaptation occur? .....	27
3.1.3	Coping: when and how does coping occur? .....	28
3.1.4	Adaptive Capacity: what are sources of adaptive capacity? .....	30
<b>4</b>	<b>Methodological Approach</b> .....	<b>32</b>
4.1	Methodology.....	32
4.2	Research Design .....	33
4.3	Research Methods .....	34
4.3.1	Comparative Case Study Approach.....	35
4.3.2	Qualitative: Interviews.....	36
4.3.3	Quantitative: Descriptive Statistics.....	37
4.4	Analysis .....	38
4.5	Ethical Considerations.....	40
4.6	Limitations.....	42
<b>5</b>	<b>Results</b> .....	<b>44</b>
5.1	Coping Capacities & Thresholds.....	44
5.1.1	Coping with physical changes in environment .....	44
5.1.2	Coping strategies in business products and experiences .....	47
5.1.3	Considerations for coping thresholds .....	54
5.2	Factors in Adaptive Capacity.....	56
5.2.1	Sense of Community as Social Capital .....	56
5.2.2	Social Capital through Identity.....	57
<b>6</b>	<b>Discussion</b> .....	<b>61</b>
6.1	Lessons of glacial decline in tourism.....	61
6.2	Analysis of Coping Capacity and Threshold .....	61
6.2.1	Adaptive Capacity .....	65
6.3	Adaptation Analysis .....	67
<b>7</b>	<b>Conclusion</b> .....	<b>70</b>
<b>8</b>	<b>References</b> .....	<b>72</b>



## Foreword

If I run through a quick life inventory, it's no surprise I landed on this topic for a thesis. Protecting nature and the links we have to it is a big part of my life. I find tourism a strange concept that has brought both immense perspective and has made me question many things about how the world functions.

In my filing cabinet of life experiences, writing a thesis will go under 'engaging', 'tiring', 'absorbing', 'overwhelming', and 'fascinating.' The process has had many mountain tops and deep dark crevasses. Writing a thesis in 4-months seems a bit like trying to run up Mount Everest, but in the greater perspective of things, I feel lucky to have the chance to study, learn, and create something of my own.

However, nothing is ever done alone. Many thanks go to my supervisors, Endre and Halvor. Thanks for your efforts and time dedicated to feedback. I very much appreciate being a small part of Project Justice and having the chance to collaborate and learn (a lot)!

Thanks to all the research participants who participated by donating time and sharing experiences. I feel that some of these experiences were quite poignant. There are few glaciers where I'm from, but I understand the connection to place and sadness in seeing it change. I appreciate your honesty and willingness to share your experiences.

Thanks to classmates & teachers who have helped along the way. Martin, thanks for helping with connections. Olafur, you are made for research and will be a great non-operational doctor. Thanks for checking up on me. Selina, I'm grateful for your friendship these months, thanks for being there. There are many other friends who have sent food, provided company, and been supportive during the ups and downs and I am thankful to have all of you in my life, near and far!

For my family, I am very glad for all of you! Thanks to Haley who is getting her PhD and is big support in my life. A massive thanks and lots of love to my father, he does not blink an eye when I move halfway across the world and is supportive no matter what. The absolute best!

I thank the memory of my mother, who in both life and death gave me opportunity, love, encouragement to live a good life. I am doing that!

"The world is indeed full of peril, and in it there are many dark places; but still there is much that is fair, and though in all lands love is now mingled with grief, it grows perhaps the greater." (Tolkien, 1954)

Bø i Telemark, 15 May 2023  
Julianna Elizabeth Burrill



## List of tables and charts

*Figure 2-1: Length changes in frontal position and mass balance for Scandinavian glaciers. (WGMS, 2021)*

*Figure 2-2: Changes in frontal positions of coastal glaciers vs inland glaciers in Norway (1900-2014). (S): Svartisen, (JB): Jostedalsbreen, (L): Landfjordjøkelen, (J): Jotunheimen are locations of glaciers in each region. (Hanssen-Bauer et al., 2017)*

*Figure 2-3: Jostedal Ice Cap, central view including Briksdalsbreen and Nigardsbreen. (Andreassen et al., 2012)*

*Figure 2-4: Briksdalsbreen frontal position changes from 1900-2004. (Andreassen et al., 2007)*

*Figure 2-5: Outline of frontal position of Nigardsbreen for selected years between 1964-2017. (NVE, 2018)*

*Figure 2-6: Comparison of Briksdalsbreen and Nigardsbreen frontal length changes in meters. Briksdalsbreen (1900 – 2015) and Nigardsbreen (1899 – 2020). (NVE, 2023a) and (NVE, 2023c).*

*Figure 3-1: Climate change impact pathways on international tourism*

*Figure 3-22: Managing risks versus developments by adaptation (Pelling, 2011)*

*Figure 3-33: Example of coping range and thresholds (Füssel, 2007)*

*Figure 3-44: Example of coping thresholds of adaptation planning (Pelling, 2011)*

*Figure 3-55: Networks of capacity as based off community resilience (Brown & Westaway, 2011)*

*Figure 5-1: Briksdalsbreen Yearly Revenue for Glacier Guiding Companies. (Proff.no, N.D.-b) and (Proff.no, N.D.-a).*

*Figure 5-2 - Revenue and Tourist Counts for Nigardsbreen Glacier Guiding Company.*

*Figure 5-3: Google Trends Worldwide Searches for each glacier by year (GoogleTrends, N.D.-a)*

*Figure 5-4: Google Trends worldwide search data for two popular nature-based tourist attractions in Norway (GoogleTrends, N.D.-c)*

*Figure 5-5: Google Trends worldwide search data for two glaciers in New Zealand (GoogleTrends, N.D.-b)*

*Figure 6-1: Summary of coping strategies in Briksdalsbreen & Nigardsbreen*

*Figure 6-2: Threshold diagram based off Füssel (2007) and re-created by Pelling (2011)*

*Figure 6-3: Simple glacial tourism system with coping capacity, adaptive capacity, and adaptation. Inspired from several authors (Birkmann et al., 2013; Dannevig et al., 2023; Scott et al., 2012)*

Figure 6-2: Threshold diagram based off Füssel (2007) and re-created by Pelling (2011)

# 1 General Background

## 1.1 Introduction

Glaciers are natural phenomena that feel the impacts of climate change almost directly and have been used both as evidence for climate change and a marker of the Earth's health (Nesje & Dahl, 2000). In addition, glaciers hold a fascination and allure for many since they are scarce, consider aesthetic, and many small glaciers are very likely to disappear by the end of the 21st century (IPCCa, 2022). Coupled with this is the tourism industry, which often relies on natural phenomena like glaciers as resources for value creation. A reliance or dependency links a natural feature and how humans use it, which has a systemic aspect. Changes that have already been felt can offer glimpses of impacts for those that rely on glaciers for economic means. This is a unique moment in time where rapid changes are occurring on the Earth and to humans, some of which can be learned from in real-time. A major theme among sustainability experts is that of outlining impacts that occur from climate change to humans, as mentioned by contributors to the most recent Intergovernmental Panel on Climate Change (IPCC) report:

*“Another core area of complexity in climate risk is the behaviour of systems, which includes multiple stressors unfolding together, cascading or compounding interactions within and across sectors and regions, and nonlinear responses and the potential for surprises. All of this is crucial for effective decision making and decision-support methods. The key risks assessed [in this report] become important in interaction with the cultures, values, ethics, identities, experiences and knowledge systems of affected communities and societies.” (IPCCc, 2022, p. 123)*

The motivation in this subject is to explore the realities of glacial decline in the tourism system. This thesis sits under a large-scale initiative called Project JOSTICE to understand the complete array of natural and societal impacts of climate change to the Jostedal ice cap (Jostice, 2023).

## 1.2 Thesis objective

The interest in this research is rooted in exploring glacial recession and the impact on tourism systems that depend on glaciers. Thus, the main objective of this

thesis is to compare two glacial arms originating from the Jostedal Ice Cap that are in different stages of climate change reaction in a systems framework and adaptation evaluation. The Jostedal Ice Cap has two optimal examples for investigating glacial recession impacts to tourism, since Briksdalsbreen and Nigardsbreen have been used for glacial tourism in similar ways. Briksdalsbreen was a popular glacier used for tourist activities up until 2007 when drastic glacial steepness and complicated access made the glacier unusable for commercial guiding opportunities (Stensland et al., 2014). Nigardsbreen, a glacial arm on the opposite side of Jostedalen, is currently used in similar ways as Briksdalsbreen was in the past. Using Briksdalsbreen as a past example and thinking about Nigardsbreen in the present and future, the research objective is:

1. What lessons from Briksdalsbreen can be applied to Nigardsbreen regarding adaptation in glacial tourism systems?

This thesis uses systems theory and adaptation framework to analyze the following sub-research questions:

- a. What are possible limits of coping capacity in glacial tourism?
- b. What sources of adaptive capacity should be considered in glacial tourism?
- c. How do adaptive capacities and thresholds contribute to adaptation pathways in glacial guiding?

A mixed-methods approach is used with a qualitative comparative case study approach as the primary method. Quantitative descriptive data is used in comparative background information for Briksdalsbreen and Nigardsbreen, along with relevant revenue, tourist, and search data. Qualitative interviews are used to expand human experience of glacial decline, understand impacts to tourism businesses, and interpret how identity is connected to glaciers and their decline.

### **1.3 Structure of Thesis**

This thesis structure begins with a broad discussion of challenges in the natural world due to climate change, the impact on glaciers, and the unique role glaciers play in tourism. There is a background section with a focus on Norwegian tourism and the two glaciers of study. Next, the theoretical framework is considered with a basis in an

adopted system theory for tourism and adaptation frameworks. Methodology, design, methods, data collection process, and analysis procedures are outlined along with ethical issues and overall limitations. Data will be presented in qualitative and quantitative form according to the analytical framework. Analysis and discussion of the results stem from theoretical outline of systems theory and adaptation perspectives. A conclusion offers final ideas with room for expansion and outline of new avenues for research.

## 2 Research problem and background

A background on glaciers and climate change impacts are introduced along with area of study. The role of tourism, differences in glacial tourism, and challenges in these systems are covered.

### 2.1 Glaciers in a changing climate

Glaciers are defined as a “mass of perennial ice on land that shows evidence of glacier flow” (Andreassen et al., 2012, p. 18; Post & LaChapelle, 2000). Glaciers are moving and changing phenomenon, not static objects. In the definition, ‘movement’ is a key word which also means that snow patches that remain year-round are not counted as glaciers (Andreassen et al., 2012). There are also several glacier types, the most relevant to this thesis have been defined as follows:

Name of Glacier Type	Definition
Ice sheet	A body of ice that covers the size of a continent. There are two in the world: the Antarctic and Greenland Ice Sheets.
Ice cap	Smaller than an ice sheet, these could be any size but are characterized by a dome shape, lies over surface topography, and have a flow that is considered ‘radial’ or outward flowing. I.E. Jostedalsbreen.
Outlet glacier	These glaciers are drainages from an ice cap. Likely valley glaciers, and they are usually named by the lower outlets. I.E. Briksdalsbreen and Nigardsbreen.
Mountain glacier	Glaciers placed and surrounding mountains.

*(Cogley et al., 2011)*

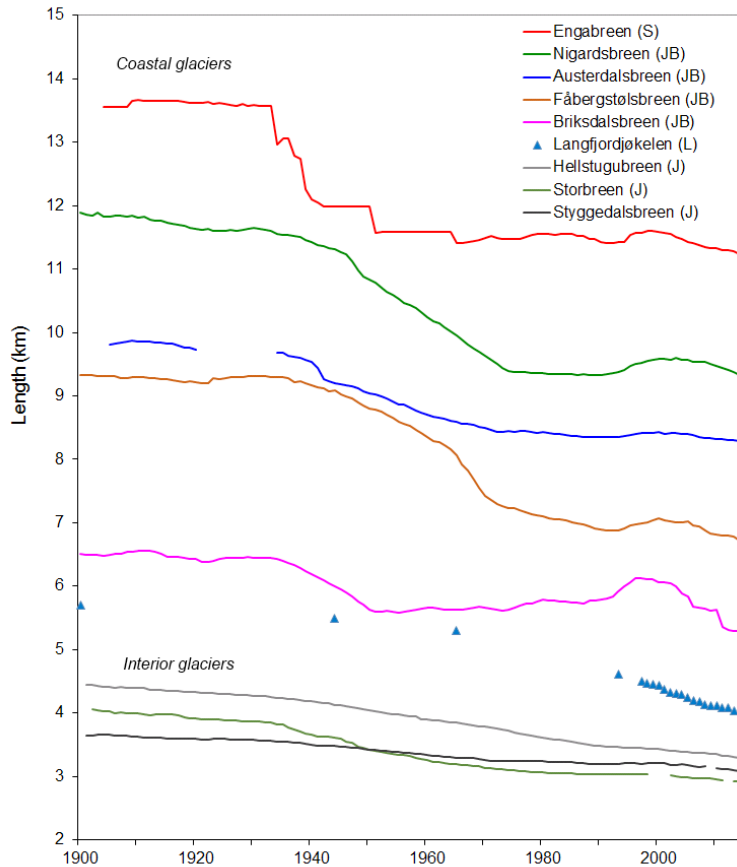
The largest glaciers in Scandinavia are found in Norway consisting of a number of ice caps that include Jostedalsbreen, the largest in Europe’s mainland (WGMS, 2021). Reports show that most Scandinavian glaciers retreated during the 20th century with some advances around 1910, 1930, 1970s, and 1990 (WGMS, 2021).

*Figure 2-1: Length changes in frontal position and mass balance for Scandinavian glaciers. (WGMS, 2021)*

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Measuring mass balance and length changes are the main ways to get a picture of how a glacier is changing. To get an annual mass balance of a glacier, measurements are taken in the winter accumulation period and again the summer to have an average mass balance value of snow density and depth (NVE, 2018). Mass balance along with frontal length measurements can be used in analyzing the change of glaciers over decades to centuries (NVE, 2023b). From 1970 to 1990 most Scandinavian glaciers showed positive mass balances, but this should not be misinterpreted: coastal glaciers saw increasing mass while inland glaciers retreated over those years, which is an impact of fossil-fuel induced climate change in conjunction with the Gulf Stream and not a marker of glacial health or resiliency (WGMS, 2021). After 2000, all glaciers in Scandinavia have showed declining mass balances in-line with most glaciers around the world (WGMS, 2021).

Figure 2-2: Changes in frontal positions of coastal glaciers vs inland glaciers in Norway (1900-2014). (S): Svartisen, (JB): Jostedalsbreen, (L): Landfjordjøkelen, (J): Jotunheimen are locations of glaciers in each region. (Hanssen-Bauer et al., 2017)



One of the primary climate change impacts on glacier landscapes in glacial recession or shrinkage (Haeberli & Beniston, 1998; Käab et al., 2005; Welling et al., 2015) and within shrinkage, there is a dual effect of glaciers both shortening and thinning (Purdie et al., 2015). These processes can happen differently in space and time depending on the glacier and its environment. The areas that contain glaciers are undeniably transformed and modified: exposure of mountain walls that previously were covered by glaciers become less stable, while glaciers also have a process of eroding rock as they retreat and change (Purdie et al., 2015). These changes have varying levels of impacts for those that interact with the glacier and the new environment it presents.



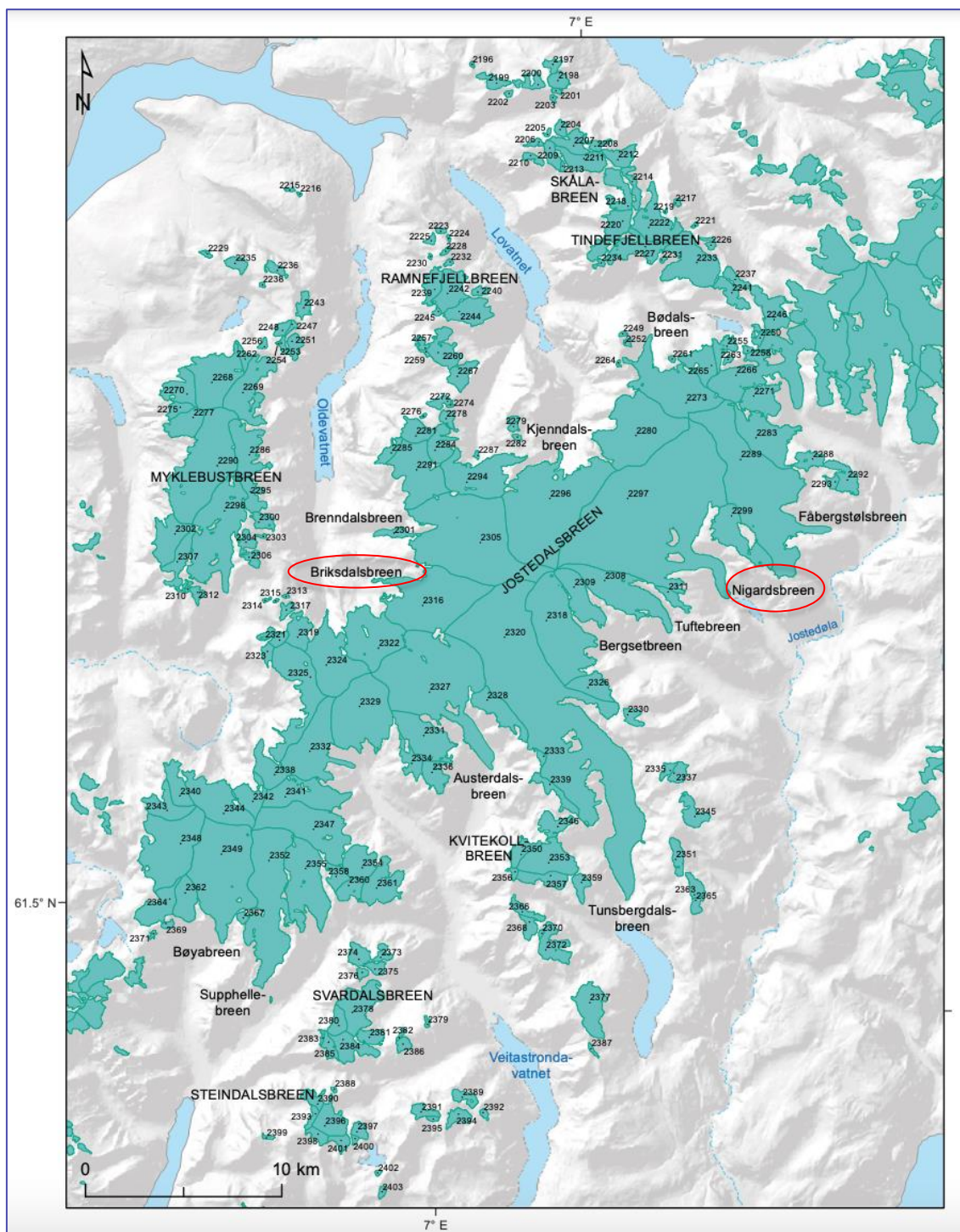
A unique feature of glaciers is that advance and recession can be tangibly seen with one's own eyes and may be an indicator of climate change on a global level (Beniston, 2003; Brugger et al., 2013; Welling et al., 2015). Fluctuations of glaciers are analyzed on global and regional scales, but it is also important to understand them on a local scale, where even neighboring or adjacent glaciers have reacted differently (Kuhn, 1985). On a local level, the sensitivity of a glacier to climatic change is very much related to the specific climate in which the glacier resides (WGMS, 2021).

Norway has a set of unique climatic conditions, both as part of temperate and polar climate zones (Ketzler et al., 2021). The North Atlantic Current, or better known as the Gulf Stream, is a notable weather phenomenon allowing for warmer temperatures along the coast, which stops ice from forming along the West Coast of Norway (Ketzler et al., 2021). Days with snow cover are likely to decrease by a substantial amount and large glaciers will very likely reduce in size by  $\frac{1}{3}$  of area and volume, while it should be expected that small glaciers at lower altitudes will disappear completely by 2100 (Hanssen-Bauer et al., 2017).

### 2.1.1 Research Area: Jostedalsbreen

Vestland is the county where the Jostedal ice cap sits in with the town of Olden closest to Briksdalsbreen in the West, and Nigardsbreen residing in the Jostedal valley in the East (Svein Askheim, 2022b, 2022c). It is estimated Briksdalsbreen attracts 200,000 tourists every year while Jostedal may see around 55,000 (Svein Askheim, 2022a; Svein Askheim, 2022). Figure 2-3 shows locations of each glacier in Jostedalsbreen.

Figure 2-3: Jostedal Ice Cap, central view including Briksdalsbreen and Nigardsbreen. (Andreassen et al., 2012)

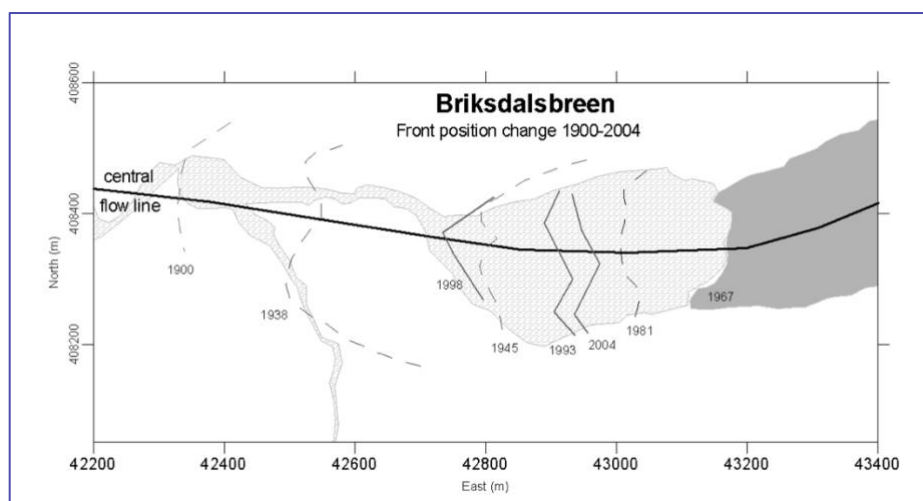


## 2.1.2 Briksdalsbreen

Briksdalsbreen (measured to be 11.9 km<sup>2</sup> in 2006) drains out on the Western side of Jostedalsbreen and is known for being short and steep while also reacting to

mass balance changes quicker than other neighboring glaciers (Andreassen et al., 2007). This glacier has had several fluctuations over the years with a notable large advance from 1987 to 1997, where the glacier covered the glacial outlet lake completely (Andreassen et al., 2007). This is also when the glacier was discovered as an exceptional place for glacier guiding. Briksdalsbreen then retreated dramatically by -220 meters from 1999 to 2004, -50 meters in 2005, and -220 meters in 2006 (Andreassen et al., 2007). Glacial measurements and monitoring ceased in 2015.

Figure 2-4: Briksdalsbreen frontal position changes from 1900-2004. (Andreassen et al., 2007)



### 2.1.3 Nigardsbreen

Nigardsbreen is one of the largest glaciers in Jostedalbreen at 44.9 km<sup>2</sup> in 2020, accounting for 10% of the total Jostedal Ice Cap and flows south-east (Andreassen et al., 2022). The frontal part is characterized by a gentle downward slope (NVE, 2020). Nigardsbreen had a large period of retreat between 1940-1970, growth from 1988-2003, and then retreat again from 2003 onward with some exceptions such as 2009 (NVE, 2020). Looking at diagram 2-5, there is a visualization of how large the glacier was with the trend of recession but some growth in the mid-2000's (2009). Figure 2-6 shows a comparison of glacial change between Briksdalsbreen and Nigardsbreen for frontal length.

Figure 2-5: Outline of frontal position of Nigardsbreen for selected years between 1964-2017. (NVE, 2018)

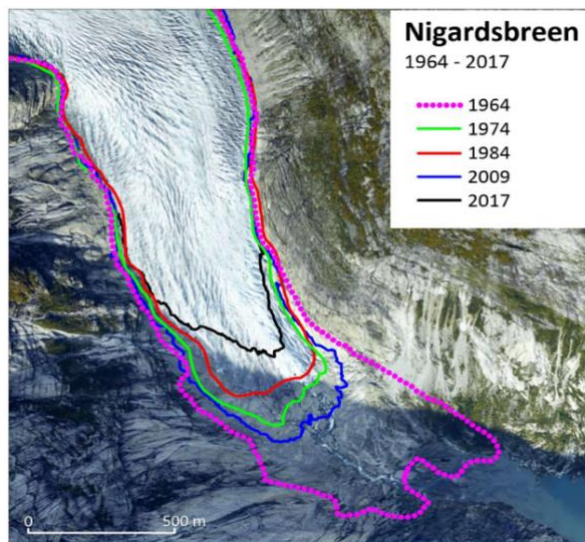
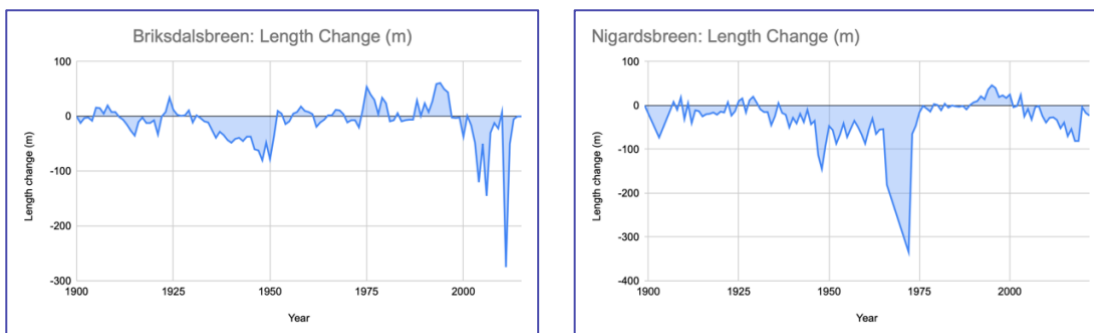


Figure 2-6: Comparison of Briksdalsbreen and Nigardsbreen frontal length changes in meters. Briksdalsbreen (1900 – 2015) and Nigardsbreen (1899 – 2020). (NVE, 2023a) and (NVE, 2023c).



## 2.2 Tourism

### 2.2.1 Tourism in Norway

Within Norway, tourism has risen over the years and reached a stable 3.6% of GDP from 2017 until the recent COVID-19 pandemic (OECD, 2023). After the pandemic, tourism recovered to steadily increase again in 2022 (Oyier, 2023). Some areas have seen tourism decrease, while others have seen increases; for the Vestland municipality, tourism has increased year-over-year (Oyier, 2023).

Seeing natural features unique to Norway is the main reason tourists want to visit, followed by historic and cultural heritage experiences (Innovasjon Norge, 2022). 'Fjords and mountains' were another top priority for tourists in the types of landscapes and experiences they wanted to have while visiting (Innovasjon Norge, 2022). While glaciers were not explicitly mentioned, they could likely fall under 'mountain' experiences although the percentage was not collected or reported.

### 2.2.2 Employment in Norwegian tourism

In Norway employment in the tourism sector is increasingly important in rural areas (OECD, 2020). Activities in 'rural' areas could be that of experiences, culture, landscapes, and artifacts (Hjalager et al., 2018; Woods, 2010) but likely are the intersection of many of these together, especially with the focus on nature-based experiences. The focus on culture and tourism is a newer strategy outlined by governmental agencies in 2019, to add more value, longevity, and recognition for Norway as a tourist destination (OECD, 2023). As this strategy develops and if there is increasing reliance on tourism in rural areas with fewer economic substitutions it is important to evaluate the trajectory of tourism, along with who is vulnerable and how adaptation can be considered. Substitution alternatives have sometimes been a method for changing access in nature-based tourism, for example with a cable car in Loen that was installed in 2017 that compensated for viewing another retreating arm of Jostedalsgreen (Marr et al., 2022). These substitutes open a range of discussions of who, what, where, and how in the localities that are impacted.

### 2.2.3 Adaptation strategies in tourism

Humans now have a new set of realities and conditions to work with when there are both rapid and slow changes in the climate. What is often found is that under changing conditions, human operators usually focus on shorter-term coping strategies instead of how to adapt in long-run scenarios (IPCCa, 2022). Since glaciers often can be a site of ski-related activities, there is a plethora of research on ski tourism and what climate mitigation techniques might exist, yet less exists on viable options for glaciers. For instance, ski resorts use snow-making as an adaptation for inconsistent or lack of

snow, but this is not a process that is possible with glacier tourism (Demiroglu et al., 2018).

For Norway specifically, literature has some differentiations on the country's capacity for adaptation in the tourism industry considering new conditions. On a national level, research by Landauer et al. (2018) has found that policies largely do not yet take into account what adaptation planning should occur in tourism scenarios. The tourism industry in Norway could greatly benefit from better research for those involved in the maintenance, creation, and future planning of what tourism will look like and the economic reliability of this industry for its stakeholders. Some research has found that Nordic tourism destinations greatly need actionable advice on substitution activities since some tourism activities either are no longer possible or will be soon due to climate change Landauer et al. (2018). In terms of adaptation to glacial recessions, tourism is generally thought of as having a low capacity to adapt to changes in the climate, yet glaciers will remain attractive for tourists (Adger, 2000; Stewart et al., 2016).

## **2.3 Glacier Tourism**

Tourism in nature-based settings and for recreational purposes has been a large part of tourism in general but 'adventure tourism' has grown in scale in more recent years (Purdie et al., 2015). Tourism that has an adventure-based component like walking on a glacier can be different from other forms of nature-based recreation like going on a hike. Participants in this kind of tourism may be testing themselves in a physical or mental capacity while engaging with nature (Purdie et al., 2015) or they require guides that have extended knowledge, expertise, or skills (including equipment, tools, and how to use them) that lie outside of an average tourist's competency. Glacial tourism itself is also a new area of focus and should be in its own category due to the uniqueness of glaciers themselves. Some of the ways glacial and conventional tourism differ are that glaciers are considered rare and fragile features, they are heavily dependent on location, and there is a merging of recreational, aesthetic, educational, and scientific value (Welling et al., 2015). One important note is that oftentimes for ski or mountaineering-based activities, a glacier is used simply as an object to cross or 'transport leg' (Breboka, 1999). However for glacier tourism, one

can delineate a definition of “walking and climbing on glaciated areas for the unique experience” (Furunes & Mykletun, 2012, p. 324) where the glacier is the main event or attraction. In addition, glacial walking and climbing can be sorted into its own sport, found to be a uniquely Nordic practice (*Breboka*, 1999; Furunes & Mykletun, 2012). It makes sense that a tourist population would not have the skills, equipment, and knowledge to show up at a glacier and be able to walk and climb on it safely. Guiding on glaciers is common, where guides are evaluating potential hazards, providing equipment, and managing risks (Furunes & Mykletun, 2012; Welling et al., 2015). Participants in glacier activities may be quite unaware of risks, placing those decisions on companies and guides that offer these activities and experiences.

### 2.3.1 Challenges of glacial tourism

The present and future challenges of retreating glaciers offer a range of issues a business and an individual guide must contend with. Two main physical aspects are the occurrence and rate of natural hazards, as well as accessibility challenges to access glaciers (Welling et al., 2015). Problems of access could be difficulty in glacial access due to debris like rockfall on exposed terrain that can be slippery and dangerous, new and potentially more complicated routes to get to glaciers, and the possibility of steep routes on a glacier that aren't feasible for tourism activities whatsoever (Furunes & Mykletun, 2012; Ritter et al., 2012; Welling et al., 2015; Wilson, 2014). There are often other challenges in changing accessibility. If walking access to a glacier is not possible, some areas have switched access options to helicopter travel instead of walking or climbing on foot (Purdie et al., 2015). There are many potential consequences to evaluate such as higher carbon emissions and pollution effects along with hazards of the glacier, furthermore something like helicopter transport is not considered in Norway due to rules and regulations (Demiroglu et al., 2018). However, these kinds of decisions are important to acknowledge because without proper planning and evaluation, climate adaptation strategies in mountain environments could make choices to further impact the problem they are battling against (Demiroglu et al., 2018).

Another challenge in glacier tourism understanding tourist demand. It is not entirely clear if tourist numbers might generally increase, remain the same, or decline

as glaciers melt. Some research in New Zealand which has some similar characteristics the Jostedal Valley regarding rural and remote areas of glaciers found that about half (46%) of all respondents in a survey indicated they would not visit a certain region if they knew they would not be able to see a glacier (Stewart et al., 2016).

Conversely, an allure for tourists can be that of a newer phenomenon called 'last chance' tourism where sites that are endangered to the point of vanishing or transforming past recognition have become major attractions (Lemelin et al., 2010). There are several nuances with this type of travel. First, tourism operators benefit from this type of economy mostly in the medium or short-term, and many have noticed the contradiction that an increase of greenhouse gasses from air travel will aid in the demise of a landscape like glaciers even faster (Agnew & Viner, 2001; Becken & Hay, 2007; Dawson et al., 2011; Gössling & Hall, 2005; Higham & Lück, 2007; Lemelin et al., 2010). Last-chance tourism may boost visits in the short-run, but there is a remaining question of what happens to areas when the glaciers cannot be seen from afar at all and have disappeared beyond recognition as icons. This will be a coming theme of discussion in the future, but especially when certain populations heavily depend on tourism for economic means.

Current research on glacier tourism shows areas for expansion. Some of the gaps that continue showing up include needing to better classify what existing or potential climate-induced impacts on glacier tourism are, as well as the need to identify adaptation strategies adopted by tourists and managers, considering rapid glacial change (Stewart et al., 2016; Welling et al., 2015). In a study of tourists stated future travel preferences, results showed there would be a decrease in demand for visiting glaciers, specifically because of the partial or total disappearance of glaciers in the specific area (Welling et al., 2015). While this is helpful insight, this doesn't give specific information on tourist preference and fluctuations in demand. Overall, these are some of the main challenges in glacier tourism to consider in understanding the main issues facing this form of tourism along with future possibilities and capacities for adaptation.



### 3 Theoretical Framework

The purpose of this section is to provide a theoretical framework for understanding the core problem of glacial recession and tourism. Systems theory is used as a basis for understanding the problem of study with a specific framework for tourism. The concept of adaptation is considered within this framework to understand and measure pathways. Components of tourism, systems theory, and the selected framework are discussed and described. Adaptation theory is considered along with definitions, dimensions, and planning framework.

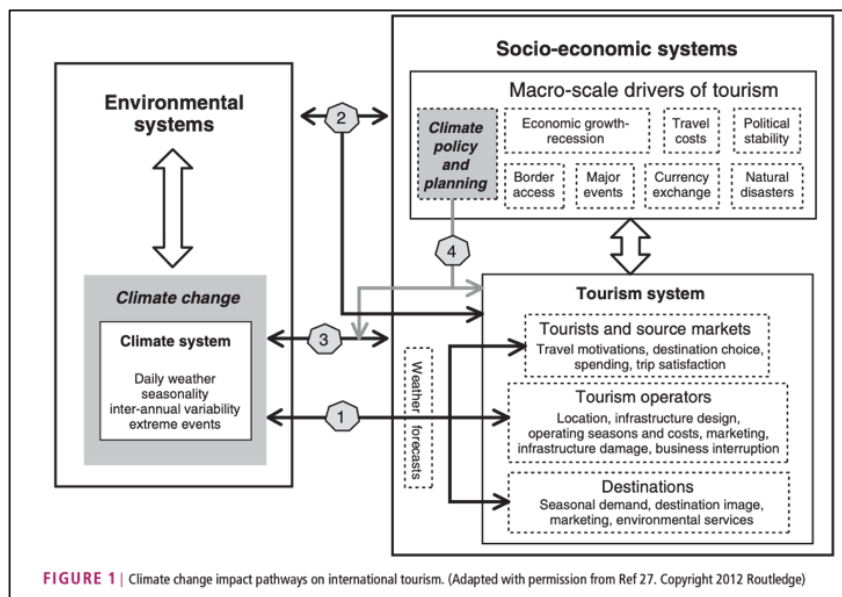
The difficulty in creating all-encompassing definitions of 'tourism' and 'tourist' is they often fail to fit every situation and case, and no single definition truly exists (Leiper, 2004). However, with that in mind, it is important to have a general idea of what is meant by 'tourism' and 'tourist.' Using the inferred definition created by Holden (2016) tourism involves interaction with a different place or environment compared to one's home, as one doing this action is the tourist. Even with this definition, there are many ways to think about tourism and tourist. For example, tourism has been thought of as an industry, market, and/or system (Holden, 2016; Leiper, 2004). With multiple definitions it is best to acknowledge their existence but to define the use case. As previously specified, this thesis engages and explains tourism as a system and the tourist a necessary component of that system visiting a place.

One of the oldest and best ways to understand something complicated is to simplify it, putting together a whole-picture perspective on how it all fits together (Leiper, 2004). Systems are sets of elements that have interaction (Bertalanffy, 1967). To comprehend the structure, operation, and results of an system, the interactions and relationships between its components are emphasized (Mele et al., 2010). Systems theory helps understand the problems and challenges this thesis engages with, which can be expanded to human-environment problems in general. Tourism is a good use case of systems, in that tourism works with human systems (social, economic, political) (Jakulin, 2016) as well as natural systems. In this system with synergies, anything out of balance has an impact on the system as a whole. Therefore, changes that occur within the natural world have impact on human-based systems and vice versa. There are many theories on how tourism works, an increasingly large number that included a systems approach, some that are specified for nature-based tourism, but few that are

made for glacier tourism. There are use cases with glacial tourism as examples to apply theory, such as Strong et al. (2023).

One framework for tourism that can be adapted to this research is presented in Figure 3-1 by (Scott et al., 2012). This framework is useful since it outlines what each system is comprised of and how the systems interact with each other. With interactions, there is an assumption that interplay between the systems create both impact and resulting effects.

Figure 3-1: Climate change impact pathways on international tourism (Scott et al., 2012)



The system framework and outlined pathways (1-4) are explained and are used to present results. Pathways are interactions between the systems and are critically important in systems theory (Lohmann & Netto, 2016).

The first system is the environmental one, in this case, each glacier, and socio-economic systems can be seen as separate but interacting systems, both containing sub-systems of tourism and the socio-economic ‘macro’ drivers of the tourism system itself (Scott et al., 2012). For the environmental system, the glacier is its own climate system that has weather occurring daily, on a seasonal basis, within a year, and sometimes faces extreme weather events (Scott et al., 2012). In this environmental system, glaciers also experience the effects of climate change. The first pathway is a connections where tourism operators are both responding and managing both conditions of a glacier and effects of climate change (Scott et al., 2012).

The tourism system, a sub-system of a greater socio-economic system, is a whole comprised of three parts: tourists and the markets they represent, operators, and destinations (Scott et al., 2012). Thus, the second pathway of “indirect climate-induced environmental change that affects natural assets” introduces feedback both from environmental systems into tourism systems, and back into larger socio-economic systems, some of which may be directly related, or have seemingly little or nothing to do with tourism or glaciers (Scott et al., 2012, p. 215).

The third pathway includes indirect socio-economic effects that occur on a larger basis, for example the war in Ukraine, which could have impacts on overall economic circumstances that have wide-ranging effects. And fourth, policy in other sectors that may occur from effects in these systems that has impact on them, that come from larger climate change policies or planning, perhaps from the government or European Union regulations (Scott et al., 2012).

For the comparison of Briksdalsbreen and Nigardsbreen, this framework helps group results by each system along with impacts, response, and effects between each system with focus on the 1<sup>st</sup> and 2<sup>nd</sup> pathways. The 3<sup>rd</sup> and 4<sup>th</sup> pathways may be discussed but are not in scope for analysis in this research. While it could be possible to even be more granular with outlying systems and their interactions, it was the intention to have a general theoretical framework to allow for a more inductive approach, rather than forcing questions and data into perfect categorizations of systems theory.

### **3.1 Adaptation in tourism systems**

Human-induced climate change invites considerable risks in society and the two central options for reducing those risks have been through mitigation and adaptation strategies (Füssel, 2007). Mitigation consists of limiting the sources (greenhouse gases) of climate change, while adaptation consists of moderating potential harm from climate change or taking advantage of opportunities to reduce vulnerability of systems (McCarthy et al., 2001). Adaptation is a seemingly simple concept with a plethora of positions and definitions. It is essential to outline how the concept is used and defined. A high-level overview of adaptation is considered, along with definitions and means of measurement. Frameworks for understanding attributes of adaptation are also discussed.

### 3.1.1 Definitions and Measurement of Adaptation

First, as climate change is a global problem, adaptation is often the way that local actors react to global phenomena that occurs at a local scale and affects those actors directly or indirectly (Pelling, 2011). The process of responding to a stimulus or stress, such as climate change, is known as adaptation (McDowell et al., 2016). The definition has also been expanded by Pelling (2011): when an actor can reflect and implement changes in practices or institutions that generate risk, shape coping mechanisms, and lead to additional rounds of adaptation to climate change, adaptation occurs. Risk is defined as the possibility of unfavorable effects on ecological or human systems, taking into account the variety of values and goals associated with such systems (Simpson et al., 2021). The crossing of risk, hazard, and/or vulnerability thresholds triggers adaptation (Pelling, 2011). Identification, information and communication systems, political and cultural context, as well as the relative, perceived importance of other risks, hazards, and vulnerabilities that compete for attention are all examples that create thresholds (Pelling, 2011). This thesis focuses on coping capacities and thresholds, adaptive capacity, and adaptation outcomes in organizing results and discussing themes.

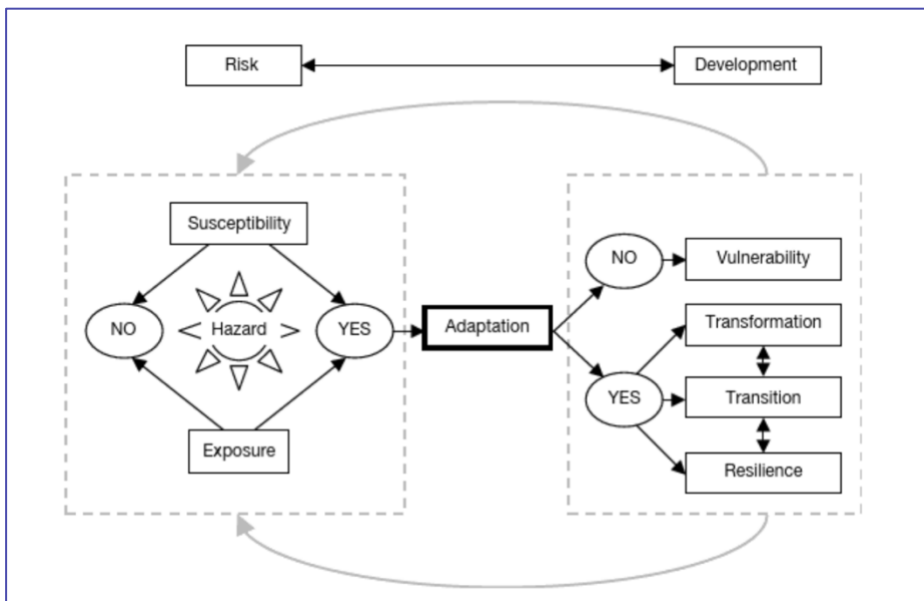
### 3.1.2 When does adaptation occur?

Along with coping & adaptive capacities, measuring adaptation is used with a framework proposed by Pelling (2011) which finds that three pathways lead to different outcomes: resilience by maintaining the status quo, transition of incremental changes, or transformation through radical change. While resiliency is often a term used on its own to assess outcomes (for example, assessing resiliency in tourism systems), this thesis uses the concept as a part of the proposed systems theory framework. For glacial guiding, maintaining resiliency by returning to a steady state in a system will often not be possible as glaciers continue to recede, so it is more forward-thinking to understand what elements in tourism systems show signs of transition or transformation.

In this framework, distinction is made between ‘coping’ and ‘adaptation’ which are often used interchangeably. Within a given system, coping is how the system survives within established set of rules and dynamics, while adaptation happens when institutions and livelihoods change (Pelling, 2011). Coping stays within the bounds of

the systems to manage difficulties that arise while adaptation is associated with development, that a fundamental change in mechanisms occurs (Pelling, 2011). Figure 3-2 shows that when an institution encounters a risk, it will attempt to deal with it until the risks are too much to manage (Pelling, 2011). In adaptation, development is necessary where developments either are not adaptive at all (and incur vulnerabilities) or follow one of the three adaptation pathways (Pelling, 2011).

Figure 3-22: Managing risks versus developments by adaptation (Pelling, 2011)



Based on which cycle is adapted to, this diagram will continue to compound in the new reality of adaptation pathway has been created (Pelling, 2011). For example, perhaps a system has reached a maximum level of risk and adaptations have created a developmental ‘resilience’ pathway. The system will again incur risks until a new adaptation pathway is necessary, and perhaps the ‘resilience’ pathway was a short-lived adaptation cycle. The system was able to maintain its status quo, but not for very long. In this way, it’s valuable to use frameworks such as this to understand the dynamic behind systems and the opportunity to better understand what is occurring in that system.

### 3.1.3 Coping: when and how does coping occur?

Coping with climate change is then the process where practices can be used and institutions can act when climate change impacts show up (Pelling, 2011). The examples in figures 3-3 and 3-4 show two examples of coping and adaption thresholds

in hypothetical examples. Thresholds in these examples have been used for extreme events or natural disasters but may also be helpful in identifying limits to coping capacities in severe changes. This type of threshold analysis is useful for finding the key points of departure when capacities are overtaken and defining when coping is no longer possible, when systems become vulnerable and must enact adaptations to persist. Identifying thresholds considerations in glacial tourism systems may be a useful and applicable exercise in planning adaptations to climate change.

Figure 3-33: Example of coping range and thresholds (Füssel, 2007)

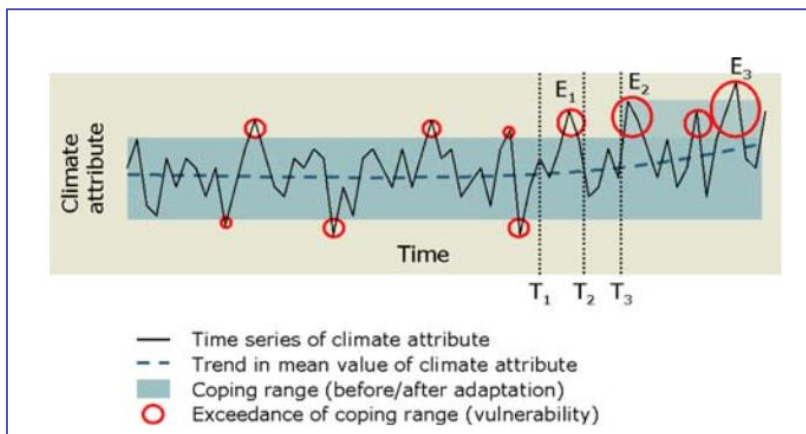
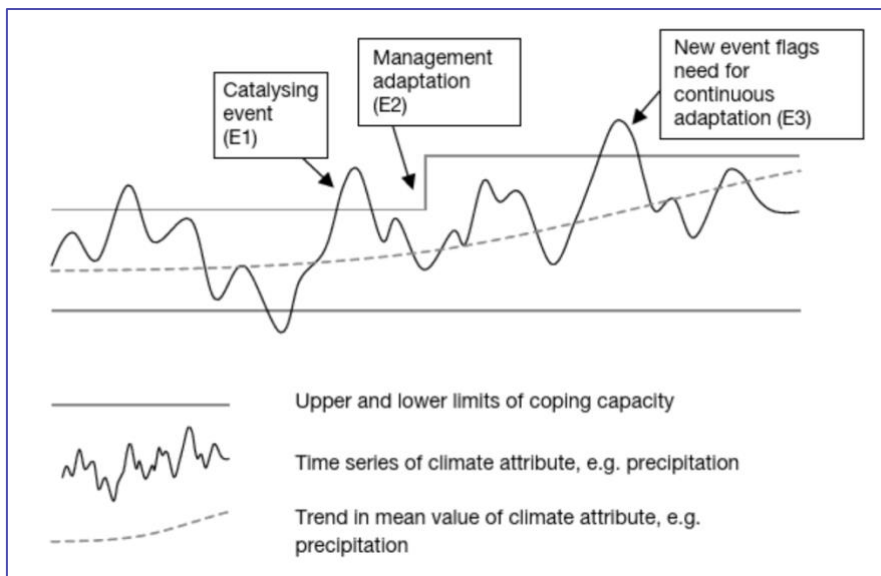


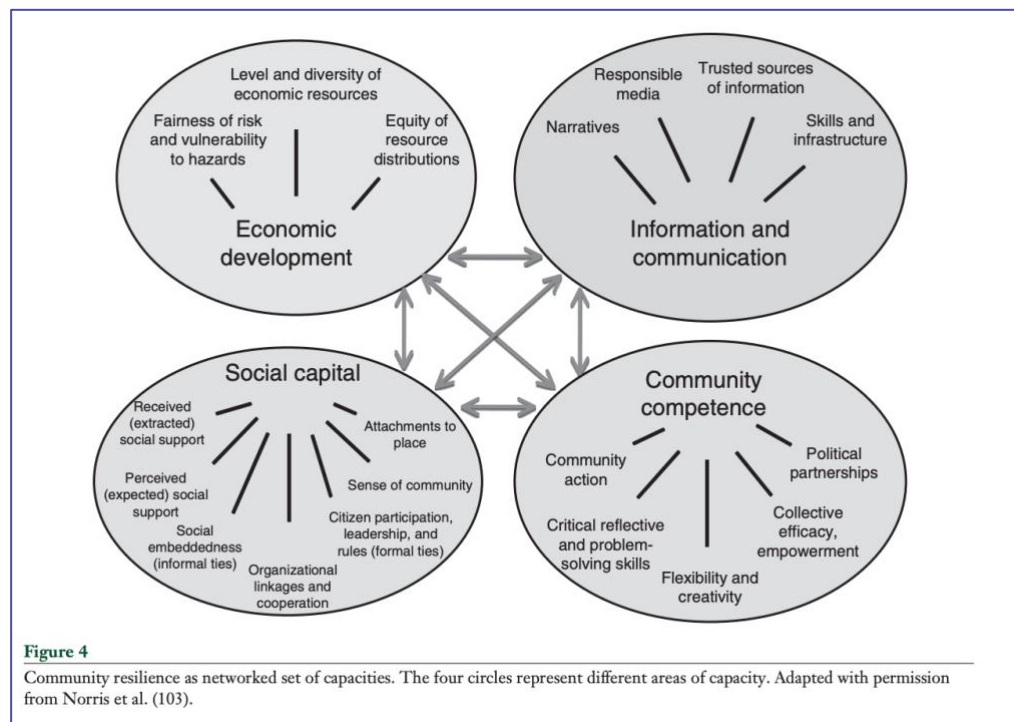
Figure 3-44: Example of coping thresholds of adaptation planning (Pelling, 2011)



### 3.1.4 Adaptive Capacity: what are sources of adaptive capacity?

Climate change research often favors biophysical, economic, and political aspects of impact and eclipses other aspects that are duly important for understanding adaptation capabilities (Allison, 2015). Adaptive capacity is the ability that a unit has to transform how it is structured, organized, and how it functions in order to survive under hazards threatening the unit's existence (Kelly & Adger, 2000). Thus in accounting for adaptive capacity in human systems, "adaptedness includes the viability of social and economic activities and the quality of human life" (Brown & Westaway, 2011). Human systems, from the individual to humanity, must improve (or at least maintain) the quality of life of its individual members given changes in environment to have capacity (Gallopín, 2006). While identifying all factors of adaptive capacity is out of scope of this thesis, social capital as a factor of adaptive capacity will be explored. Social capital is one important factor that can be used to enhance or maintain a particular community's well-being (Brown & Westaway, 2011; Chaskin, 2008). An adapted version by Brown and Westaway (2011) of difference sources of capitals is taken from post-disaster risk and resilience research by Norris et al. (2008):

*Figure 3-55: Networks of capacity as based off community resilience (Brown & Westaway, 2011)*



Two resources in social capital are considered: sense of community and attachment to place.

Sense of community can be attitudes of shared concerns, shared values, respect, sense of connection, trust, and belonging with other members or in a local sense (Goodman et al., 1998; Perkins et al., 2002). A 'sense of community' may likely be a part of community capacity, another part of adaptive capacity which is overall a part of community resilience (Goodman et al., 1998; Norris et al., 2008).

Attachment to place refers to both physical and social bonds that are developed with specific places, through meaning-making processes (Lewicka, 2011; Scannell & Gifford, 2010; Sherry et al., 2018; Stedman, 2003). Place identity can also be an "inclusive term for describing the relationships people have with place, for the purposes of exploring how individuals and communities define themselves" (McAndrew, 1998). Since environmental surroundings or phenomena shape a person's understanding of who they are individually and as part of a community, these identifies can be jeopardized by something like glacial recession, where events change the surrounding environment or environments disappear (Adger et al., 2013; Allison, 2015; Heyd, 2014; Sherry et al., 2018). In addition to personal, community, and cultural levels of identity, there is also occupational level where actors may rely on a natural resource because it has become part of their identity (Marshall et al., 2013; Tunstall, 1969). Environmental phenomena can then shape identities and well-being can be jeopardized by something like glacial recession, when something significant changes or disappears in the surrounding environment (Adger et al., 2013; Allison, 2015; Heyd, 2014; Sherry et al., 2018). Place identity and attachment along with a sense of community can create social groups that merge physical, social, cultural, political, and economic aspects (Lewicka, 2011; Manzo & Perkins, 2006; Perkins & Long, 2002; Sherry et al., 2018). Social capital is then quite important to consider underlying conditions shaping adaptive capacity.



## 4 Methodological Approach

This section describes and specifies how research was carried out. This section begins the underlying philosophy of research, design, research methods, and explanation of how research was conducted. The comparative case study method is described, along with each quantitative and qualitative components and the corresponding elements of information selected for data analysis. Data collection procedure and data analysis methods are described, with ethical considerations and limitations of the study last.

### 4.1 Methodology

This thesis uses a relational ontological basis, which is supported by a critical realist philosophy. Relational ontology finds that systems are made up of parts, and to understand those parts, understanding interactions is the best way to do so (Biggs et al., 2021). This worldview asserts that systems are sets of interconnections that produces behavior where interactions have effect on the whole system (Biggs et al., 2021). Systems emerge through interactions that create behavior patterns, so understanding the interactions between systems is more indicative of how systems behave (Biggs et al., 2021). The set of relations that make up a process define its properties and functions, so processes are best understood as patterned change over time (Biggs et al., 2021) which explains many systemic themes in this thesis such as notions of ‘sustainability’ or ‘adaptation’. The larger theoretical position of relationality is upheld by the concepts of critical realism worldview.

Critical realism recognizes these concepts are social constructions created by humans, and these concepts have real consequences even if they are not labeled or observed by scientists (Easterby-Smith et al., 2008). Under a systems theory framework, the nature of reality is that certain entities are created which may not directly visible, for example, ‘the glacial tourism system.’ There are components in this system that make the whole that are not directly able to be viewed, but that does not mean they don’t exist (Biggs et al., 2021). In this way, critical realism can support both in social and natural sciences perspective where laws of natural sciences are considered along with an interpretation in social sciences (Easterby-Smith et al., 2008).

Epistemology, or the way of asking questions and generating knowledge to better understand systems and their processes, is supported by a social constructivist point of view in this thesis. Systems theories are numerous, as are the ways in which to research them (Biggs et al., 2021). The social constructivist is often an approach to qualitative research, which is where the bulk of data and analysis rests (Creswell, 2014). Social constructivists have a view that individuals are subjectively creating meaning of their experiences in the world where the researcher is to interpret meanings from those individuals (Creswell, 2014). Thus, relational and critical realist ontologies create the basis for the set of beliefs this thesis originates from using a systems theory to guide research viewpoint and direction. A social constructivist epistemology is the way that interactions from these beliefs are generated, measured, and explained (Creswell, 2014).

## **4.2 Research Design**

Design and strategy of this research is to take a comparative approach where two case studies are considered. The methods used for comparing the two glacial arms is a mixed-method approach. Qualitatively, interviews are performed with glacial guiding managers and guides to help understand the constructions and connections in each specified system (IE physical-environmental system, tourism system, etc.). Quantitative data in descriptive form is intended to provide summaries and presentations of numerical datasets. The primary use of quantitative data is to explore rather than explain, and to triangulate information from qualitative interviews. A mixed-methods approach gives many options for a comparative case study, where similar data can be compared in descriptive statistics, and interview data can be compared between individuals in similar roles and timeframes.

There is a fundamental element of exploration in this thesis. Given that there are several case studies but few theories that fit specifically to glacial tourism, part of exploration was to find theory and concepts that help explain the phenomena and how it fits in a larger systemic context. This also intersects with the position of the researcher of this thesis. First, exploration can be used when the researcher has limited scientific knowledge of a given phenomenon but still believes there are elements worth investigating (Stebbins, 2001). This was evident during research, that

although I did not have in-depth scientific information on glaciers, the application of systems theory in tourism allowed for exploration of interactions between environmental and social worlds. Second, in finding effective ways to understand these interactions, two orientations of flexibility and open-mindedness were paramount in considering different data sources that could compliment the overall systems approach (Stebbins, 2001). Hence, 'alternative' data sources like Google Trends were considered for exploratory means. When looking for exploratory data, I chose to include elements that were a part of the outlined system and might help in triangulating data by relating similar categories of data (Berg & Lune, 2012). As in this study and many exploratory research designs, qualitative data is the predominate source, but additional sources can enhance analysis in various descriptive statistical forms (Stebbins, 2001). In this way, exploration is also a component of a predominately inductive process (Stebbins, 2001).

While theory can help take research and put it in a framed perspective, it is necessary to specify the type of research being conducted. This research goal is not to confirm or deny theory, and in that manner is still a primarily inductive approach. With an inductive approach, data is taken and analysis is made to explore and better explain phenomena, rather than to confirm existing theory (Stebbins, 2001). With some of the theories used, the role is to create structure and elevate conversations to a more meaningful and wider perspectives of what this research is about. However, even induction relies on other processes and modes of inference to inform conclusions (Danermark et al., 2001). A more precise approach might be called abductive that describes and contextualizes data: events or phenomena are related to rules and generate new ideas about that event or phenomena (Danermark et al., 2001). An abductive approach includes interpretation and coding that fits into preconceived notions of 'naturalness,' originating from the researcher's cultural and social context (Danermark et al., 2001).

### **4.3 Research Methods**

A mixed-methods approach is used for this thesis, through a comparative case study strategy. Interviewing and subsequent thematic analysis were used as the qualitative research method. Quantitative methods were to as descriptive statistics to visually and anecdotally present data.

### 4.3.1 Comparative Case Study Approach

Case studies are often used and can be quite helpful for researching sustainability-oriented work, such as this one. The interaction between people and their environment deals with both, which occurs throughout work with a sustainability focus that has 'social' and 'biophysical' components (Evans, 2011). Evans (2011) has put it well that "whether looking at the environmental, economic or societal elements of sustainability, what we are looking at is, by definition, the actions of human beings in the world" (p. 56).

A case study method is used as Yin (2014) notes that this method is best used when questions are being asked about contemporary, real-life events which there are no possible means of control from the investigator. In addition, case study methods are flexible enough for the fluidity of this type of case and data. Many sources of evidence are considered that help triangulate data while also benefiting from previous creation of theories that aid with collection and analysis of data (Yin, 2014). Within case study research, assuring sufficient samples in the method design is often unattainable (Evans, 2011). It's the relationships that are more worth spending time to understand, so with this method, analytic generalizations are understood and translated into bigger discussions and see if these can result in larger conclusions (Yin, 2014).

The concept of time in this research is important to address. With a comparative approach, the reach of research can be expanded to not just to compare and contrast, but to trace change across scales and sites in the name of discovery (Bartlett & Vavrus, 2017). If we find a particular phenomenon of interest, in this case glacial recession, the phenomena can help discover to whom it matters and why it is important both in the past and future (Bartlett & Vavrus, 2017). This approach can help evolve analyses: a comparative approach can take into account factors such as how policies or phenomena unfold in locations that are socially produced, phenomena across scales, or phenomena cases across time (Bartlett & Vavrus, 2017). This topic, involving two examples that differ in space and time, can help both understand the past, present, and future in a more in-depth manner while considering both human and environmental elements of change.

### 4.3.2 Qualitative: Interviews

One-on-one interviews with researcher and interviewee were conducted as the primary method of data collection and analysis. From these interviews, a semi-structured or semi-standardized approach was used, so that some questions were created beforehand, and some questions asked in the moment. Semi-structured interviews are helpful in understanding a participant's worldview, or to allow for conversations to naturally flow in unexpected directions (Berg & Lune, 2012). Each interview was intended to be about an hour, which happened to be a happy medium between getting all questions asked and answered along with maintaining respect for the interviewee's time. After interviews were completed, they were transcribed and a content analysis was done. The content analysis was comparative in manner, so information from each glacial arm was separated (i.e., Briksdalsbreen vs Nigardsbreen). Participant selection is described below, and the 'rhyme and reason' to the content analysis is elaborated in the analysis section.

Interviewing as a method has been described as "a conversation with a purpose" (Berg & Lune, 2012, p. 65). In this way, the researcher has a role in interviewing not just to extract information but have an exchange with the interviewee or participant, therefore the role of the interviewer is just as important as the interviewee (Berg & Lune, 2012). Metaphors often used are that an interviewer may be an interpreter and director (Berg & Lune, 2012), but could be expanded to that traveler, where the conversation becomes a journey that leads the interviewer to new processes of reflection and self-understanding (Kvale & Brinkmann, 2009). These metaphors feel true in retrospect, for while I was bringing my own ideas, values, and perceptions of what needed from interviews, I often felt that exchanges were more meaningful in ways I had not expected. Interviews were an exchange where I brought my perception of what needed to be asked but came away with new ways of thinking or understanding from the interview process. If interviews were purposeful conversations, then interviewees were not just sources of information but collaborators in research (Karagiozis, 2018).

#### 4.3.2.1 *Participants*

Who did I talk to, and what were the limits of who I considered for an interview? Several qualifications were outlined in both position and through time. For both Briksdalsbreen and Nigardsbreen, it was critical to have interviews with the largest companies that ran and continue to run commercial activities on their respective glacier which was achieved, save for one company both in Briksdalsbreen and Nigardsbreen. It was also imperative to get a guide's perspective, and smaller operations should not be excluded as their perspective and experience is just as important. However, when we are discussing the length of time, it was also critical to have interview participants with several years' experience. For the context of describing the glacier, time spent over many years was an important factor to consider in this research. A time limit of at least 3 years' experience was considered sufficient to be able to describe changes over time and seasons, but most interviewees spent from 5 years or even more than 30 years on each respective glacier. The interview size is small but given length of experience, information was not compromised especially in a longer time-frame perspective.

There is sometimes a difference between an owner of a company, a manager of a company, and a guide who works for a company. Many times, guides became owners or started companies after their education, so the line between 'owner' 'manager' and 'guide' is quite blurred. This is beneficial for this research though, as owners and managers were interacting, viewing, and witnessing the glaciers on a regular basis. It is often true that guides who had no formal management or ownership roles also spent considerable amounts of time planning, engaging, and assisting in decisions that had an impact on the company, so even a guide is not separate from business-doings.

#### 4.3.3 Quantitative: Descriptive Statistics

This section lays out the sources of quantitative descriptive data: revenue, tourist counts, and google trends data.

Revenue data is found from Norway's system called Proff.no which registers the financial health of companies. Most of this data is made public, however some

companies choose to form in a way that allows for yearly financial data to be obfuscated.

In discussing tourism, the tourist is a component that has influence on tourism businesses. Should preferences change and tourists disappear, there would be considerable implications for tourism businesses. When possible, tourist counts were used to understand how tourist demand has occurred in the past.

To give perspective on what tourists find engaging and are interested in seeing, Google Trends can be helpful to see what search trends are still relevant. It is an assumption that much of planning a vacation is done from a computer, and often tourists find their routes and attractions based off what is seen and searched for on the web or on phone applications. This is of course not a perfect correlation that an internet search translates into interest, but these searches can confirm that a place or attraction is still viewed as interesting and can pique a tourist desire to see it. There is very little data on this, save for marketing data with no empirical evidence behind it.

With these three main groupings of quantitative data, information on the kinds of assumptions made can be confirmed. These sources tell a story of company history and interest of tourists. For all quantitative sources, simple Excel analyses were used. Visualizing data graphically helps compare two cases, hence translating the objective quantitative data into qualifying and anecdotal forms.

## **4.4 Analysis**

This section discusses the ways in which data was analyzed and processed. First the process of quantitative analysis techniques is described along with quantitative analysis procedures.

Qualitative interview data was analyzed by performing a comparative content analysis which was then translated into broader-spectrum themes to be addressed in the discussion section. The first procedure was to take transcribed data and generate codes from the text. Codes were then taken and translated into bigger themes as suggested by Braun and Clarke (2006) to support interpretation both in comparison and a wider thematic context. When doing a thematic analysis, it's important to specify what might count as a theme. A theme both relates to the research question in some way but also shows a pattern in responses in data Braun and Clarke (2006).

Some pre-formulated questions asked during interviews were designed specifically to address gaps in quantitative data. For instance, mass balance and frontal length of glaciers are yearly markers employed for analysis over long periods of time but fail to address what a guide might see over a 3-month long summer season, as many relevant phenomena can occur like melting rate, weather events, changes in the conditions of the ice, or increase in steepness of a glacier. Other themes were identified from coding when managers or guides brought them up with experiences on one or both glaciers, as patterns emerged. When the data was contradictory but had a similar category, it was important to make sure those pieces were captured as codes and then translated into themes. Other themes emerged naturally underneath the umbrella of the research question, in relation to tourism, the nature of glaciers, guiding, and so on.

Coding is one of the more important parts of going beyond descriptive data collection and ensuring there is a link with the explanation of its meaning (Charmaz, 2001) During the coding process, research questions were considered with high priority but in addition, if a pattern was evident or a phrase was relevant in context, it was coded. Since coding is also where the process of building theory begins, ensuring systematic and scientific mechanisms was important but often codes were thought of as something to be discovered (Saldaña, 2021). Coding was also performed several times to make sure important data was not missed. The next step was taking codes and synthesizing fractured pieces of information to make a “new whole” (Saldaña, 2021, p. 13). Generating themes from coded content was done by using specific guidelines from Braun and Clarke (2006). A summary of steps is outlined below:

1. **Familiarization of data:** data was transcribed, and initial ideas were written out. Data was listened to and read over several times.
2. **Initial coding:** early emergence of themes was coded, and data points were collected in relation to each code.
3. **Search for themes:** codes were made into potential themes.
4. **Review of themes:** first, making sure themes are sufficient with their codes but also made sense with the entire data set. Some themes were re-worked so each was clear and distinct.
5. **Theme definitions:** refining each theme with clear names and definitions.



6. **Production of a report:** selecting key examples, analysis of examples, and making sure the analysis ties back in with the research questions. In this case, creation of report includes list of themes more description is detailed under each theme's section.

(Braun & Clarke, 2006)

After general themes were selected, narratives emerged and are presented as differences between each glacier, utilizing the comparative approach. The diagrams and descriptions were then compiled with quantitative data for a comprehensive overview of all data points and analysis.

Within data analysis, the first step was to take quantitative data and transform it from spreadsheet numbers to descriptive charts, graphs, and compilations. For revenue from guiding companies, graphs are presented by company or by glacier. If possible, tourist counts are included. There are several limitations with this data: incomplete or missing information, company mergers, and/or inclusion of other glaciers in revenue numbers were difficult to capture in data so they have been explained. Even without perfect data for comparison, some qualifying information can be extracted that are a valuable part of the analysis process and results. For Google Trends data, comparison graphs of search terms are created with the longest time span available. Search trends can be an additional source of information that aids in analysis by triangulation, verifying these other sources of information when they do not contain complete or perfect data (Berg & Lune, 2012). These data then are joined with the rest of the qualitative themes to make up a larger comparison between Briksdalsbreen and Nigardsbreen, and spark discussions of what this research has found and what it means. Connection to both groupings of research questions is considered and is discussed in further detail in the results section.

## 4.5 Ethical Considerations

This thesis interacts with the lives of many both in direct and indirect ways. As a part of social science, there are ethical obligations to consider and mitigate (Berg & Lune, 2012). Ethical obligations are considered in regards to the studied population, colleagues or partnerships with this research, and society at large (Berg & Lune, 2012).

For the studied population, it was essential to apply ethical procedures for the interviewees or participants of the study. First, the project and intended study

population parameters were registered in Sikt, which assists researchers in the process of safely and ethically carrying out their research (Sikt, N.D.). Before study participants were contacted, research project parameters were registered in Sikt. An 'Interview Consent & Information Letter' (Appendix 1) was tailored to this study project and information was given on Norway's rules and regulations for data processing and storage. It was made clear that individuals would be knowingly participate in research without elements of fraud, deception, or manipulation (Berg & Lune, 2012). Informed consent also means outlining benefits to providing information with possible risks, and how potential risks are handled (Berg & Lune, 2012). The consent and information letter was sent ahead of time or if that was not possible, presented before interviews commenced. In some instances, it was not possible for interviewees to read the letter beforehand, so time was given for review in the beginning of interviews and all interviewees had the choice to decline. All participants were asked to either sign the letter of consent or provide verbal agreement that the form had been read, considered, and agreed to. All participants gave verbal agreement that taping, transcribing, and interpreting interview content was accepted. The appendix contains the consent and information letter with several considerations such as data processing, storage, sharing, accessibility, and deletion in Appendix 1.

In regard to confidentiality, there were all possible active measures taken to protect identity of subjects (Berg & Lune, 2012). Measures were to replace individual names and company names with interview case number. Taped interviews and transcriptions have been stored as per Sikt's qualifications along with removal of identifying information of subjects. Taped and transcribed interviews will be securely stored and encrypted for a 1-year period before deletion. It was decided that in an effort not to release information that could be identifying of participants, transcriptions are not included in appendix material.

In a larger context, ethical considerations were considered in the research design process (Berg & Lune, 2012). It was assessed that potential harm and risk could be minimized by following steps outlined above so participants would not be affected in their daily lives. In the process of this research, other misconduct on behalf of the researcher such as fraud, lying, misleading, or stealing other's work was considered and addressed (Berg & Lune, 2012). Results have not been tampered with,

interpretations have come from analysis and research, and references to others' work is managed through APA 7 referencing with guidelines from the 'Citation Compass' (N.A., N.D.). To continue academic integrity, the completed thesis will be shared with all participants and any who were involved and will be published with open-source access.

## 4.6 Limitations

As in any research, limitations will always exist, and it is the hope all have been laid out to supply quality information on the validity of research and issues encountered along the research process.

First, the quantitative data for glacier guiding companies on Briksdalsbreen was more difficult to obtain and tourist numbers for many companies were not able to be retrieved. In addition, when data was available there were instances where companies merged and at times there was not a clear separation in the data of tourists on one glacier specifically, rather overall tourist counts. This is specified by figure. Still this data helps understand the nature of someone who wants to participate in a guided glacier tour or educational course. It can help speak to the nature of being interested in tourism or educational activities on glaciers in general.

Data from Google Trends is an interesting data addition but should not be overstated in what it tells us. Internet searches may very well not correspond to visitation. However, with multiple sources, triangulation is possible so that several sources can back up assumptions of one (Creswell, 2014). The Google Trends data possibly speaks to a general interest in glaciers or seeing a glacier on vacation but may not tell us much else specifically. In terms of limitations with interviewees, some declined to be interviewed so the perspective of qualitative data is not from every company and every guide on Briksdalsbreen, but a select group that was willing to spend time providing their thoughts and detailing past and present experiences.

The largest limitation is likely my role as a researcher and the flaws in the creation and process of research, design, and analysis because it is impossible to perfectly separate individual and researcher: the two will always have some aspect of collision (Karagiozis, 2018). Indeed, while creating questions for interviewees, I could easily see that without being aware of it, specific questions could be asked to gain a certain kind

of response. I did my best to try and keep an objective view and ask a variety of questions that would aid in research and not my personal passions and interests, but it can never be certain that perfect objectivity will be achieved. There are many ways the personal experiences and background of a researcher can influence the research itself almost like a camera that includes or excludes certain colors or shapes: “cameras also have filters covering their lenses that let certain wavelengths in and keep others out” (Saldaña, 2021, p. 10). This metaphor accurately asserts that our person will absolutely have effect on our research. Things like biography, thinking, habits, patterns, values, learning and experience in addition to the ontology and epistemology the researcher chooses will have effect on what is included or filtered out of research (Karagiozis, 2018; Saldaña, 2021). Similarly, the same factors can be applied to research participants and they should not be viewed as ‘objective sources of data’ but as co-producers of research (Karagiozis, 2018). Replicability will never be perfect and the same outcome from two different researchers cannot be guaranteed. However, the limitations of researching with a certain lens can also present opportunity for uniqueness, where new ideas and theories are built that are expressions of that person’s characteristics and eccentricities.

## 5 Results

For each glacier and surrounding area, interviews with two major glacial guiding companies were completed for the representation of Briksdalsbreen and the West Valley. For Nigardsbreen and the East Valley, interviews with an owner of largest guiding company and two guides with significant experience (more than 3 years) were completed. Qualitative data and descriptive quantitative information are filtered into relevant sections. Results are presented by theoretical framework categorizations of adaptation. Results are presented in two main categories as discussed in adaptation theory, first by data associated with coping and then adaptive capacity considerations.

### 5.1 Coping Capacities & Thresholds

#### 5.1.1 Coping with physical changes in environment

There is always a range of environmental conditions in mountains, but two groups stood out as new, which were weather and glacial changes. In Briksdalsbreen, there were increased instances of hard ice that were impenetrable by safety equipment which was the most difficult issue that guides had to contend with and created challenging guiding situations. However, the weather patterns that created this situation and other mountain environmental conditions like continuous rockfall were known to guides and many guiding experiences were able to be adapted around it.

*“The safety margins to the trail and glacier is big that we never got hard rock on the path or coming into the glacier close to us. But if you’re there one week you will hear the rockfall. That’s normal. That’s a bigger problem in Nigardsbreen on the old bridge, it was going too close to the mountains” (Interview 5)*

Eventually both in Briksdalsbreen and Nigardsbreen, changes in weather events felt more extreme:

*“Also, when it started to change, that’s around 2000, this is subjective, but we had more summers, more windy, warm summers that created more wind so the glacier melted faster” (Interview 2)*

*“Nigardsbreen some years ago we had this what do you call a small tornado, because it was a really sunny warm day and then suddenly it started to rain a lot ... that hasn't been normal” (Interview 1)*

These weather events like the small tornado and increasing number of thunderstorms felt different from periods of stable and predictable weather in the past. Similarly with many situations in the mountains, guides are prepared for the unexpected and can adapt both in the moment and in longer-term planning.

Glacial change was understandably a large focus on conversation, as the conditions and changes on the glacier were both noticeable and impactful. Adaptation to changing glacial conditions occurred both with growing and shrinking volumes of the glacier. In Briksdalsbreen, there were increased instances of hard ice that were impenetrable by safety equipment which was the most difficult issue that guides had to contend with and created challenging guiding situations.

*“... the spikes didn't go into [the glacier], you could slide on the crampons. With tourists and extremely slippery ice it was scary. And this came more and more.” (Interview 2)*

In the period of intense glacial recession, melting was so extreme that it looked like many bathtubs of water on the glacier with water sometimes even flowing in fountains out of the ice. It was the speed of recession in Briksdalsbreen which was the most difficult to adapt to though:

*“... we knew what was coming. But it was faster and more dramatic than we could imagine. It was the maximum in 2000 and we had to stop 5 years later” (Interview 2)*

In Nigardsbreen, instances of challenging years meant that adaptation on the glacier could be managed such as larger crevasses. Observations of the glacier melting are that the glacier is thinning, a well-known process in glacial recession but it also meant that guides had to adapt to what was described several times as a “boring” glacier.

*“Well it's easier now I would say, it's an easier glacier to walk on” (Interview 3)*

when asked about adapting to glacial conditions throughout guiding tenure. When changes in the glacier or surrounding mountain environment occur, guides can adapt by changing route-making, infrastructure, and accessibility to and around the glacier.

*“And that was also, advancing glaciers creates some problems, creates some challenges, because rapidly advancing and high steep glacier so it was lots of work to make the route safe for the clients” (Interview 4)*

This included chopping steps, securing poles in the ice, utilizing risk management professionals, and using safety equipment to tourists like helmets and ice axes. This occurred in Briksdalsbreen as a normal reaction to guiding on a moving, changing phenomena and the same continues to occur in Nigardsbreen. Challenging conditions for adaptation included both when the glacier was growing or receding:

*“We had some years in Nigardsbreen, that’s a little bit over now but I think it was 15/16 /17 when the glacier in front was really really difficult, we chopped so much and we had to make bridges, it was like Khumbu ice fall on Nigardsbreen, it was crazy, we had to do so many things in order to make it safe and also have guiding” (Interview 1)*

Adapting to the environment is a fundamental part of guiding in an ever-changing environment like a glacier, yet some changes are un-adaptable.

The breaking point of adaptation on a glacier is steepness, which was duly shown in Briksdalsbreen. The fast and dramatic changes were difficult to manage, but it was the steepness of the terrain underneath that meant adaptation would no longer be possible. In Nigardsbreen, the worry of terrain underneath the glacier being steep is the main concern in adapting to a changing glacier.

One other important detail was an acknowledgment that glaciers are often changing phenomena regardless of climate change, but these impacts showed up faster than expected.

*“I don't think anyone in the glacier business doubted climate change, but it was the speed of it” (Interview 2)*

Throughout the data, there was a trend of feeling that climate change impacts were imperfect in how, when, where, and in what way changes present themselves. Some discussions also highlighted tensions between what is ‘normal’ change and climate change, and how difficult it is to separate out the two.

*“... you can understand climate change that occurs now but I think that you don't tell the whole story, the climate is changing the whole time, but now it's changing faster and it is human impact” (Interview 5).*

There was acceptance in glaciers being changing phenomena, but the surprise was of how dramatically and quickly the response to climate change came.

Part of guiding on glaciers and in mountain environments includes understanding safety procedures and understanding risk. In the environment, it was felt that risk may have increased over time, even if the exact reasons were difficult to pinpoint. Some mentioned instances uncommon weather events (as mentioned in theme 1) or factors like increasing rockfall that increased risk in guiding over time. Interestingly, some interviewees on Nigardsbreen felt the flatness of the glacier in recent years significantly decreased risk. Nigardsbreen experienced the most risk in years of challenging conditions and in glacial growth:

*“...it was a new situation with growing glaciers and here in the end of the valley it was a family, a Dutch family, 3 people were killed. So it’s also a risk” (Interview 4).*

Both safety and risk were often intermingled. First, there is safety during the experience of a guided trip and with that comes an understanding of what safety precautions were taken along with the accidents guides encountered on a regular and non-regular basis. In Briksdalsbreen, safety measures were adapted over time until steep and dangerous terrain made it impossible to keep improvements above an acceptable risk level. While changes in a glacier and mountain environment may have increased difficult conditions, many were perceived as manageable. Different risks had different levels of adaptation through safety measures, tour modifications with certain components that make it easier or more difficult to work with.

### 5.1.2 Coping strategies in business products and experiences

Along with changes in environmental conditions, there were resulting changes in the business side that were qualified. Adaptive measures were made in both tour products and experiences, and at the same time products had to be amended for the clientele.

In Briksdalsbreen, the rapid demise of the glacier led to rapid changes in the businesses, in that tours were shortened until the business itself was forced to transform. The range of possibilities for businesses operating on Briksdalsbreen were to move to other glaciers for guiding purposes and downsize, or terminate a company completely.

*“With business, it just went back to a small hobby business, and that’s fine because I got kids and another job” (Interview 2)*



With Nigardsbreen, the business product has changed some but many of the same products remain. One popular ‘family tour’ was ended due to safety concerns:

*“[We had] to change a lot with the tours the last years because we spend a lot longer time walking in with the tourists walking in from the boat. So it’s a totally different type of product we have now than we had 10 years ago for instance” (Interview 1)*

For both Briksdalsbreen and Nigardsbreen, the experience of the tourist was much different from previous years. Tourists had shortened times on the glacier and walked much longer to access the glacier itself. In Briksdalsbreen:

*“We shortened the two hour ones as well and in the last summers we just did one hour trips and a guide could walk a one hour trip in 10 minutes so it was really small in the end” (Interview 2)*

Similarly in Nigardsbreen, the walk time has more than doubled. It seems with this issue, there are two elements happening at once: the changes a receding glacier presents make a more demanding physical experience for tourists, while it also may be that the general tourist or clientele has less technical skill and experience:

*“And also I think more tourists are getting less and less used to walking in rough terrain, also Norwegians. That’s my experience at least from over the years and also in the mountains in general, they’re not as good as walking in the mountains as people were before in a way” (Interview 1)*

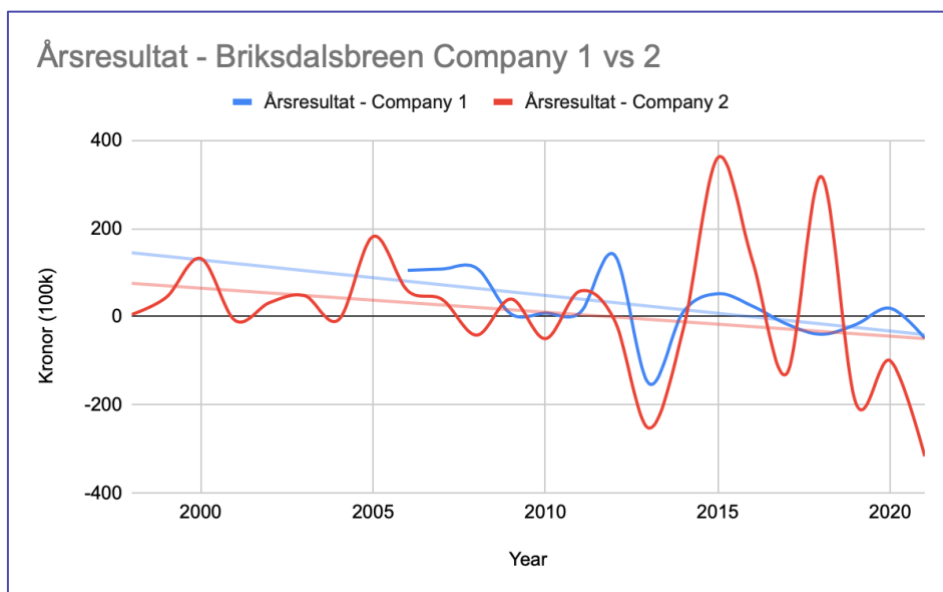
*“I mean I’ve thought about it a few times but just in the sense of coming a longer and longer hike for people and the tourists that are hiking on Nigardsbreen aren’t always the best hikers. So maybe something has to happen with the trips that we offer, that we have to expect more of people, that they can hike for longer” (Interview 3)*

However, adaptation strategies to keep the business running has happened and will continue to happen every year.

Quantitative data shows similar findings from narratives described above. Figure 5-1 presents two of the three glacial guiding companies that operated on Briksdalsbreen. What this data shows is that Company 1 saw declining revenue over time. This was confirmed in the interview with the principal manager. Company 1 has continued with glacier and mountaineering courses and mountaineering experiences, but in other areas. Company 2 has seen a more variability in revenue with some growth spurts in 2015 and 2018 but still with general decline. This company expanded

into different activities in new areas, such as kayaking. However, the manager of this company declined to be interviewed so why these years had such significant growth over other years it not completely understood. When looking at the years of 1998 to 2006, there is some fluctuation as the business was growing with a peak in 2005 and followed by a rapid decline. This data captures three points of interest: 1) companies were discontinued because Briksdalsbreen became too steep for guiding, and 2) businesses grew from the start of guiding on Briksdalsbreen but also declined in-line with the recession of the glacier, and 3) companies that did not expand business operations to new areas saw overall decrease in revenue and growth.

Figure 5-1: Briksdalsbreen Yearly Revenue for Glacier Guiding Companies. (Proff.no, N.D.-b) and (Proff.no, N.D.-a).

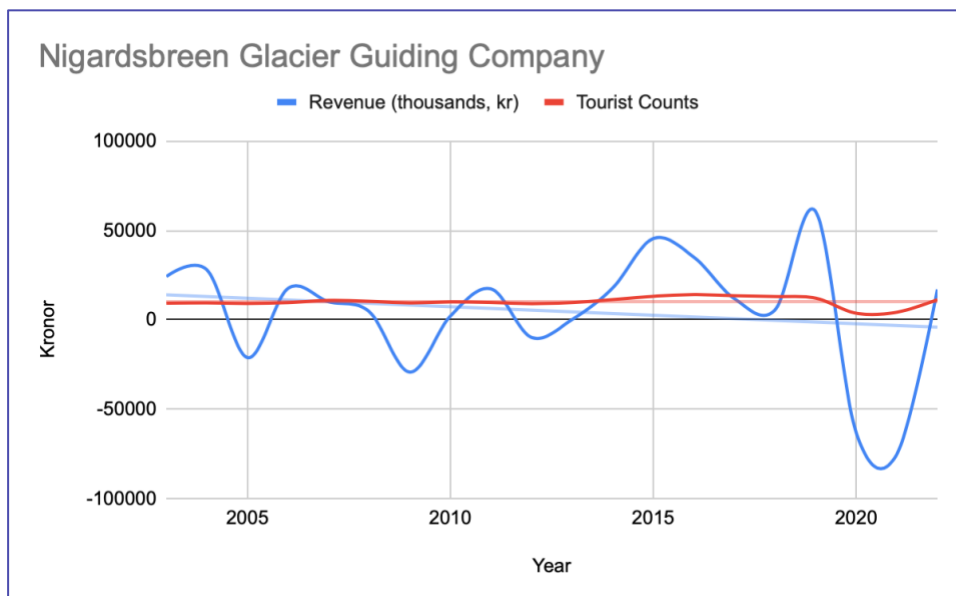


At first glance, one could make several conclusions but there are several distinctions and limitations in what is presented. First, this data does not capture when these companies ended commercial guiding on Briksdalsbreen. Both companies eventually shifted locations to different locations or activities, including guiding on different glaciers. Second, for the first company (Årsresultat 1), there is data missing as the company was filed as a private entity and did not have public accounting data available in Proff, nor were previous managers able to find year by year revenue data. From an interview with the main business manager, it was theorized the business saw 500 customers in 1995 and then saw increasing tourist counts until the peak in 2001,

where it was thought there were upwards of 10,000 tourists the whole summer. Since no revenue data was available, it is difficult to tie these numbers to revenue but from interviews it was helpful to estimate that 2001 was the peak of business, and the last guiding activities commenced between 2005 and ended in 2006. Third, what the numbers does not show is that these two companies were separate legally but had cooperation between themselves, which also muddles the data. There was a third company that operated on Briksdalsbreen, but neither revenue nor tourist counts were available. This company was terminated around 2005 was unsafe to guide on the Briksdalsbreen. One perception in Interview 5 was that interest in walking on Briksdalsbreen may had seen some decline. The last condition is that tourist counts are not shown in Proff or anywhere else, and managers of these companies did not have tourists counts available for the analysis.

On Nigardsbreen, there is one primary company for glacial guiding. Revenue and tourists count for are presented in Figure 5-2 for that company. There is another significant company that is registered as a private entity, so data is not available, and the manager of the company declined to be interviewed.

*Figure 5-2 - Revenue and Tourist Counts for Nigardsbreen Glacier Guiding Company. (Proff.no, N.D.-c) and (Jostedalen Breforlag AL, personal communication. February 27 2023).*



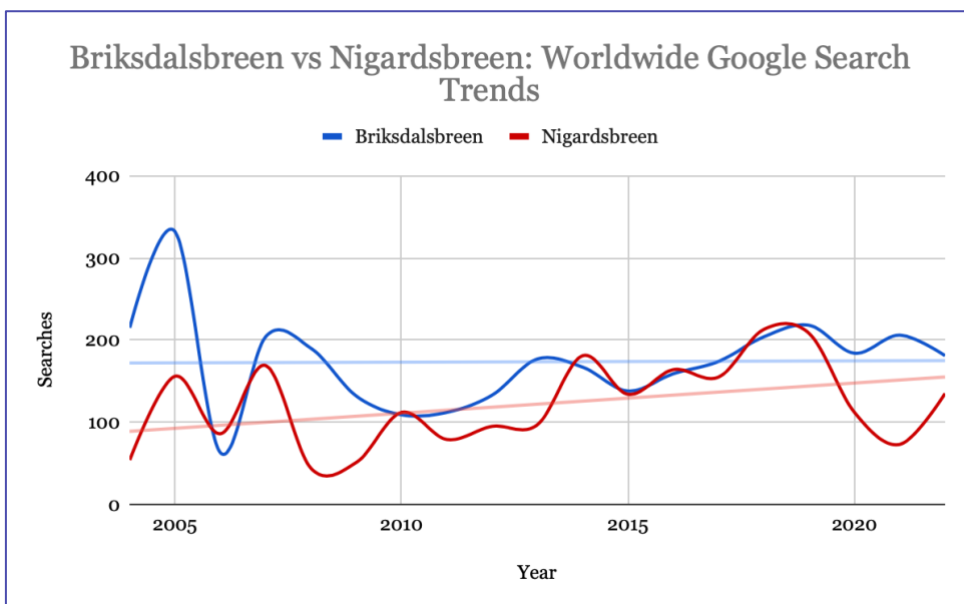
This data from 'Nigardsbreen Glacier Guiding Company' shows similar patterns of fluctuation compared to Briksdalsbreen in revenue with a slight trendline of decline,

but this may likely because of extraordinary impact to tourism from COVID-19. Tourist counts remain steady overall with a dip due to COVID-19 where virtually all tourists and clients were Norwegian and there was less demand for glacier guiding because of the seasonal international market being cut off from all travel and access until 2022.

One often-discussed concern of tourism which would greatly affect capacity to cope and resulting adaptation options are the continuity of tourists. If tourists react to climate change conditions and how remains an open question. On Nigardsbreen, demand for glacial guiding remains a constant and steady source of business for this company.

There is often the concern of decreasing or disappearing tourist when glaciers start to recede. Understanding tourist preference is not entirely understood in glacial tourism but some unique data sources were considered as potential for insight. Google Trends is a tool that shows anonymized internet search activity and may show general interest in locations or topics over time (Choi & Varian, 2012). Data was pulled from the beginning of Google Trends in 2004 to the present year 2023.

Figure 5-3: Google Trends Worldwide Searches for each glacier by year (GoogleTrends, N.D.-a)



Over time, worldwide searches for Briksdalsbreen see an almost constant trend of interest (Figure 5-3). For Nigardsbreen, worldwide searches have been increasing year by year with a notable recent decline in 2020 likely because most could not visit

attractions in Norway during the COVID-19 pandemic. In using this data, I was slightly dubious in the overstatement of internet search data supplying useful information for tourist attractions so two auxiliary data sets were extracted to understand if this data might be useful in this research. Figure 4-5 takes two popular nature-based tourist attractions, the Trolltunga and Pulpit Rock hikes. Pulpit Rock has been popular for many years, but it was the Trolltunga hike that many felt had somehow exploded in interest and image search may have had a factor in its newfound popularity. The graph used to show this data tells the story that while Pulpit Rock has steady search interest with an increase in 2009, but it was sometime in 2014 where Trolltunga became recognized worldwide with a sharp increase in search interest in 2015.

Figure 5-5 explores a different area in identifying if other areas with decreasing glaciers might see increasing, steady, or decreasing trends in search interest. Worldwide searches have seen a general decrease since 2004 till 2023 for both the Fox and Franz Josef glaciers in New Zealand, which are two glaciers with similarities to Briksdalsbreen and Nigardsbreen in glacial guiding. Again, the COVID-19 pandemic has undoubtedly had an impact on interest when travel is not possible. This data is a leeway into asking if tourist preferences for receding glaciers are also decreasing and for what reasons, however this question needs to be explored in more depth and outside of the research. New Zealand has many differences to Norway in tourism and glacier access, but it is important to see that glaciers like Nigardsbreen may be gaining interest in general search activity.

Figure 5-4: Google Trends worldwide search data for two popular nature-based tourist attractions in Norway (GoogleTrends, N.D.-c)

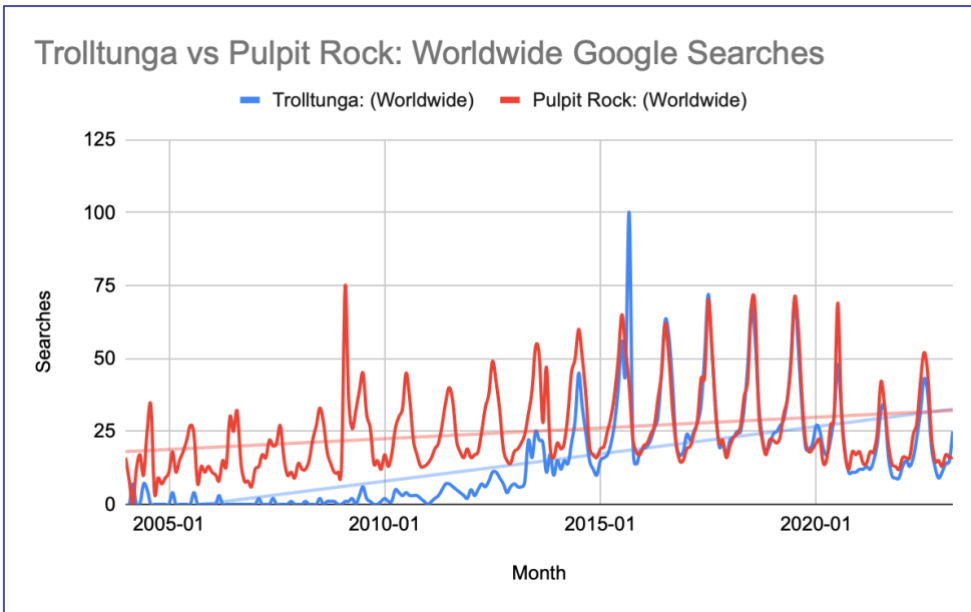
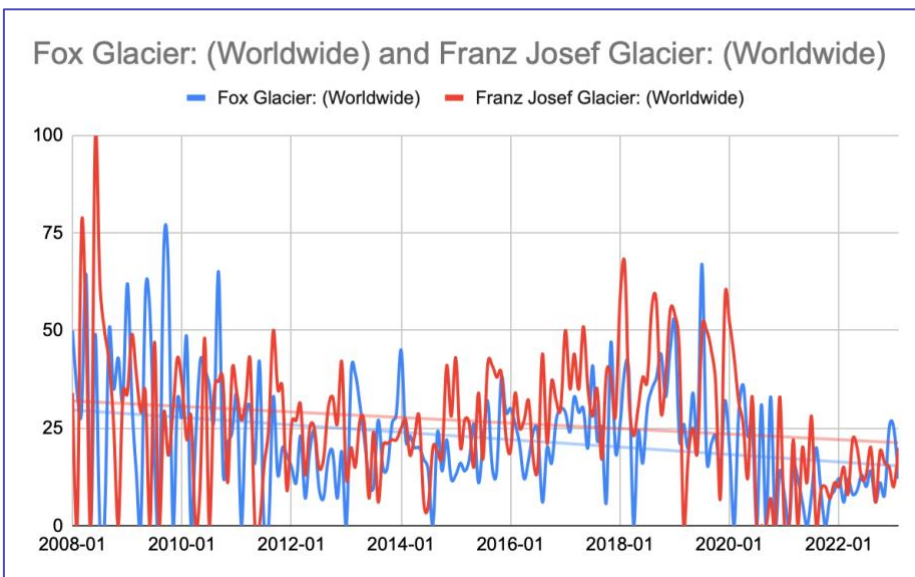


Figure 5-5: Google Trends worldwide search data for two glaciers in New Zealand (GoogleTrends, N.D.-b)



These results do not prove anything though. They are exploratory means to understand preference given a limitation in data. More research into how trends correspond or correlate with behavior for tourist demand is needed for this data to explain anything.

### 5.1.3 Considerations for coping thresholds

This theme qualifies information pertaining to each glacier and its surrounding area. What emerged in this collection was data that gives both context and better understanding of how each valley depicts itself and neighboring valleys. Certain depictions naturally surfaced between Briksdalsbreen and corresponding community, compared with Nigardsbreen and its community.

Some of the defining qualities of the community in Briksdalsbreen was an acknowledgement of a long history of tourism and large tourism presence. It was generally accepted that a large tourism population existed with many options for tourists, along with an infrastructure that supported large-scale tourism.

*“In Stryn kommune, tourism has been a big part of their economy for 100 years or maybe more. I don’t know how many employees they have, but the Hotel Alexandra in Loen has several hundred people working there so in Stryn there is every season maybe 500 people. It’s a big difference compared to Sogndal” (Interview 5)*

Discussing large-scale infrastructure deviated to what several interviewees named as “mass” tourism, sometimes described in tandem with “over” tourism. The feeling was either that infrastructure allowed for a greater number of tourists than in the Jostedal Valley but also hinted there could be too many tourists in Briksdalsbreen.

In comparison, Nigardsbreen and the surrounding Jostedal Valley felt tourism had been and continued to be vitally important to their communities and economy, but noted that limited infrastructure and location introduced challenges:

*“We are not in the center of the world in Jostedalen. It’s a big detour up here and we have many day tourists coming here to Jostedalen. In the Nigardsbreen area, we have about 45,000 visitors every summer season and we have only one hotel and one campsite. So many of the visitors come in here to Jostedalen and they stay in the fjords or cabins or hotels. Outside of Jostedal” (Interview 4).*

With only one summertime bus, the infrastructure capacity felt smaller compared to other tourism areas in Vestland that attracted and retained tourists regularly. Dialogue often pointed to the link between tourism and economy, which was vitally important to the small population in Jostedal, once even referred to as a “resource colony.”

*“It’s important to have these activities, because also the impact of the economy and local community because we are not so many residents in Jostedal” (Interview 4).*

*“We try to get as many visitors to stay in Jostedal. It’s good for the local economy and community” (Interview 4).*

Still, it was felt that several features of Nigardsbreen make it one of the few glaciers left with both relatively easy access while still allowing for the experience of walking on the glacier itself which is unique and lucky. The worry of what could happen to the valley with the possibility of Nigardsbreen receding beyond guiding capabilities elicited much worry, fear, and concern.

For both glaciers, many felt that a reduction in demand had not been felt yet, for instance it was mentioned several times that Briksdalsbreen was still a popular attraction for tourists.

*“There are still many people there, couple of hundred thousand visitors every summer ... coming to see the small remains of Briksdalsbreen.” (Interview 4).*

The same has felt true in Nigardsbreen.

*“I think the people, the amount of tourists, except for the COVID years, have been pretty stable. So I don’t think it’s that much of a difference” (Interview 3).*

For Nigardsbreen this is no surprise since the glacier still sees stable demand and continued interest.

Out of this premise, many acknowledged the topic of new access methods to maintain some sort of glacial tourism. During interviews, the idea of changing access to glaciers through two main forms of replacement activities, both helicopter and gondola or cable car, was a topic of discussion especially for the West Valley. Participants with connection to both glaciers felt mostly negative about these types of replacement activities.

*“Yeah, that I think it’s important to not, for example, fly a lot of helicopters and basically not to do things that make them melt even more” (Interview 3).*

Some mentioned that plans for ‘building up’ the nature around Briksdalsbreen had been discussed for many years, a revolving conversation about how to continue tourist activities if the Briksdalsbreen should disappear from view.



## 5.2 Factors in Adaptive Capacity

### 5.2.1 Sense of Community as Social Capital

Within glacial tourism, there were distinct groups that emerged in connection to witnessing decline. The formation of certain communities along with characteristics that relate to sense of community are explained for glacial guides.

There is a “front-line” nature to guides and guiding that includes strength in connection to glaciers and strong social cohesion. Guides were the closest in proximity, interaction, and many had spent a large cumulative amount of time on these glaciers, ranging from six years to over 30 years. Guides being some of the first to witness and experience change on a day-to-day basis, creating a high level of connection.

*“... but in general [guides] are just seeing how much it is receding every year, because you’re a lot more out there all the time” (Interview 1)*

Some of these levels of connection meant that shared concerns, values, and a sense of togetherness or belonging were very strong in the guiding community. Collaboration, sharing of information, communicative, and openness were themes in many conversations:

*“... if you go to the glacier beforehand you have a course or something, it’s not always that you have time to do that so it’s just talking a lot in the community and also for instance, especially we have a very open community in the guiding community” (Interview 1)*

While the front-line role increased a sense of community around the glaciers, the ability to have agency and influence was seen as a difficulty. Guides often felt it was paradoxical that aviation can increase fossil fuel emissions, which directly influence the glacial landscapes that they felt should be preserved.

*“...it’s interesting to work with people in that type of environment and just to, as a guide to make people understand how nice it is in nature and also trying to tell people, it’s very paradox in a way, you have many people traveling from China to Norway to see this poor receding glacier but still it’s kind of, I think for me it’s quite important to also tell people how everything is in terms of how fast it’s melting and how important the glacier is for the community in Jostedal” (Interview 1)*

The tourist role in viewing and experiencing a glacier is they are likely seeing the phenomena once in their lifetime and many are hoping to see something unique and fascinating, to be experienced in a lucky moment before the phenomena has

disappeared. Many felt tourists were aware of climate change and the impact on glaciers in a not-so-distant future.

*“But I think awareness of the glaciers and how it will be in the future is quite ... people are aware” (Interview 2)*

In both glaciers, it appears that many tourists are motivated to see them as a last chance viewing.

*“Some of them are coming here to experience a glacier and hike on a glacier before it’s all history” (Interview 4)*

In some ways, tourists were seen as uninvested, uncaring for the phenomena they are witnessing. These features have a resonance of passivity for the tourist, as one who consumes and experiences what is available to them without the depth of knowledge or connection through community and time spent on a glacier that a guide or resident might have. Guides were on the one hand affected by the toll of glacial decline but were also aware that without tourists their businesses and surrounding communities would suffer economically.

### 5.2.2 Social Capital through Identity

Throughout interviewing, it became clear that identity was a major aspect of glaciers and glacial recession. The ties were fourfold, between the glaciers and community, cultural, occupational, and personal identity.

For Briksdalsbreen, the glacier is still in use for touristic purposes, and it could be assumed there is much importance to the community although this wasn’t specified by interviewees. In discussing community around Briksdalsbreen, there was certainly not the sense of worry and fear as in Nigardsbreen. The participants in Nigardsbreen all noted how important the glacier is:

*“I think not only for me, for many other people it’s an important part of the identity of the community and individuals here in the valley” (Interview 4)*

Many participants felt the Jostedal glacier is one of the strongest ties to identity with the surrounding valley centers, with Nigardsbreen is the most significant access point for Jostedalen.

*“I think the glacier means very very much ... because it’s defining for the valley. Because it’s called Jostedals glacier and it’s the biggest glacier in Europe so I would assume that they have they identify themselves quite a lot by it, the culture and the history” (Interview 3)*

The change in the glacier brought out many worries about how the valley would define itself, but also sustain itself. As one participant noted, many have left the small rural settlement for larger towns and cities, with a worry that this trend signifies the loss of attachment to a place through dispersal of the community. There seemed to be the worry that when glaciers recede, the community would no longer be able to sustain itself.

It was clear that each glacier has ties to culture heritage and important parts of Norwegian history. For Briksdalsbreen, many stories emerged about mountaineers, travel, transportation, and trade that were important connections to the history of Norway, and what gives Norway culture heritage. For example, stories connected traditions of farming in the valley and using horses in a barter system translated to aspects of cultural heritage being used in modern tourism purposes. Until recently, transportation to the Briksdals glacier used a horse and carriage as a part of that history in the tourism experience. To interviewees, these were legacies and traditions of history that clearly marked a tie to the greater umbrella of Norwegian culture. There were also stories of ‘how things came to be’, for instance, why walking in the mountains can be seen as a key cultural aspect in Norway that were viewed as identifying to the culture. The connection between modes of transport and similar dialects was a striking example of how cultural heritage and history is weaved together.

*“I find it interesting that all these people and communities have been living here all these years and have been doing logistics between the villages and we hear a lot about the history of using a boat, and boat was the most easy way to move around but there were also people walking in the mountain passes and the oldest trail in Norway goes from Skjolden. So that’s like cairns, small rocks on top to mark the path. All the cairns are along the lake, around 1000 years old. So people have been walking over these mountains. There was no forecast, no avalanches, no GORE-tex. And in Jostedal, you have the hotel and shop and the dialect is much more similar to the dialect in Stryn than in other places because they were exchanging genes, people were traveling over the glaciers” (Interview 5)*

It was also felt that “old” ideals, such walking in nature and guiding on glaciers, is not just something nice to do but originated from a part of shared identity.

*“This glacier guiding and glacier courses are built on old ideals of taking what you can carry and walking ... Calm and silence, and everything we love” (Interview 2)*

From the data, it was undeniable that interviewees felt the history of an area and nature were tied together, and felt it was especially true for Norway. Given that Norway shares a cultural identity and heritage with being in nature, many felt there were strong bonds with glaciers through this connection. Several interviewees noted concern in cultural shifts occurring to Norwegians, that seemed to already have occurred:

*“It’s also interesting, if you look at the history of climbing and glacier walking in Norway, there were more people on the glaciers than climbers and seeing that today is amazing, and that is, even in 1990, 40 years ago, glacier trekking and tours were maybe at the same sizes as mountain climbing. Now it’s not comparable” (Interview 2)*

It was insinuated the connection between nature and culture in Norway had already felt a decline. Of the two managers, both felt that registrations in technical glacier courses were participants are learning how to guide themselves on glacial terrain was less popular that it had been, or that less had interest in engaging with glaciers in that way which was culturally important to Norway through bresport.

*“I guess when you asked what the glaciers mean for me that’s one of the things that are kind of cool in Norway, I think, that we like to walk on glacier because it’s fun. See the glacier as a playground, whereas everywhere else, the Alps and the US I guess, they’re just an obstacle” (Interview 3)*

To end every interview, the last question I always asked was “what does this glacier mean to you?” so it’s not surprising that a wealth of information pertaining to personal identity and each glacier became a major topic. Briksdalsbreen was felt as a personal identifier, as was witnessing its decline. The change of the glacier meant a change in personal and occupational identify, where the glacier both creates identity, and when the glacier recedes, it was felt that identity was concurrently altered:

*“Briksdals was a major thing in my life, when I saw it in 2002, I think it’s stopping soon, it’s a big thing in my life. And then my identify as a glacier guide is threatened in one way” (Interview 2)*

In this explanation, identity incurs profound shifts when the attachment is lost. Many noted the dependence on the glacier felt and occupation made-relying on the glacier is feel like a risk.

*“We have dealt with many risks in the past in this job, but now the bigger risk is receding glaciers” (Interview 4).*

Risk can also be perceived as what is relied upon, that a glacier is a dependence and if that diminishes or completely goes away, it challenges occupational and personal identities.

The honesty in this example shows the connection to place and personal identity is strong, where the identification to a place can be profound and the connection with emotional weight of decline is intensely felt:

*“It’s a special place, maybe the special place but it’s not there, it’s gone. It means a lot. I go there now and then to see it, but I get sad” (Interview 2).*

Many guides described the cumulative weight of watching glaciers recede as “not very fun” as fewer and fewer glaciers have become suitable for guiding purposes. Almost all described sadness or shock as the emotional experience, both in the glaciers they had close association with or glaciers in general. The close ties with identity contributed to difficulties maintaining well-being in the process of experiencing glaciers decline and recede. The strong relationships between glaciers are felt on many identity levels as shown in these examples.

## 6 Discussion

This section expands on results and is presented by analytical framework categories as used in results section. Interviews with guides and managers of glacial guiding companies was the primary qualitative method, with descriptive quantitative data from companies and search data as secondary.

### 6.1 Lessons of glacial decline in tourism

The first aim is to compare tourism systems Briksdalsbreen and Nigardsbreen, as two glacial arms of the Jostedal Ice Cap and understand what implications from glacial tourism Briksdalsbreen may be useful for the future of Nigardsbreen. Utilizing Scott et al. (2012) systems framework adopted to tourism, environmental and tourism systems are connected through interdependent feedback loops. Results are considered in each system and by the processes that occurred in pathways of connection. The first research question that will be addressed is:

2. What lessons from Briksdalsbreen can be applied to Nigardsbreen regarding adaptation in glacial tourism systems?

This thesis uses systems theory and adaptation framework to analyze the following sub-research questions:

- a. What are possible limits of coping capacity in glacial tourism?
- b. What sources of adaptive capacity should be considered in glacial tourism?
- c. How do these capacities and thresholds contribute to adaptation pathways in glacial guiding?

Using the adaptation framework, coping capacities and thresholds are considered to answer research questions. Adaptive capability is discussed and adaptation in the tourist systems is presented last. Limitations and avenues for further research are suggested.

### 6.2 Analysis of Coping Capacity and Threshold

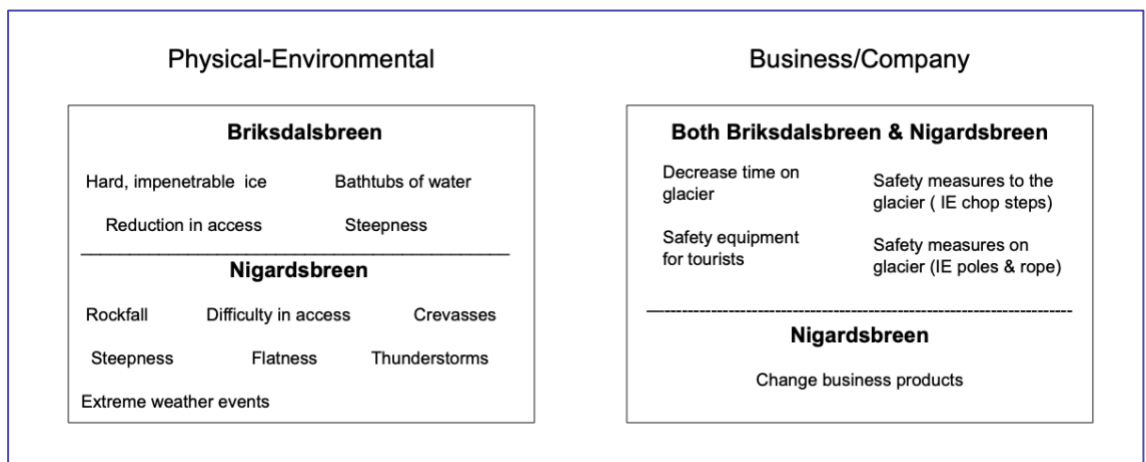
Coping with climate change is then the process where practices can be used and institutions can act when climate change impacts show up (Pelling, 2011). Coping can

be seen as the different ways a system deals with risks without change in underlying rules or creating development into adaptive pathways (Pelling, 2011).

Coping first occurred in the glacial tourism system by adjusting to physical-environmental changes. Weather and glacial change were the two categories of difficulty to contend with. The range of new conditions has been found in previous research (Purdie et al., 2015; Ritter et al., 2012; Salim et al., 2021a; Salim et al., 2021b) (cite). The coping strategy for increasing risk was to increase safety measures, examples are shown in Figure 6-1.

Like managing physical-environmental changes, coping strategies a tourism business were possible until risk was beyond acceptable levels for guiding. When physical-environmental risks were too much to manage in Briksdalsbreen, businesses either had to be terminated, downsized, or expanded into other markets or areas which will be discussed in a larger adaptation perspective. For Nigardsbreen, some of the business products have changed over time and may continue to change.

*Figure 6-1: Summary of coping strategies in Briksdalsbreen & Nigardsbreen*



As was found in Briksdalsbreen, changes due to reduction in access will be a prominent concern in Nigardsbreen, which has also been similarly voiced in other research of main challenges to glacier guiding (Salim et al., 2021a). Surprisingly, managing changes in Nigardsbreen did not necessarily mean that difficulty, risk, and safety concerns were increasing. Interview results revealed that glacial changes in Nigardsbreen have generated a less exciting glacier to guide on. While effects of climate change to weather and to the glacier may be perceived as overall a 'bad' thing, not all changes mean that conditions are dangerous or scary to contend with. However

in discussing coping strategies, is useful to find what tipping points might exist after range of actions has been exhausted (Pelling, 2011).

Coping thresholds can be helpful in understanding what risk, hazard, or vulnerability tipping points may spur adaptations (Pelling, 2011). Briksdalsbreen has shown that one key attribute is steepness, that prevents physical adaptations. Glacial decline is often a slow, unfolding of many processes but in glacial guiding tourism, this represented an event where risk exceeded coping strategies. The other main lesson from Briksdalsbreen, is climate change impacts may come faster and more dramatic than envisioned. Attributes of adaptation are shown to favor extreme events over slow-changing conditions and it is a helpful exercise to review adaptation strategies as thresholds of hazard change (Pelling, 2011).

However, experiences in Briksdalsbreen may not necessarily mirror the cycles of change on Nigardsbreen. A glacier like Briksdalsbreen may be a testament to climate change in the speed, unpredictability of change, but also in unfortunate luck of steep terrain and a much smaller glacial arm that would further exacerbate inability for commercial guiding activities. Nigardsbreen may be an example of the unfolding of processes, in that changes are slower and more manageable and may yield to the same outcome, but with less speed and at a much later date.

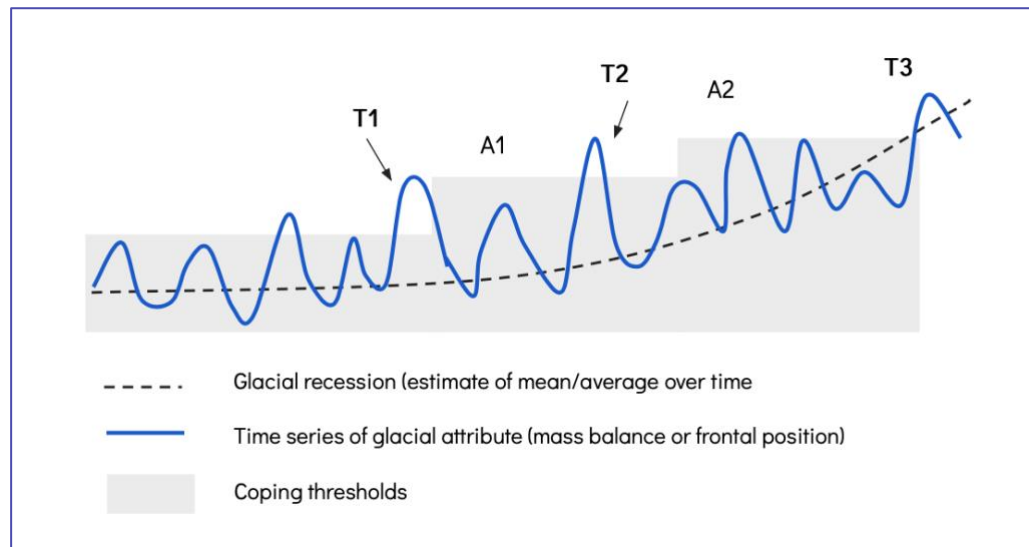
Thresholds are socially constructed and in that a result of many factors, such as information and communication, culture, or how important other risks, hazards, and vulnerabilities are that all compete for attention (Pelling, 2011). In comparing Briksdalsbreen and Nigardsbreen areas, results pointed to ideas of attributes in each area that may ease or exacerbate tipping points. In Briksdalsbreen, the idea that infrastructure, large number of tourists, major point of entry for tourism, ability for businesses to transition or transform could potentially keep tipping points at bay. In Nigardsbreen, there was the opposite idea that the area was more vulnerable. Factors mentioned were limited infrastructure, smaller tourist base, difficulty keeping tourists in the area, and remoteness of location.

In discussing thresholds, it seems Briksdalsbreen has experienced one major tipping point with some hints on what other lie ahead. In other previous research, a reduction in aesthetic quality has been found to be a concern for glacial tourism (Salim



et al., 2021a; Salim et al., 2021b; Wang & Zhou, 2019). The fact that Briksdalsbreen still has an accessible viewpoint for tourists to see the glacier is also a consideration.

Figure 6-2: Threshold diagram based off Füssel (2007) and re-created by Pelling (2011)



In Figure 6-2, it is helpful to understand coping thresholds paired with a hypothetical example in retrospective and future time view. Using Briksdalsbreen as an example, glacial recession increased with suitable coping strategies until 'T1' where the steepness of the glacier crossed an acceptable level of risk. In this case, the notion of risk is assumed to be an invisible, socially constructed boundary grounded in many factors such as guides' knowledge, perception, etc. New management strategies must be employed as a new risk threshold is exposed, The time between the event (T1) and adaptation (A1) reflects new risk thresholds (Pelling, 2011). In the case of Briksdalsbreen, the new adaptation (A1) for tourists to continue the glacier was almost instantaneous, but future events in the future (T2 & T3) may involve more planning and greater time span to implement adaptation. A potential event, such as when the glacier falls out of sight from the current viewpoint, may need extensive planning measures, infrastructure, costs, and time to implement changes (Pelling, 2011). From this conceptualization, Briksdalsbreen has not seen the full spectrum of impact of glacial recession on tourism systems, outside of the glacial guiding tourism system. In Nigardsbreen, many have already been aware of lessons in Briksdalsbreen and other glaciers where steep terrain under a glacier is highly impactful for the future of glacial

tourism. The mapping as a part of Project JOSTICE (Jostice, 2023) will be invaluable to aid in planning for the future of Nigardsbreen's future in glacial tourism.

In planning adaptations, the consideration of tourist supply and demand of viewing glaciers introduces a true challenge. In the scope of maintaining tourism to glaciers in any capacity, the example of Briksdalsbreen implies that with substitution activities, tourism to glaciers is still viable. Tourists often have no frame of reference for how a glacier used to be and it is interpreted that viewing glaciers can still be attractive. The concept of 'last chance tourism' makes it difficult to assess how long that fact will be true. Tourist preferences for seeing glaciers and corresponding visitation counts may be falsely inflated with unusual demand for seeing glaciers before they are gone or reduced in aesthetic quality. In this discussion, trying to predict the future or make conclusions is difficult, as there are many factors that could change preferences which cannot be predicted. Findings in this thesis from several sources imply that for now, interest in glaciers is stable and continuous.

### 6.2.1 Adaptive Capacity

When adaptations are necessary, adaptive capacity is the ability that a unit has to transform how it is structured, organized, and how it functions in order to survive under hazards threatening the unit's existence (Kelly & Adger, 2000). Adaptive capacity can be seen on many levels and in many ways. A small part of adaptive capacity is discussed through social capital, with sense of community and attachment to place through identity as two important factors.

From results, guides were the most connected to the glaciers they guided on, witnessing them change daily, seasonally, and annually which gave a 'front-line' perspective. Many felt the shared experience of being in the guides made for a tight-knit community with open communication, shared experiences, trust, and respect. Some of the challenges in having strong connections and cohesion was the sentiment that factors occurring on much larger scales were out of control, leading to loss of ability to act and have meaning in action. In relating these conclusions to social capital and adaptive capacity, Norris et al. (2008) finds that capacities become adaptive when they are able to counteract a stressor or hazard. Agency is an important factor in adaptive capacity, giving an actor the ability to just be a passive bystander (Brown &

Westaway, 2011). In this way, adaptive capacity could be undermined due to the inability to preserve glaciers.

In attachment to place as social capital, attachment to glaciers was intensified by identity which occurred on many levels: community, cultural, occupational, and personal. Nigardsbreen may have stronger attachments in community identity, which could also intensify other identities. Some research finds examples where the stronger attachment to place, the more likely the community may be to planning, reorganizing, and adapting to changes (Marshall et al., 2013). As was similarly expressed in Nigardsbreen, attachment to place in tourism left many feeling they could be vulnerable, as some research has shown that occupational identity can be stronger than attachment to one's home (Marshall et al., 2013). Occupational identity has seen to both increase a dependence on a natural resource but also that an individual can be more sensitive to changes of that resource (Adger, 2000; Marshall et al., 2013). Marshall et al. (2013) found that levels of adaptive capacity were higher among those who had smaller businesses, high levels of occupational identity, place attachment, formal networks, and strategic approaches. According to these findings, resource users who are more sensitive to change may not necessarily be the most vulnerable because their sensitivity may be offset by their capacity for adaptation (Marshall et al., 2013). Sensitivity to changes was not seen as a barrier in adaptations but was a factor in the psychological side of glacial decline.

In terms of the effects of well-being, experiences in Briksdalsbreen demonstrated the emotional and psychological cost of glacial decline. Considering the cost to well-being should be a regular part of adaptive capacity assessments. A community may have the capacity to adapt, but quality of life and well-being should be considered (Brown & Westaway, 2011). It seems to be similar trend to find that psychological dimensions and social-cognitive processes of adaptation are often undervalued in adaptive capacity assessments (Grothmann & Patt, 2005). Again, tying this back to the definition of adaptive capacity, adaptedness should occur while at least maintaining (or improving) quality of life such as well-being, given changes in environment (Brown & Westaway, 2011).

Overall, there is often the tendency to focus on resources as the central focus on adaptive capacity but two other categories of agency and social structures should not

be dismissed (Brown & Westaway, 2011). While the nature of closeness to glaciers may aid in adaptive capacities, a loss of agency and implications for well-being should be factors to consider in adaptation processes and outcomes.

### **6.3 Adaptation Analysis**

In this section, glacial guiding tourism and tourism systems are discussed. A summary of framework and theoretical material is considered to conclude.

Most glacial guiding companies were able to be resilient in their adaptation strategy and through coping mechanisms. Businesses that specifically focus on glacial guiding suffered the most impacts from glacial decline. Most glacial guiding companies are still in operation and have turned to transitioning by making incremental changes: changing locations to new glaciers is an example. For Nigardsbreen, glacial guiding businesses should expect to be able to be resilient if they are able to engage in transitional or transformative business adaptation approaches as have occurred in Briksdalsbreen.

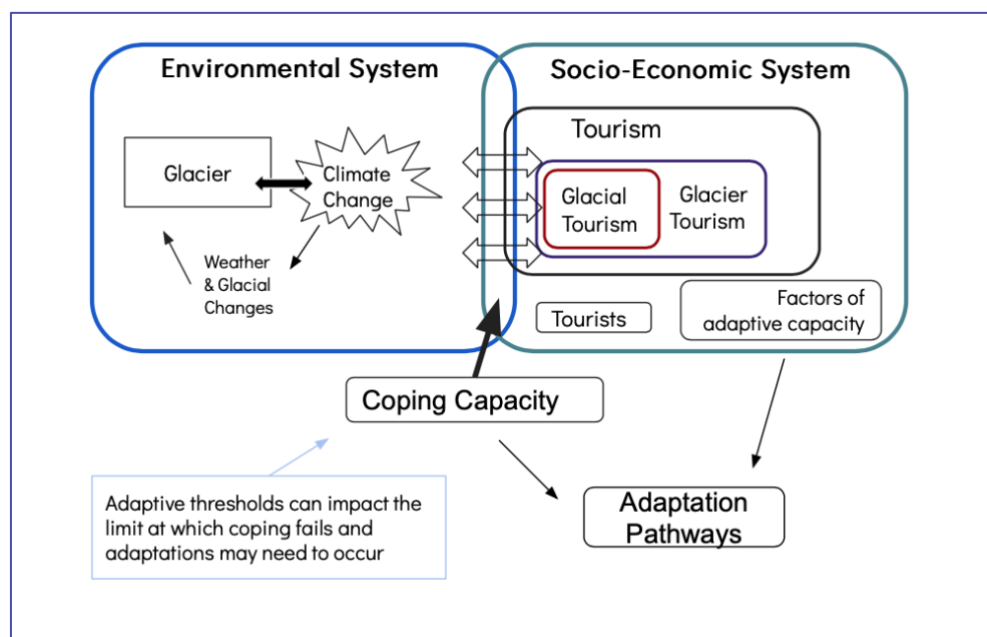
As the goal to maintain tourism, tourism systems in Briksdalsbreen appear to be on a resiliency path in this moment. If the glacier disappears from the viewpoint it is seen at today, there will have to be transitional or more significant transformational adaptations made otherwise this system will see a breaking point where glacial viewing will disrupt the tourism system. When Briksdalsbreen recedes out of view, the threshold for maintaining tourist visitation will be exceeded and transformational adaptations will be necessary. These conclusions can be useful for tourism systems in Nigardsbreen to expand future ideas of planning in adaptations.

One point that must be made is to ask if the tourism system itself is on an adaptive path. In some instances, mitigation has been seen as a form of adaptation where preventing the cause of climate change is an approach to stop climate change effects from happening in the first place and stop the need for future adaptations (Pelling, 2011). Much research is focused on the paradoxical nature of tourism and in this research as well, increasing levels of climate effects will undermine the ability for tourism actors to have time to react, limiting adaptive capacities. Relying on glaciers for tourism is difficult in this way, as the certainties for recession create tension in creating adaptations that will influence them to decline even further: that of tourism itself means visitors will leave their homes and expend fossil fuels at different levels on

their path to witness a dying phenomenon. Glacial guiding tourism and general glacier tourism strongly point to being quite vulnerable, but there is room for that to be mitigated.

For considerations in theory and framework, concepts of coping capacity, adaptive thresholds, adaptive capacities, and adaptation have been applied to these cases. This thesis finds systems theory to be a useful lens to view tourism and its complexities with a simple diagram for glacial tourism (Figure 6-3). Note that factors not discussed such as government, policy, etc. have been excluded as they extend out of the scope of this thesis.

*Figure 6-3: Simple glacial tourism system with coping capacity, adaptive capacity, and adaptation. Inspired from several authors (Birkmann et al., 2013; Dannevig et al., 2023; Scott et al., 2012)*



Coping capacity and adaptive thresholds are limits of coping techniques where when crossed, may fuel adaptation. In this thesis, clear boundaries were placed between ‘coping’ and ‘adaptation’ which is very blurred in much adaptation literature, as it seems these terms are often use interchangeably. Adaptive capacities are necessary to consider, as adaptation should not come at the cost of decline in well-being and psychological health. Adaptation as the result of these factors is an

incredibly complex concept with significant important for future decisions, as are the pathways that may emerge.

## 7 Conclusion

The main lessons from tourism systems in Briksdalsbreen that may be applied in Nigardsbreen offer ideas and notions of what may be next. The first strategy in glacial guiding is to adapt to the physical. It became clear that it was not just that glaciers recede, but an aspect of steepness develops. Steepness is the identifiable coping limit. In addition, businesses cope until capacities fail and the businesses that did not transform were substantially impacted. The lifecycle of glacial tourism may be shifting as glaciers recede, but it seems that tourists are still keen to witness them in a variety of ways. Glacial guiding tourism still has the capacity to transition, but transformation will be necessary in a long-run perspective and may pull operators away from guiding onto glaciers and into different markets of nature-based tourism that include glaciers.

A small subset of adaptive capacity has been explored with a more holistic view rather than measuring differences between communities in Briksdalsbreen and Nigardsbreen. Sense of community and place attachment are two parts of social capital, where emotional and psychological aspects were considered. Understanding the connections that communities, nation-states, and individuals have with the natural environment are critical areas to capture yet may sometimes not receive adequate attention in adaptation considerations. Tensions existed when agency to act is lost, yet identity to glaciers may strengthen connections and offer hope for strength in adaptive capacity. Glaciers could also be viewed as a source of cultural capital, where bonds and attachment may also strengthen the desire to adapt. Adaptive thresholds may be very different from each other, which in turn may affect how fast coping limits are realized. There are many lessons weaved in from findings, but in this exploration, there is more room to expand on mechanisms, capacities, and interactions between glacial guiding systems and networks beyond.

As in much of case study research, there will exist limitations in comparing two different places and making bigger conclusions that extend farther than the places that have been analyzed. Part of this thesis has been to explore what happens in glacial decline and tourism, another part to explore how theory in climate change can be applied, tested, and discussed. It should be noted that examples like that of Marshall et al. (2013) or Brown and Westaway (2011) come from disaster research but some

aspects of glacial decline have similar 'extreme' events and tipping points, as discussed in coping capacities and thresholds. Using theory from Pelling (2011), it was clear that adapting to climate change opens a world of refinement of what adaptation actually means. Given that humans are living in the age of climate change, these definitions matter as adaptation becomes more into real-world scenarios and should be used outside of fancy concepts in academic literature.

Recommendations for future research are to increase interdisciplinary nature of study for glacier tourism research. As Lang et al. (2012) and Salim et al. (2021b) have concluded, studies that combine social and environmental methods of study can help decrease tourism operator's vulnerability and aid in resiliency. Considering psychological and social aspects of climate change may be suitable areas of expansion. With qualitative techniques, the 'invisible' impacts of climate change like emotional components, identity changes, and so forth should not be minimized and perhaps deserve greater attention especially in understanding resiliency and adaptation. In Norway specifically, there is room for expanded theory of place attachment and identity, as this was discovered as a gap during research. Research on different capitals shows room for expansion, especially in a local context. There should be continued research in glacial tourism that extends the reach on what has been discussed in this thesis but also connects the localities that are dealing with the same range of challenges.



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# Appendix

Appendix 1: <Interview Consent and Information Letter>

## **Taking part in the research project: “A Tale of Two Glaciers from the Jostedal Ice Cap: Impacts, challenges, and future outlook for tourism and beyond?”**

Here is information about participation in this research project. In this letter we will give you information about the purpose of the project and what your participation will involve.

### **Purpose of the project**

This is master's thesis as a part of the Sustainability Management Master at University of South-Eastern Norway.

The main purpose of this master's thesis is to quantify and qualify societal impacts of glacial retreat by comparing two glacial outlets of the Jostedal Ice Cap.

### **Who is responsible for the research project?**

The University of South-Eastern Norway is the institution responsible for the project.

### **Why are you being asked to participate?**

You have been identified as working with or on either Briksdalsbreen or Nigardsbreen glaciers. Since there are few companies and/or guides, we are hoping you will be able to participate in this project! There are 3 businesses selected for interviews for Briksdalsbreen and also 3 for Nigardsbreen.

Your contact information has been provided from research on the companies operating in this area. This master thesis is written in collaboration with Vestlandforskning, who runs the Project JOSTICE.

### **What does participation involve for you?**

Methods are in-person interviews with each individual subject. If you choose to take part in this project, this will involve that you participate in an interview lasting for about 1 hour. Information on your past workplace, job position, length of position will be asked. Other information like observations, perspective, feelings, and personal accounts in past, present, and future will be a part of the interview. The interview will be recorded electronically with sound recording and securely stored. It is possible to use a video recording in addition to sound, although this is not required. You will have notification of deletion of interview. Interviews will be transcribed and used for thematic interpretation for data for the purpose of the master thesis.

For businesses, information will also be collected on proff.no and ssb.no on a yearly and monthly basis.

### **Participation is voluntary**

Participation in the project is voluntary. If you chose to participate, you can withdraw



your consent at any time without giving a reason. All information about you will then be made anonymous. There will be no negative consequences for you if you chose not to participate or later decide to withdraw.

### **Your personal privacy – how we will store and use your personal data**

We will only use your personal data for the purpose(s) specified in this information letter. We will process your personal data confidentially and in accordance with data protection legislation (the General Data Protection Regulation and Personal Data Act).

- *Myself, Julianna Burrill, in addition to the University of South-Eastern Norway is responsible for the project. Endre Før Gjermundsen is the project supervisor.*
- *Revealing information such as names and contact details will be replaced with codes. Business or companies described will be transcribed as “Company 1” etc.*
- *The list of names, contact details and respective codes will be stored separately from the rest of the collected data, and data will be stored on a research server, which is locked and encrypted.*
- *No persons from other institutions will be given access to any personal data.*
- *Occupation and working age range will be published in data but should not expose the participant.*

### **What will happen to your personal data at the end of the research project?**

The project is scheduled to end June 16th. Stored personal data and digital recordings will continue to be securely stored at the end of the project until deletion one year later. If data is needed for other projects, participants will be notified if they give consent or not.

If the collected data will be anonymised at the end of the project but continuation of storage allows for data to be utilized for follow-up studies or archiving for future research opportunities related to this master thesis. The project leader and supervisor will have access to data.

### **Your rights**

So long as you can be identified in the collected data, you have the right to:  
access the personal data that is being processed about you  
request that your personal data is deleted  
request that incorrect personal data about you is corrected/rectified  
receive a copy of your personal data (data portability), and  
send a complaint to the Data Protection Officer or The Norwegian Data Protection Authority regarding the processing of your personal data

### **What gives us the right to process your personal data?**

We will process your personal data based on your consent.

Based on an agreement with the University of South-Eastern Norway, Data Protection Services has assessed that the processing of personal data in this project is in accordance with data protection legislation.

### Where can I find out more?

If you have questions about the project, or want to exercise your rights, contact:

- University of South-Eastern Norway via Paal Are Solberg.
- Project Supervisor is Endre Før Gjermundsen. Collaborator at Vestlandforskning is Halvor Dannevig.
- USN Data Protection Officer: Paal Are Solberg can be reached at [personvernombud@usn.no](mailto:personvernombud@usn.no) at the University of South-Eastern Norway.
- Data Protection Services, by email: ([personverntjenester@sikt.no](mailto:personverntjenester@sikt.no)) or by telephone: +47 53 21 15 00.

Yours sincerely,  
Julianna Burrill  
Project Leader

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Consent form

I have received and understood information about the project *A Tale of Two Glaciers from the Jostedal Ice Cap: Impacts, challenges, and future outlook for tourism and beyond* and have been given the opportunity to ask questions. I give consent: to participate in an in-person interview for my personal data to be stored after the end of the project for a one-year term, approx. June 2024

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(Signed by participant, date)

## **Appendix 2: <Interview Guide>**

This guide is an outline of interview questions. Interviews were performed in a semi-structured/semi-standardized manner so this does not entail the entire set of questions asked to participants.

### **Briksdalsbreen**

#### Basic Introductory Questions

1. Introductory questions: occupation, where you're from?
2. Could you describe your job or jobs in relation to guiding on the glacier?
3. For how long have you had that position(s)?
4. Can you describe the history of [x company]? What changes has the company gone through?
5. Company was closed in 2021? Or is it still running? What happened to revenue prior to 2013?
6. When did you start noticing changes in the glacier? Can you describe what changes you saw?
7. What are some of the changes you had to make to the/your business? If you can walk through the time period and changes that were made.
8. How drastic were these changes?
9. What were some of the tourist reactions to changes? Did you feel over time that tourists noticed and had adverse experiences? Better experiences, perhaps educationally?
10. Do you feel guiding was becoming riskier over the years?
11. What were the natural risks and how did you manage them? Human risks?
12. Do you feel you had any tools or advice to understand what changes in the glacier were coming? If so, did you feel you knew what to do with the tools and advice?
13. What information did you feel was missing and from who? [scientific community, government, kommune]
14. Is there something you wish you had to better prepare for potential changes ahead to the glacier and your business?
15. What are some of the main learnings or ideas you have thought about with the drastic recession of Briksdalsbreen? [it's sad, it doesn't matter, it's provided educational opportunities, etc.]
16. How do you feel the businesses in the area reacted? Were there any major changes that had lasting societal effects on the area after guiding was reduced?
17. What does this glacier mean to you? What does it mean to you seeing the changes in Briksdalsbreen?

### **Nigardsbreen**

1. Introductory questions: age, occupation, where you're from?
2. Could you describe your job or jobs in relation to guiding on the glacier?
3. For how long have you had that position(s)?
4. When did you start noticing changes in the glacier? [Can you describe what changes you saw?]

5. Have you had to make changes to your business due to glacial decline? If you can walk through the time period and changes that were made.
6. Are tourists notice glacial decline?
7. What kinds of things are they saying or asking questions about?
8. How does it impact their experience?
9. Is there a difference in attitudes in tourists?
10. Do you feel guiding is riskier now?
11. What new risks have you/do you notice and how do you manage them?
12. Do you feel you have any tools or advice to understand what changes in the glacier were coming? If so, do you feel you know what to do with the tools and guidance?
13. What information do you feel was missing and from who? [scientific community, government, kommune]
14. Is there something you wish you had to better prepare for potential changes ahead to the glacier and your business?
15. What is the worst case scenario with glacial recession?
16. What are some of the positive aspects of glacial recession?
17. How do you feel about other businesses in the area? Are they noticing changes?
18. How would you feel about the nature of your job changing?
19. Are you excited for changing possibilities IE less guiding?
20. What future areas could you see guiding replacing?
21. What does this glacier mean to you?