



Participatory scenario planning under scenarios of climate change and tourism growth in Southeast Iceland

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1. Introduction

It is well known that peripheral livelihoods and land-use depend heavily on natural resources, however, their management is often contested by diverse stakeholder interests and therefore hampered by the emergence of multiple natural and social drivers of change. The challenge of reconciling various land-use modes is how to acknowledge, combine and make use of local, scientific and other expert knowledge, and how to handpick relevant knowledge in decision making (BuSK, 2017).

This report presents an Icelandic case study that is a part of the NPA-BuSK (Building Shared Knowledge capital to support natural resource governance in the Northern periphery) project, focusing on its first objective, i.e. to develop the collection of local knowledge in land-use planning – especially by using participatory GIS (BuSk, 2017). The case study belongs to WP2 in BuSK which focusses on the relationships between state agencies and local communities, and examines the potential difficulties of collaboration in land-use management decision making.

This Icelandic case concentrates on the planning of recreation of glacier sites in Iceland. Hence, it attempts to develop a GIS grounded participatory approach to support the planning of nature based recreational sites, and to test the approach in a glacier site in southeast Iceland called Þróng, which is a part of the Breiðamerkurjökull glacier in southeast Iceland. The information collected in this case study through participatory action research (PAR) and PGIS resource will give planners/policymakers valuable insight in to the knowledge of local communities and the traditional management practices. that may already be in practice.

This report is divided into five chapters. After this introduction, a brief problem description of glacier sites in Iceland is outlined. In the third chapter, the methodology as well as the case-study area are outlined and presented. Chapter four summarizes the findings of this case study, followed by discussion on the approach developed, the results and methodology used, as well as by drawing out recommendations regarding participatory land-use planning and a final conclusion.

2. Problem description

Iceland has 266 named glaciers which in total cover roughly 10% of its terrestrial surface (Sigurðsson and Williams, 2008). Only a couple of these glaciers are, however, exploited for recreation purposes on a frequent scale (Fig. 1). Recreation glacier sites are mostly situated where there is direct access to Iceland's main road (the Ring road which circles the country) and/or are located in the direct vicinity to other tourist attractions. For this project we define these glacier sites as natural recreational areas which glacial features, processes and morphology constitute the main attraction of visitation.



Figure 1: Map of main glacier tourism sites in Iceland (adapted from Welling and Áráson, 2016).

The Vatnajökull icecap, the largest icecap in Europe by volume, has an area of ca. 7800 km² (Björnsson, 2017) and contains several popular glacier sites which are all situated on different outlet glaciers on the southeast part of the icecap. These outlet glaciers flow towards the southeast coast, where most of them are easily accessible. The southeast part of the Vatnajökull icecap is marketed by the regional tourism sector as the *Vatnajökull region* (www.is.visitvatnajokull.is). In this report we will use the name Vatnajökull region to indicate the general area in which our case-study is situated. Table 1 shows the number of visitations to some popular glacier sites within the Vatnajökull region.

Table 1. Visitation numbers of popular glacier sites in the Vatnajökull region (data obtained from Þórhallsdóttir et al., 2017).

Glacier tourist sites	Visitor no. (2016)
Jökullsárlón	620.480
Skaftafellsjökull	80.039
Svínafellsjökull	148.717
Heinabergsjökull	10.400

The number of visitors to these sites are not equally distributed. For example, the glacier site Jökulsárlón, a scenic pro-glacial lake, is one of the most visited tourist attractions in Iceland with over 620.000 visitors in 2016, while a few kilometers to the east a less iconic and accessible glacier site can be found that did not have more than 10.500 (Heinabergsjökull) in 2016 (Þórhallsdóttir et al., 2017). Welling et al. (2018) show that glacier sightseeing is the most popular glacier site activity during both winter and summer. However, in the summer season guided glacier walks and glacier boat tour are equally popular and glacier cave or ice cave tours in the winter season (table 2). Welling et al. (2018) show that glacier sightseeing is the most popular glacier site activity during both winter and summer. However, in the summer season guided glacier walks and glacier boat tour are equally popular and glacier cave or ice cave tours in the winter season (table 2).

Table 2: Percentage of visitors of the Vatnajökull region that conducted different recreational activities at a glacier site.

Activities conducted at glacier sites			
Summer 2016 (N=435)		Winter 2016-2017 (N=139)	
Glacier sightseeing	76%	Glacier sightseeing	68%
Guided walk	38%	Ice cave tour	45%
Glacier Lake Boat tour	20%	Guided walk	29%
Hiking	18%	Hiking	9%
Ice Climbing	7%	Super jeep tour	11%

2.1 Glacier sites attributes and their planning and management

The planning and management of glacier sites is a difficult and challenging task due to the interplay of several particular characteristics of these sites. Glacier sites in the Vatnajökull region are extremely dynamic and can be highly dangerous due to risk of mass movements and constantly changing glacial rivers and river beds. During the last decade they have however become increasingly popular among tourists and subsequently also more contested by local stakeholders. We will give a short description of these specific attributes of glacier sites in southeast Iceland below.

2.1.1 Increased popularity of glacier sites

Since 2011 Iceland has faced an exceptional strong growth of inbound tourism. The foreign visitor numbers have increased by 217% in only half of a decade, from 565.611 visitors in 2011 to 1.792.201 visitors in 2016 (ITB, 2017). This fast growth of numbers of visitors to Iceland is reflected by an increase of glacier site visitation in the Vatnajökull region. Table 3 reveals the rapid increase of visitation at selected glacier sites in the Vatnajökull region over the last three years. Although some sites have a faster visitor growth rate than others, all sites have experienced an increase above 30% in the last three years.

Table 3: Increase in visitor numbers of different glacier sites in the Vatnajökull region (data obtained from Þórhallsdóttir et al., 2017).

Glacier site	Period of measurement	Increase between 2014-2016
Skaftafellsjökull	Summer	30,5%
Jökulsárlón	Summer	40,4%
Svínafellsjökull	Summer	61,2%
Heinabergsjökull	Summer	68,8%
Fjallsárlón	Autumn	152,4%

2.1.2 The dynamic environment of glacier sites

In Iceland glacier sites are extremely dynamic and therefore their environment is highly uncertain and unpredictable. In general glaciers are constantly moving due to the combination of a snow accumulation and ablation process and gravity. Icelandic glaciers are so-called warm based glaciers, characterized by ice that is close to its pressure melting point so that water is constantly dripping through the icemass resulting in huge and often violent glacier rivers as well as increased movement of the whole icemass (Sugden & John, 1976). More importantly, since the 1990s all Icelandic glacier are shrinking at an accelerated pace due to changes of the regional climate (Hannesdóttir et al., 2010). The southeast glaciers of Vatnajökull are located in the warmest and wettest area in Iceland and therefore respond quickly to changes in temperature and precipitation. Since the year 2000, the southeast outlet glaciers of the Vatnajökull have retreated very rapidly, and their mass loss per unit area is among the highest in the world (Hannesdóttir and Baldursson, 2017). Some of the Vatnajökull's outlet glaciers recede 150 meter per year on average (Björnsson et al., 2017). It has been estimated that the annual mean temperature in Iceland is likely to increase by ca. 2°C during the 21st century, and that the temperature will therefore continue to increase during the next century (Hannesdóttir and Baldursson, 2017). Recent glacier models indicate that Vatnajökull could lose ca. 25% of its current volume within the next fifty years (Björnsson, 2017).

A direct consequence of glacier retreat is the increase of pro-glacial areas, such as glacial moraines and lakes which totally alter the landscape of these sites. Some glacial lagoons have in recent years formed in front of many outlet glaciers of the Vatnajökull region these illustrate the development of such lagoons, from small pools initially that then merge into an elongated lake between the glacier moraine and the glacier terminus (Hannesdóttir and Baldursson, 2017). In addition, glacier rivers constantly change their course due to the glacier dynamic or processes such as jökulhlaups, abrupt sub glacial lake outburst floods, which can alter the accessibility of a glacier sites enormously.

2.1.3 The complexity of glacier sites

Glacier sites are very sensitive, especially recently de-glaciated areas that are very sensitive to erosion and therefore need conservation to prevent for example pertinent marks that vehicles often leave behind, or visitors by means of trampling. Therefore, the use of glacier sites is often contested concerning the acceptability of different forms of land-uses of these often pristine landscapes. There exist opposite opinions between nature conservationist and nature based tourism entrepreneurs regarding the amount and type of tourism activities at the glacier sites, but also between different types of tourism such as the motorized and non-motorized tour activities (Benediktsson and Þorvarðardóttir, 2005)

Furthermore, glacier sites, and especially the glaciers themselves, are high risk areas and therefore dangerous to access without proper gear and professional guidance. Several lethal accidents have happened at glacier sites in Iceland due to visitors' lack of experience or careless behavior. In addition, as the outlet glaciers are rapidly retreating due to climate change, the mountain slopes become unstable and landslides and rock avalanches are triggered, which increases risk of hazards for visitors (e.g. Kaab et al., 2005; Ritter et al., 2012, Purdie, 2013).

2.2 Current governance

About 15% of the total number of glaciers in Iceland larger than 0,1 km are part of a protected area (UST, 2017). However, because the large Vatnajökull icecap is one of these protected glaciers, approximately 82% of the total glacial terrestrial surface of Iceland has a protected status (UST, 2017) (fig. 2). The majority of the recreation glacier sites in Iceland are part of two national parks: Vatnajökull national park and Snæfellsjökull national park, which are managed in accordance with the IUCN regulation category II (IUCN, 2017). The main goals of these national parks are to combine the protection of natural bio-/geodiversity and landscapes along with their underlying ecological structure and supporting environmental processes, with the promotion of recreation, education and rural development. This means that there exists a legal mandate for the planning and management of most of the popular glacier sites in Iceland and therefore the national park authorities carry responsibility for the planning and management process.

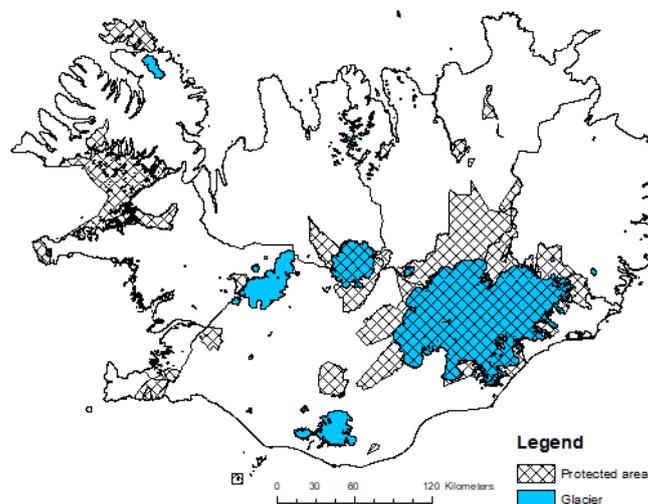


Figure 2: Icelandic glaciers and protected areas (data derived from UST, 2017).

Despite the fact that glacier sites are highly dynamic, hazardous, characterized with fragile ecosystem and have become very popular as tourist destinations, none of the glacier sites in Iceland have a specific visitor planning or management strategy. During this case-study project the VNP was extended This case study aims to develop an approach that supports recreational land-use planning and management of glacier sites in Iceland.

2.3 Goals

Aim of the project is to develop a GIS grounded participatory approach to support the planning of nature based recreational sites, and to test the approach in a case-study, a glacier site in southeast Iceland.

This approach has to be able to:

- a) incorporate a glacier site's highly dynamic characteristics,
- b) address different stakeholders' perceptions,
- c) integrate multiple drivers of land-use change simultaneously, and
- d) address multiple **future** recreational land use implications.

3 Methodology

3.1 General approach

There are several types of scenario planning methods which can be categorized according to the scenario analysis' goals (from exploration to pure decision support), process design (from intuitive to formal), and scenario content (between complex and simple scenarios) (Godet and Roubelat, 1996; Van Asselt, et al., 2001; van Notten et al., 2003). We choose to apply participatory exploratory scenario development as our main tool. This is a suitable method to explore potential futures and their social and environmental consequences or implications, as well as potential solutions to these socio-ecological implications. By using scenarios which are not exact forecasts but an image of a plausible future, we can address uncertainty in the planning process. Furthermore, the scenarios were developed by researchers and through local stakeholder participation, so the approach offers a chance to give insight into and discuss stakeholders' different perceptions and interests. In addition, we attempt to create tailor-made scenarios that build on the stakeholders' own concerns, which according to Carlsen et al. (2013) make the scenarios relevant to the end-users and increase the likelihood of scenarios actually being used.

Furthermore, we applied Participatory GIS (PGIS) to collect, edit and disseminate spatial data. PGIS combines the general approaches of participatory learning and action with geographic information technology and systems (Rambaldi, 2005). This results in multiple ways to apply PGIS without a strict protocol. For this research, we applied the general approach outlined by Forrester and Cinderby (2011) that entails the practice of gathering data using traditional methods, such as local stakeholder workshops and focus groups, supported with paper maps to allow these stakeholders to record spatial details. This information was then digitized to be analyzed and interrogated using the power of GIS software, and following this the outputs were then communicated using computer-drawn map outputs (Forrester and Cinderby, 2011).

3.2 Research framework

To analyze our data in the scenario development process, we adopted a cause and response framework known as *Drivers-Pressures-State-Impact-Response* (DPSIR) framework (EEA 1999). This framework emerged in the early 1990s as a general framework for organizing information about the state of the environment assuming cause-effect relationships between interacting components of social, economic and environmental systems (EEA 1995), but gradually was applied in other research fields. One strength of the DPSIR framework is that it includes societal (human) and ecological (biophysical) subsystems in mutual interaction, considering the study unit as a social-ecological system (Rounsefell et al., 2009). In this case study we used the DPSIR framework as a blueprint for carrying out different sequential steps in the scenario development process (fig. 3). Each component of DPSIR was identified and analyzed in the context of the case study and constitutes a cause and effect relation with the subsequent component.

In the framework used, the *drivers* are the underlying causes of socio-economic and environmental change that are exogenous to the study area in question (e.g. climate change, global economic crisis) that will influence recreational land-use in the near future. *Pressures* constitute the endogenous variables that quantify the effects of drivers within the study area (e.g. precipitation levels, visitor numbers). The *state* variables are in this case the future recreational land-uses within the study area. The *impacts* form the negative or positive effects of future recreation change (state variables), which in this study are presented as threats and opportunities. Finally, the *responses* are strategic measures

that aim to minimize the threats or maximize the opportunities through planning and management intended to cause changes in the drivers, pressures and state variables.

All of the concepts of the framework were identified and defined by the stakeholders.

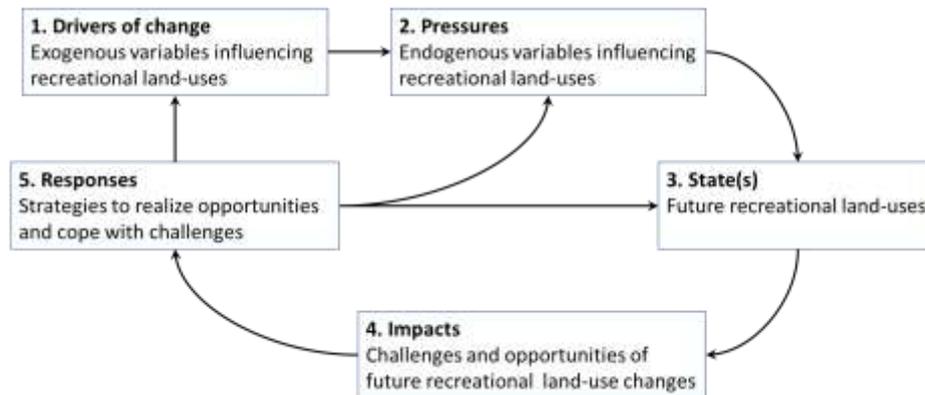


Figure 3: DPSIRS framework used in the case study for recreational land-use.

3.3 Study area

The case study area is called Þröng, and is an approximately 16,5 km² glacier site that is part of the Breiðamerkursandur area in southeast Iceland (fig. 4). The recently de-glaciated part Þröng is part of the VNP since the park's establishment in 2008 and has a IUCN II status. The rest of the Þröng site is only recently (2017) added to VNP and is still missing an IUCN classification because the management plan of this area remains to be developed. The Þröng site has no visitor infrastructure or facilities and can only be accessed by an un-marked and un-maintained track that can only be used by 4-wheel drive vehicles. Current recreation activities during the summer season are guided glacier hikes and in the winter season glacier cave tours. Non-guided visitors are almost absent at the Þröng site.

We chose the Þröng site because it is still a relatively un-exploited area but has the potential to attract more visitors due to its natural characteristics and vicinity of the popular glacier lagoon destination, Jökulsárlón, which is the one of the most visited destination in Iceland (ITB, 2017)

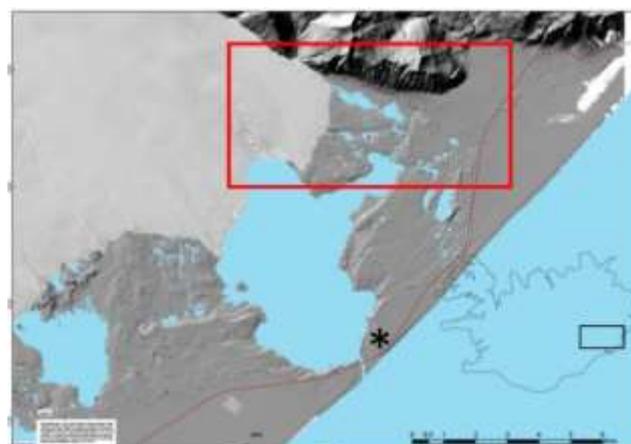


Figure 4: The location of the case study area: the Þröng site (marked by the red rectangle), * = parking of Jökulsárlón

We chose a period of 10 years to explore future scenarios (2016 – 2026). This time span concerns a foreseeable future that entrepreneurs and tourism planning and management actors ideally want to know in relation to changes in accessibility of glaciers and risk regimes. Moreover, regular management plans regarding recreation destinations typically cover a period of no longer than 10 years.

As regards future recreational planning and management of the Þröng site, the retreat of Breiðamerkurjökull is an important development that effects different land-uses and land-covers of the site. A recent study by Guðmundsson, Björnsson and Pálsson (2017) shows that Breiðamerkurjökull lost a glacier area of 33 km² between 1890-1945 (0,6 km² per yr, on average) and 81 km² between 1946-2010 (1,24 km² per yr) (fig. 5).

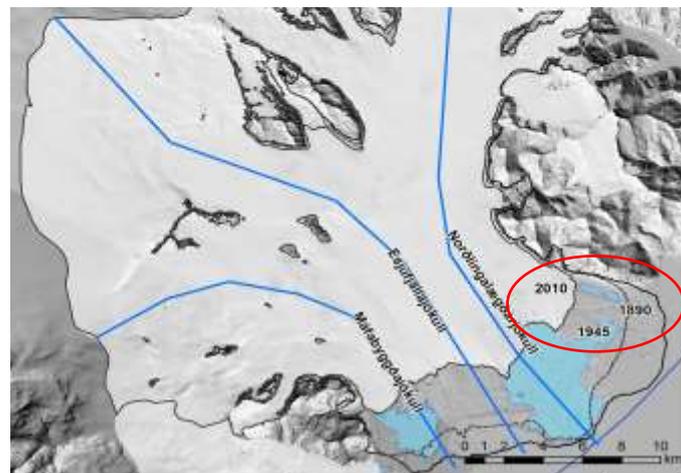


Figure 5: Retreat of Breiðamerkurjökull between 1890-2010 (Guðmundsson et al., 2017). The Þröng site is located within the red oval.

During the last 10 years (2010 -2016) the retreat of the eastern part of Breiðamerkurjökull, the Þröng site, has even accelerated in pace. The margin of the glacier there is thus receding approximately 100 – 150 meters per year (fig. 6).

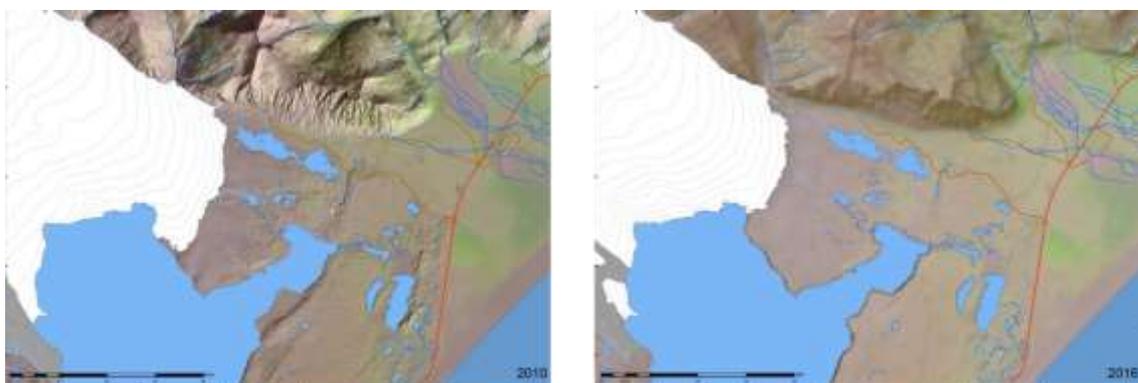


Figure 6: The glacier margin of the Þröng site in 2010 (left) and 2016 (right). (Maps Snævarr Guðmundsson).

3.4 Data source: local stakeholders

The key data source of this case study was a local stakeholder group. Therefore, an important step in our project was to compose a representative and functional stakeholder group for our case study area. We connected our research approach to an existing local stakeholders network, a closed Facebook group named 'learning in recreational tourism' that was launched in the beginning of 2016 by the Head Master of the local secondary school in Höfn to reach out to local tourism entrepreneurs, with the aim of providing tailor made education in an unconventional way. This Facebook group is a closed group whose members include local tourism entrepreneurs (including all the tour operators that provide tours at Þróng), scientists, local authorities, and local NGOs. This network assisted in identifying key stakeholder groups and participants, but also helped to establish trust and mutual recognition among the participants. This was considered to be an important aspect in order to increase participants' willingness to share information and speak freely during the workshops. We established a stakeholder group which participated in all workshops during the whole project. Table 5 presents composition of the stakeholder group. Not all the stakeholders participated in all three of the workshops. Every workshop consisted of 8-10 participants that represented the main stakeholder groups. Furthermore, all stakeholders are residents in the Vatnajökull region except the tourism experts.

Table 5: The local stakeholder group

Stakeholder group	Specific	Number
Entrepreneurs	Local glacier tour operators	5
National Park	Park managers and staff of VNP	3
Municipality	Officials from planning and tourism development department	3
NGO	Nature conservation organization	1
DMO	Regional tourism promotion	1
Experts (scientists)	Expert field: glaciology, geography and tourism	2

3.5 Data collection

The main data collection was by means of stakeholder workshops. A total of three workshops were held in Höfn with members of the stakeholder group, the first one in November 2016, the second in June 2017 and the last one in October 2017. In every workshop different nominal group techniques (Delbecq et al., 1975) were conducted to obtain the necessary data, such as brainstorming, problem identification, group discussion and solution generation.

3.6 Scenario development and application process

Our scenario planning approach provide an easily accessible and repeatable procedure with the involvement of local stakeholders and aims at local planning and decision-makers as its main users. The development of the scenario planning approach was based on research presented by Carlsen et al. (2013), who developed a tailor-made scenario planning tool based on local stakeholder

participation, and by Malek and Boerboom (2015), who combined qualitative methods such as cognitive mapping with geospatial methods in the scenario planning process. Our approach can be divided into seven sequential stages which coincide with the different part of the DPSIR Framework (fig. 7):

1. A review of the current challenges and opportunities regarding recreation at the study area and its direct vicinity. This review is conducted by means of a stakeholder workshop in which the different stakeholders are ask to address the most important current issues with regard to recreation in the study area.
2. Creation of a cognitive map of the recreation in study area. A cognitive map is a mental representation that is created to represent and communicate human cognition for both geographical and non-geographical information (Goodier and Soetanto, 2013). To develop a cognitive map of the recreation of the study, a soft system methodology technique is applied to support the stakeholders to describe and map the main elements of a conceptual socio-ecological system such as drivers, actors, resources and services (Jetter and Kok, 2014). First, the local stakeholders identify the key drivers of change of the recreational land-uses of the study area and then, based on these drivers, they develop a cognitive map of the rest of recreation system of the study area.
3. Assessment of future states of drivers of change and pressures. During a stakeholder workshop, participants are asked to assigned plausible future states to the different drivers of change. The plausible future states can range from a strong decrease of the drivers' future development to a strong increase. Subsequently, on basis of these potential future states of the different drivers of change, together with the cognitive system map, the future states of local pressures are assessed. On basis 'scenario logic' (Rounsevell and Metzger, 2010), challenging combinations of future states of pressures are put together to construct significantly different plausible future scenarios by using a scenario matrix (table 6).

Table 6 Scenario matrix with key drivers, pressures, and their future states (adapted from Carlsen et al., 2013). The blue cells represent a scenario. In this table, many combinations could constitute multiple scenarios, however, the set of possible scenarios is limited due to many implausible combinations.

Driver A		Driver B		Driver C	
Pressure 1	Pressure 2	Pressure 3	Pressure 4	Pressure 5	Pressure 6
State 1a	State 2a	State 3a	State 4a	State 5a	State 6a
State 1b	State 2b	State 3b	State 4b	State 5b	State 6b
State 1c	State 2c	State 3c		State 5c	

The potential future state of glacier land cover of the study site was assessed by means of a recently developed glacial land-cover model based on glacier modelling technique (Guðmundsson, Björnsson and Pálsson, 2017) which estimates future glacier volume by comparing digital elevation models (DEMs) of the glacier surfaces from previous years (using LiDAR data) and then extrapolates the land-cover changes in to the future (2026).

4. Creation of future land-use/land cover scenarios. This stage consists of two consequential steps. First, the scenario constructs are translated into story-lines, one page simple descriptions of the different future state of pressures and corresponding recreation land-use of the particular scenario, with a few illustrations that represent the story-lines. Second, spatial attributes of the scenarios (e.g., amount and type of visitor facilities, protection status of the site) together with the results of the glacier land cover modelling are processed by means of a GIS software (ArcGIS® 10.4) into land-use and land cover maps that consist of a set of accumulated (overlaid) land-use and land cover feature

layers. Land cover is determined by direct observation of the earth’s surface such as glaciers, lakes and infrastructure, while land-use is a socio-economic interpretation of the activities that take place on that surface, such recreation and nature protection (Fisher et al, 2005).

5. Identifying future opportunities and threats. In fifth stage of our approach, the scenario story-lines and maps are discussed with the local stakeholder group in a workshop. After the discussion, the stakeholders are asked, per addressed scenario, to identify the most important recreation opportunities and threats.

6. Identifying and selecting adaptation measures. In this stage, the local stakeholder group establish to a set of adaption option or measures to deal with the main threats and opportunities identified in the previous stage by means of a workshop.

7. Assessing the capacity to adapt to the future opportunities and threats. The last stage of the scenario planning approach the current capacity of the management of the study area to adapt to future threats and opportunities is assessed.

Fig. 7 show a total overview of the different stages of the scenario planning approach with the corresponding phases of the DPSIR framework and the main data collection methods. From the seven stages of the approach six were conducted in one of the three stakeholder workshops. The identification of the drivers and pressures contains the first three stages of the approach which are all conducted in the first workshop. The analysis of future states of recreation in the study comprises the fourth stage of the approach which is conducted by means of desk research and a field survey of the study area. The impacts analysis is conducted in stage five of the approach by means of a second stakeholder workshop. The response analysis includes the stage six and seven of the approach which both take place in the third local stakeholder workshop.

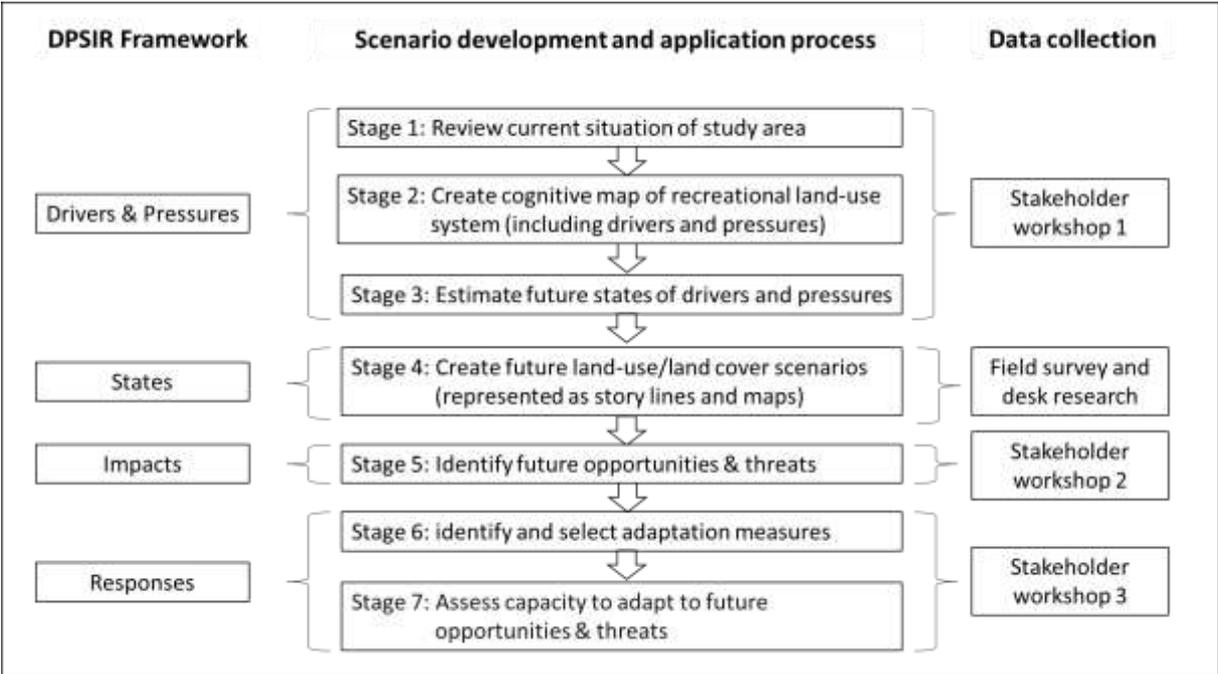


Figure 7: Overview of scenario development process

4. Results

4.1 Current situation of study area (stage 1)

In the first stage of our approach, the stakeholders were asked to list a set of current issues in form of challenges and opportunities and then subsequently pinpoint their issues on a A0-size map of the area where they consider these issues take place (fig. 8).

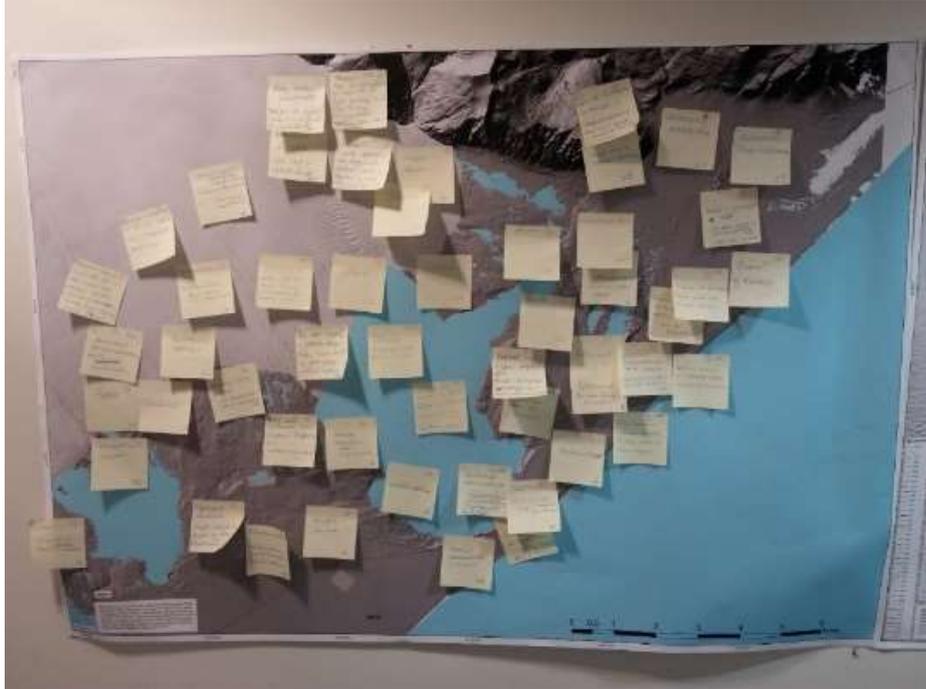


Figure 8: Spatial distribution of stakeholders' identified issues related to the current situation in study area and its vicinity

The stakeholders identified and addressed more 35 opportunities and 33 challenges (33) regarding the current recreational land-use in Pröng (table 6) and its direct vicinity (table 7). Several issues were identified as both challenges and opportunities (tour operation development; destination management/planning; nature conservation). Destination management/planning issues (29) were the most identified issues, followed by tour operation development (19) and nature conservation (8). A complete list of all addressed issues during the first workshop can be found in annex I of this report.

Table 6: Identified current issues concerning the Pröng site

Description topic	Type	Frequency
Destination management/planning	Challenge	2
Education	Opportunity	1
Nature conservation	Challenge	1
Tour operation development	Challenge	1
Tour operation development	Opportunity	4

4.2 Cognitive map of recreational land-use system (stage 2)

In the second stage of the scenario planning approach, the stakeholders were asked to create a cognitive map of the recreational land-use system of the study area during the second part of the first workshop.

Table 7: Identified current issues concerning the vicinity of the study area

Description	Type	Freq.
Communication of area opportunities	Opportunity	3
Cooperation stakeholders	Opportunity	3
Destination management/planning (Facilities)	Opportunity	2
Destination management/planning (Impacts)	Challenge	12
Destination management/planning (Lack of)	Challenge	8
Destination management/planning (Safety)	Challenge	5
Education	Opportunity	1
Nature conservation	Opportunity	6
Nature conservation	Challenge	2
Research	Opportunity	2
Rural development	Opportunity	1
Tour operation development	Opportunity	12
Tour operation development	Challenge	2

First, the participants were asked to identify the main drivers of change (external variables of the research area) in the Bröng site for the study period. A set of four main drivers were identified: i) Tourism development, ii) land-use management policies, iii) social media, and iv) climate change. Then, the participants were asked to write down, per driver of change, a list of local elements (e.g. actors, activities, natural features, processes, etc.) that they consider important and to be influenced by the drivers of change. A single element or factor was allowed to be grouped under different drivers of change. Every participant wrote down the different factors per driver of change on a post-it and then stuck this on a poster paper where the drivers of change were already written down. In this way, the different factors and entities identified by the stakeholder group made up the cognitive system map of the research area. Then, the participants discussed and determined the connections between the factors/entities (relationships or edges) and directions of those connections (positive or negative influences) which were put up on a poster paper (fig. 9)

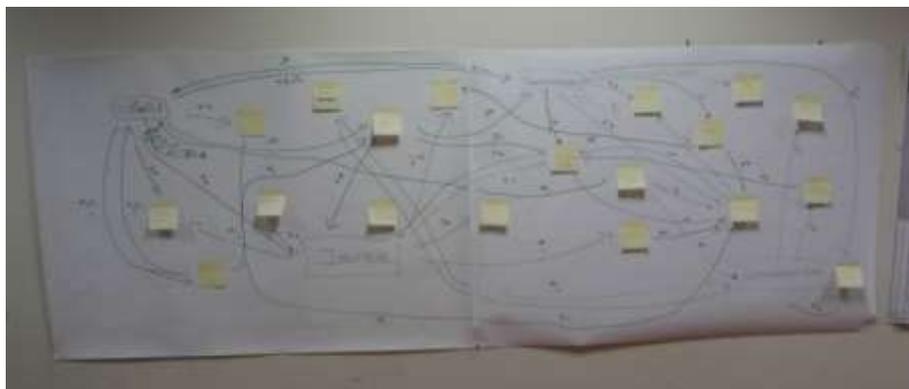


Figure 9: cognitive map of the Bröng site

After the workshop, the results were imported into the software program Vensim to create a clearer representation of the cognitive system of Þróng site (fig. 10). Slight alterations of the original set of drivers of change were made regarding wording and merge social media (original driver of change) with area media coverage (original pressure) in order to reduce ambiguities and improve clarity. On basis of this map, the different pressures were identified.

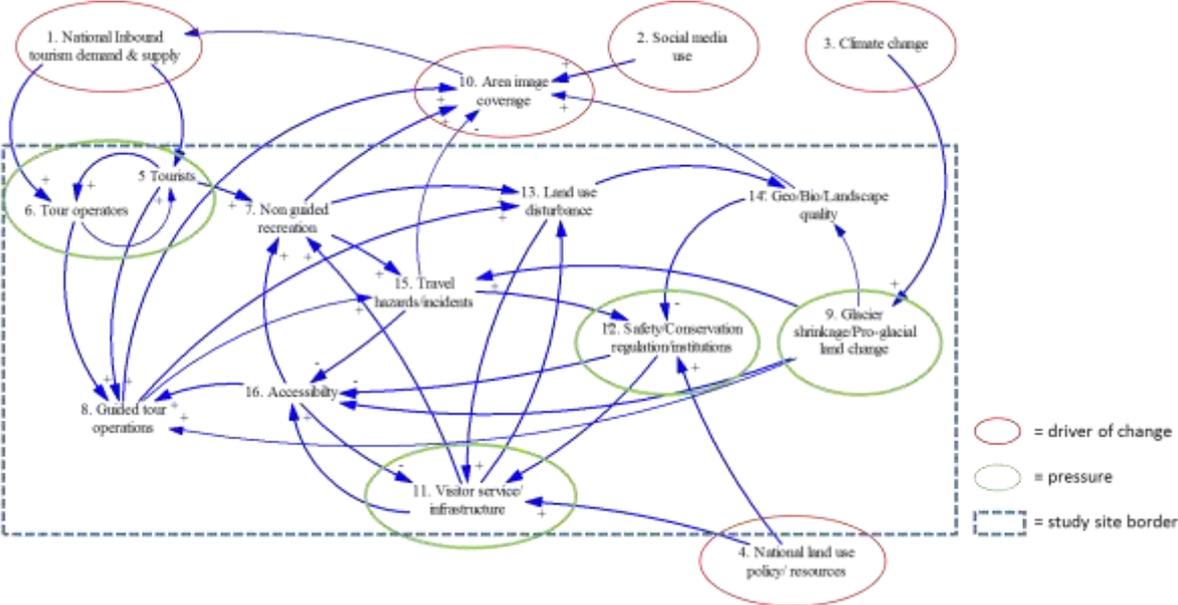


Figure 10: Representation of the cognitive map of recreational land-uses system of the Þróng site

4.3 Future states of drivers and pressures (stage 3)

In third stage of the scenario planning approach, members of stakeholder group were asked to identified and assigned plausible future states to the different drivers during the last part of the first workshop (table 8). The stakeholders assigned three plausible future states to the driver *land-use management policy* (stabilize, strengthen limited and a strong), two plausible future state to the driver *tourism development* (slow and fast increase), and two to the driver *social media area coverage* (slow and fast increase). The future trend of the driver *climate change* was not assessed by the stakeholders due to its complexity, but instead was based on future projections made by the Icelandic Meteorological Office (MENR, 2014).

Table 8: Future state indications per identified driver of change

Drivers of change	Land-use management policy	Tourism development	Social media area coverage	Climate change ¹
Potential future states	Stabilize	Slow increase	Slow increase	Moderate increase
	Strengthen (limited)	Fast increase	Fast increase	
	Strengthen (strong)			

¹The future trends of the climate change were left out of the workshop

On basis of the potential future states of the different drivers of change, together with the cognitive system map, the future states of local pressures could be assessed and filled into the scenario matrix (table 9). Three relevant combination of future pressures were selected and named the scenarios: i) Business as Usual scenario, ii) Hot Spot scenario, and iii) Green Tourism scenario (table 9).

The scenario Business as Usual contains of a stationary or unchanged land-use restriction and visitor infrastructure development with a limited increase in visitors and tour operations at future Þröng site. The Hot Spot scenario comprises in limited enhancement of the land-use restrictions and a moderate increase in visitor infrastructure while there is a strong growth in visitors and tour operations. Finally, the Green Tourism scenario contains a strong strengthen of land-use restrictions and a moderate increase in visitor facilities at the future Þröng site with a moderate increase in visitors and a limited growth of the number of tour operations. Furthermore, in all three scenarios the future volume of the Breiðamerkjökull glacier at the Þröng site will reduce moderately while the future pro-glacial zone of Þröng site will increase, naturally, with the same trend.

Table 9: Scenario matrix of Þröng site

Drivers and pressures						
<i>Drivers of change</i>	National land management policy		Inbound tourism development	Social media area coverage	Climate change	
<i>Local pressures</i>	Land-use restrictions	Visitor Infrastructure	Demand (visitors)	Supply (tour operations)	Glacier volume	Pro-glacial zone
Scenarios						
Business as Usual	0	0	+	+	--	++
Hot Spot	+	++	+++	+++	--	++
Green Tourism	+++	++	++	+	--	++

-- = moderate decrease, 0 = stabile, + = limited in increase, ++ = moderate increase, +++ = strong increase

4.4 Land-use and land-cover (LULC) scenarios (stage 4)

In stage 4 of the scenario planning approach the results of the scenario matrix were translated into scenario story-lines, a glacial land cover map and subsequently into three spatial land-use/land cover scenario maps.

4.4.1 Recreational land-use story lines

Simple socio-economic story-lines per scenario were developed which differ from each other in terms of the type, intensity and distribution of tourism demand and supply, and visitor regulation and infrastructure. The complete story-lines per scenario can be found in annex II of this report.

4.4.2 Future glacial land-cover map

The result of glacial land cover model estimated a retreat of the glacier margin of approximately 1,2 km to a 20-meter higher altitude, the emergence of 2,6 km² of moraine area, and two new rivers. The

model results were put into GIS in which a future land cover map layer was created that constitute a spatial base for the development of the scenario Land-use/land cover maps (fig. 11).

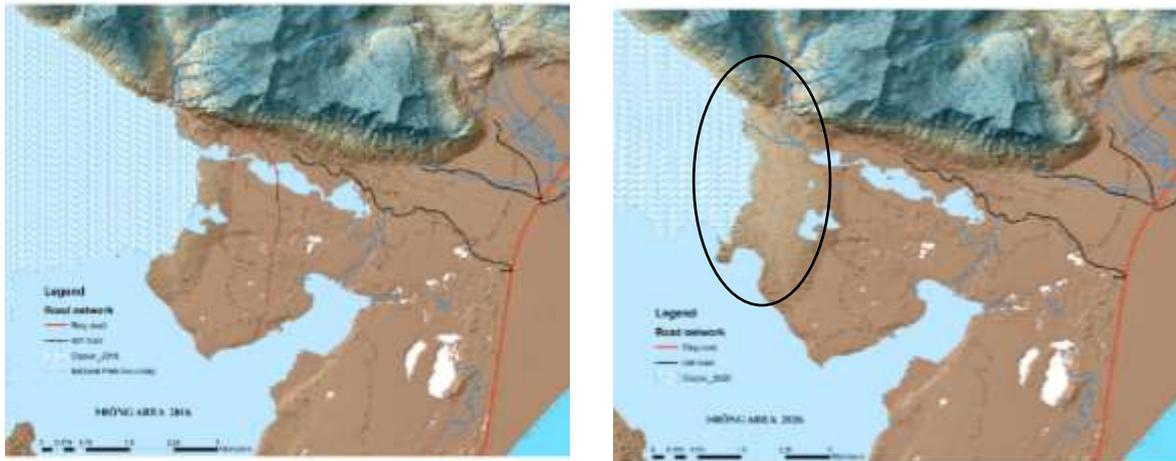


Figure 11: Projected changes in glacier land-cover of the Pröng site between 2016 (left) and 2026 (right). The black oval represents the major changes.

4.4.3 Developing future recreational LULC scenario maps

Combining the glacier land cover maps with the spatial land-use attributes for the story-lines resulted into three land-use/land cover scenario maps:

i) *Business as Usual* scenario map which involves, besides the physical land-cover changes, only a limited extension of the track and an extension of the Vatnajökull national park (fig. 12)



Figure 12: Map presenting the scenario Business as Usual

ii) *Hot Spot* scenario map (fig. 13) shows several changes compared to the current situation. Besides the change in land-cover features, this scenario includes several tourism facilities such as bridges over small river streams, hiking trails, a built-up gravel road, a parking lot and cafeteria and a hotel facility by the junction between the Ring road and road to the Pröng site.



Figure 13: Map presenting scenario Hot Spot

iii) *Green Tourism* scenario map (fig. 14) reveals several changes compared with the current situation at Pröng. There are several visitor facilities such as a few long-distance hiking trails, walking bridges, and a hiker's hut. There are also two restriction zones implemented, one which totally bans any recreational activity and another where motorized travel is not permitted.

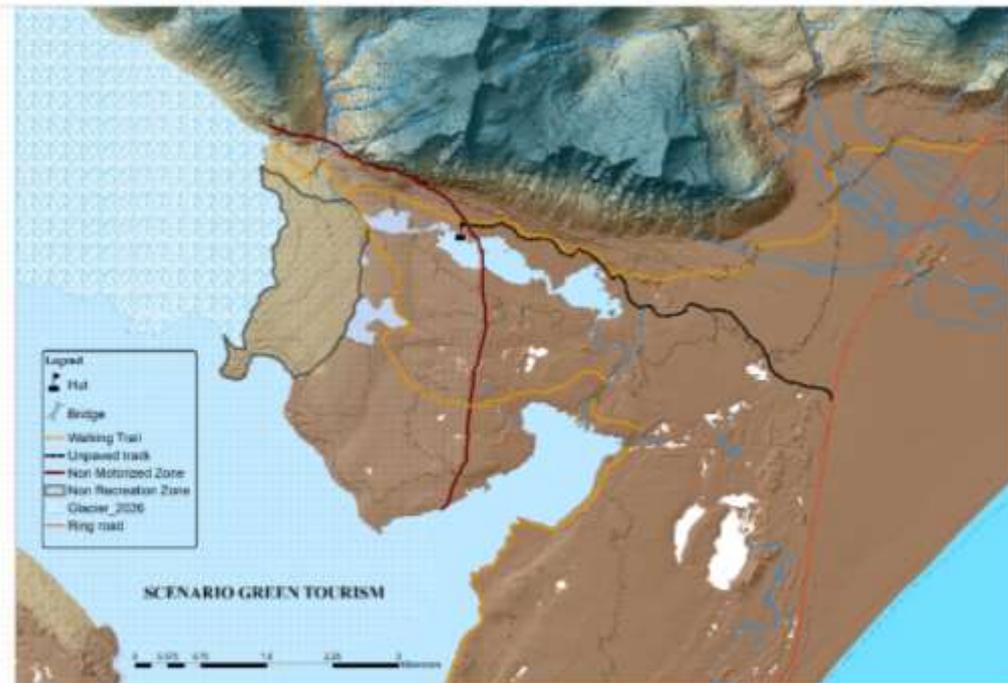


Figure 14: Map presenting scenario Green Tourism

4.5 Future opportunities & threats (stage 5)

In the fifth stage of the scenario planning approach, the maps and story-lines were presented and discussed in a second stakeholder workshop. The participants were asked to identify the main opportunities and threats regarding recreational land-use in each future scenario and asked to write these down on post-its and pinpoint these on the different scenario maps in poster format so that their spatial distribution became visible (fig. 15).



Figure 15: second workshop meeting in Höfn

The different threats and opportunities are described in table 10, 11 and 12. The stakeholders identified 14 threats and 12 opportunities in total. In the Business as Usual scenario, four threat were identified which relate to emergence of chaos and conflict among tour operators, reduced accessibility of the site, a lack of recreational planning and an increased risks of accidents. The opportunities identified by the stakeholders in this scenario were opportunities for research, passive site conservation, a growth in tour diversification and enhancement of visitors' untouched nature experiences.

Table 10: the identified threats and opportunities regarding scenario Business as Usual

A. Business as Usual scenario	
Threats	
Conflicts (chaos)	Lack of rules will cause conflicts concerning sustainable management and operation rights.
<i>Poor access #</i>	<i>The increased distance between parking and margin of the glacier is a burden for the tours</i>
Lack of planning	No visitor planning of the area will result in conflict situation
<i>Risk of accidents</i>	<i>The increase of visitors in de-glaciated areas causing increased risks of accidents and other dangers.</i>
Lack of visitor planning-policy	There is no clear policy how regulate and manage ice-cave tourism and prevent chaos
Opportunities	
Research	De-glaciated areas form a valuable source for (geological, biological) research
<i>Passive nature conservation</i>	<i>Lack of and bad quality of infrastructure prevents tourism impacts and conserves nature</i>
Tour diversity and availability	The area provides opportunities for more diverse tours and continuation of the development of tours availability.
Poor accessibility experience	The difficult accessible area provides opportunities for specialized (slow) adventure tours.

#The threats and opportunity in italic were selected to be addressed in the third workshop on basis of relevancy and importance

Regarding the Hot Spot scenario, the stakeholders mentioned an increased pressure on nature and local society, a decrease in wilderness experience by visitors, an increase of the risk of accidents and stakeholder conflicts and the creation of an economic bubble situation as plausible treats for future recreation. Furthermore, as opportunities in this scenario the stakeholders indicated economic growth, increased tour opportunities and site accessibility, and opportunities to inform and educate visitors.

Table 11: the identified threats and opportunities regarding scenario Hot Spot scenario

B. Hot-spot scenario	
Threats	
<i>Increased pressure both on nature and society</i>	<i>Deterioration of natural environment and social cohesion of local community which transfers into a goldmining community</i>
Decreased wilderness experience	Crowding of visitors will lead to deterioration of remoteness and tranquility of the area
Risk of accidents	Increase risk of accidents among visitors and companies can lead to reduced safety of visitors and pollution of the area
<i>Increase conflicts</i>	<i>Increased conflicts between landowners, park and entrepreneurs where land-use planning is most limited</i>
Bubble phenomenon	Can lead to bubble economy phenomena: an accelerated growth crossing its carry capacity followed directly by a total collapse.
Opportunities	
Economic growth-Increased income	Increased visitation demand will lead to more tourism related local jobs and increase in livelihood and household income
Increased business opportunities	Increase visitation demand will lead to increased opportunities for tour companies
Increased accessibility to the area	Growth of infrastructure to and within Pröng increase accessibility to the area
<i>Educating public</i>	<i>Information and education opportunities to visitors about the socio-historical, geological heritage and climate change.</i>

#The threats and opportunity in italic were selected to be addressed in the third workshop on basis of relevancy and importance

The threats identified by the local stakeholder group of the Green Tourism scenario were an unrealistic scenario, increased conflicts between stakeholders, excessive visitor management and a limited market group for glacier tour operations. The mentioned opportunities in this scenario related to holistic planning possibilities, eco-tourism development, and opportunities for increased wilderness experience among visitors and application of research knowledge into tourism practices.

Table 12: the identified threats and opportunities regarding Green Tourism scenario

C. Green Tourism scenario	
Threats	
Wishful thinking	Not realistic to become reality.
Conflicts due to great changes	Non-motorized and non-visitors zone will lead to conflicts with tour operators and local community.
<i>Excessive management</i>	<i>Limited recreation opportunities due to excessive management control and partly area prohibition.</i>
<i>Limited market group</i>	<i>Reduced economic prosperity due to the attraction of a too limited marketing group</i>
Opportunities	
Holistic planning	The planning would involve local stakeholder, municipality and park authority that focus on park area and direct vicinity.
<i>Eco tourism</i>	<i>Development of eco-tourism creates local employment and entrepreneurship, reduces environmental degradation and promote local natural-cultural heritage of area.</i>

Wilderness experience	Stimulation of wilderness, landscape experiences, peace and quite
Research	Include science (regarding e.g. experiences, innovation) into travel industry

#The threats and opportunity in italic were selected to be addressed in the third workshop on basis of relevancy and importance

4.6 Adaption to future threats and challenges (stage 6)

In the sixth stage of the scenario planning approach, the stakeholder group identified a set of adaption strategies to deal with the main threats and opportunities of the three future scenarios. To support this process, two focal questions were defined:

- what kind of measures/measures are necessary to prevent or diminish the identified threats per scenario?
- what kind of measures/measures are necessary to realize or increase the identified opportunities per scenario?



Figure 16: the third workshop meeting in Höfn

The resulted adaptation measures or means per scenario identified by the stakeholders were written down on the blackboard to present a clear overview and discussed with the stakeholder group (fig. 16). A total of 61 different measures related to three scenarios were mentioned by the stakeholders. On an overall level, measures can be summarized as attempts to establish cognitive and behavioral change among the recreational site visitor's, tour operators and park authority. The measures were grouped into 6 measurement types: improvement of policy/regulation process, improvement of policy/planning process, research/education, promotion/marketing, communication, and cooperation (table 13; Annex IV).

The improvement of policy/regulation process, which comprises the implementation, adjustment or enforcement of recreation regulations and tour operation guidelines were mentioned 21 times. The measurement type was identified by the stakeholders as a mean to diminish threats as poor site

accessibility, risk of accidents, pressure on the natural environment, stakeholder conflict and a limited market group, but also the realize the opportunities passive nature conservation, visitor education and eco-tourism. The improvement of policy/planning process, which consist of implementation or extension of visitor infrastructure/facilities (e.g. access roads, walking trails, demarcation signs) planning and maintenance was mentioned 13 times. Stakeholders indicated this measure to reduce the threats poor access, risk of accidents, pressure on the natural environment and stakeholder conflict, as well as to realize the opportunity to educate visitors (by means of the construction of a visitor center).

Table 13: Overview of the number of measures per scenario mentioned during workshop.

Measures / Threat-Opp.	Scenario BAU			Scenario Hot Spot			Scenario Green Tourism			Total
	T1	T2	O1	T3	T4	O2	T5	T6	O3	
Policy - regulation process	1	2	3	8	2	1		2	2	22
Policy - planning process	2	1		6	3	1				13
Research - Education				2	2	3	1			8
Promotion - Marketing	1		1		1	1		1	3	8
Communication					7					7
Cooperation			1	1			1			3

Treats - T1: Poor access, T2: Risk of accidents, T3: Pressure on environment, T4: Stakeholder conflict, T5: Excessive management, T6: Limited market; Opportunities O1: Passive conservation, O2: Educating public, O3: Eco-tourism

Both measurement types can be described as means to improve the institutional management processes of the national park or tour operators (fig. 17). This process contains the development, implementation and evaluation of national park’s and corporate policies and strategies into: a) infrastructural planning and its maintenance, and 2) recreation regulation and corporate guidelines and their enforcement.



Figure 17: Improvement or adjustment of policy-planning/ policy-regulation process indicated by stakeholders to reduce threats and realize opportunities

The measure type education was mentioned eight times as means to prevent the treats pressure on the natural environment, stakeholder conflicts and excessive site management as well as to realize opportunity of visitor education. Promotion-marketing was indicated seven times in all the scenarios as measure, both to prevent/reduce threats as well as to realize opportunities. The mean communication was mentioned four times only as a measure to prevent or diminish the threat of stakeholder conflict of the scenario Hot Spot. Finally, the measure type cooperation was addressed three times, in every scenario one time, to diminish pressures on the environment and excessive site management, as well as to realize the opportunity of passive conservation. The last five measurement types can be summarized as the enhancement of a cognitive informative/persuasive process which main goal is to improve current knowledge and understanding in order to change attitudes and behavior of park visitors, park organization and tour operators (fig. 18).

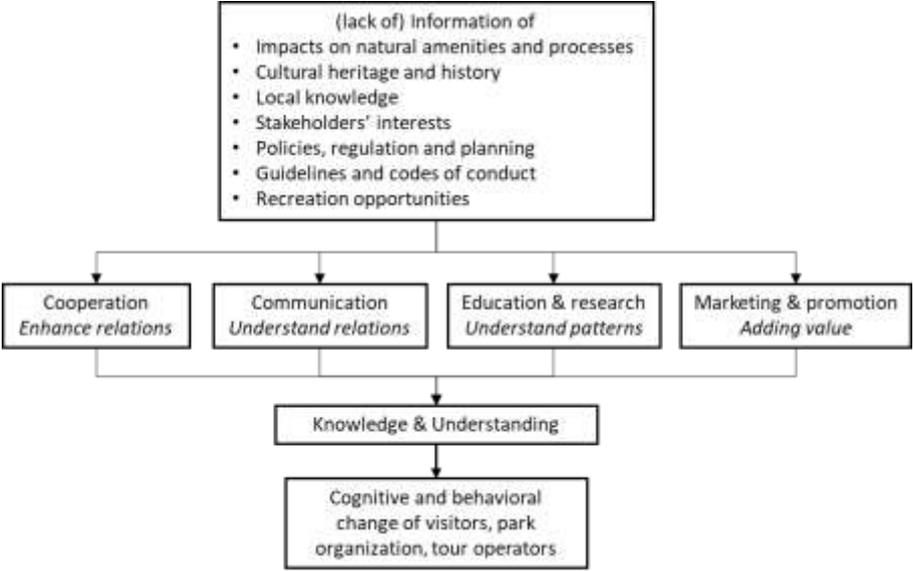


Figure 18: The enhancement of the cognitive persuasive/informative process as indicated by the stakeholders to reduce threats and realize opportunities

Table 12 shows which actors are responsible for the development and implementation of the measures. The responsibility for a majority of the measures is accrued to the national park authority. This is not surprising because most of the measures are part of the policy regulation or policy planning process for which the park authority is responsible. However, more than a quarter of the named measures fall under a shared responsibility between park and companies and/or municipality, which indicates that mutual cooperation is necessary.

Table 12: Responsible actor for mentioned measures during the workshop.

Responsible actor(s)	Freq.	%
Park	27	44,3
Tourism companies	5	8,2
Municipality	3	4,9
Park-Companies	10	16,4
Park-Municipality	3	4,9
Municipality-Companies	0	0,0
Park-Municipality-Companies	6	9,8
University/NGO	1	1,6
National government	1	1,6
Total	61	100

4.7 Assessment of capacity to adapt to future opportunities and threats (stage 7)

In the last stage of the scenario planning approach the current capacity of the management of the study area to adapt to future threats was assessed. In order to do this, the project group selected with the consent of the stakeholder group a set of measures/measures per threat (T 1-6) on the basis of relevance and importance and attempted to assess the adaptive capacity by means of the following guiding questions:

- ‘Which actions and changes in current management/planning of the area are necessary for the ability to realize the identified adaptation measures?’
- ‘What kind of resources are in general needed to establish the adaptation measures?’
- ‘Are these resources available and, if so, are they sufficient and are they easy to acquire?’

Due to the limited amount of time that was available during the workshop and maximum amount of time stakeholders bear during a focus group session, the project group decided to address just 1-2 measures per threat (T 1-6). The results of this second session of the third workshop are summarized hereunder in table 13.

Table 13: Results of adaptive capacity assessment.

Necessary changes	Needed resources	Available	Sufficient	Easy to acquire
<i>Measure to reduce threat T1: Repair and extend the road and tracks</i>				
Allocation of extra finance for infrastructure by user (tour comp.)	Financial capital (from tour companies)	Yes	Yes/No	Yes
Permits (for commercial use)	Institution - regulation	Yes	Yes	Yes
Establishment of visitor planning	Institution (flexibility)	No	-	Yes
<i>Measure to reduce threat T2: Mandatory to travel with guides</i>				
Rules (restrictions)	Institution	No	-	No
Apply fines to tourists (enforcement)	Human capital (staff)	Yes	No	Yes
<i>Measure to reduce threat T3: Network of walking paths</i>				

Implementation of infrastructure fund financed by user (tour companies)	Financial capital mechanism - Flexible Institution	No	-	Yes
Expert knowledge, e.g. concerning hiking trails	Knowledge	Yes	Yes/No	Yes
<i>Measure to reduce threat T4: Proactive master and local planning</i>				
Holistic vision	Social capital (cooperation)	No	-	No
Willingness to cooperate	Social capital	Yes	Yes/No	Yes
<i>Measure to reduce threat T5: Cooperation venue between companies and the VNP</i>				
Increase in cooperation	Social capital (leadership)	Yes	Yes	Yes
<i>Measure to reduce threat T5: Change visitors' attitudes to nature</i>				
Education / training / knowledge	Knowledge	Yes/no	No	No
<i>Measure to reduce threat T6: Opportunity for promotion individual products utilization</i>				
Marketing - Increase the obviousness of value of the area	Human capital	Yes	Yes/no	Yes
Grants for pro-environmental innovation and development in tourism	Financial capital	No	-	Yes

The results of the seventh stage indicate that there are several factors that enhance the capacity of Pröng recreation land-use management to respond properly to potential future threats.

- The presence of an operating ground network consisting of the park, tour operators and municipality which can be mobilized for specific targets or support
- The presence of local knowledge of the natural environment and recreational possibilities
- The willingness to establish cooperation between park, municipality and operators.

However, there are also factors that reduce the adaptive capacity of Pröng site management:

- Elements of the institutional planning/policy process are lacking or inadequate and difficult to obtain. Parts of this process are rigid and viscous. They operate at different scales (local, regional, national level), are sometimes outsourced, or non-transparent due to insufficient communication.
- There is a lack of a holistic vision that grounds both policy/planning process as well as the cognitive persuasive/informative process. The planning/policy process is almost entirely based on a reactive response mode.
- There is a lack of a sufficient financial mechanisms based on polluter (user) pays principle, which can finance facilities, infrastructure, education and maintenance under changed visitation demands.

5. Discussion and conclusion

The aim of this case-study was to test a participatory approach that support the planning of nature based recreational sites. This approach identified potential drivers and pressures of land-use change, developed multiple scenarios maps and story-lines of future recreational land-use, and examined their potential consequences and adaptation measures by means of a PGIS methodology. In the context of the BuSK objectives, the use of PGIS as an overall methodological framework revealed several advantages. The stakeholder workshops provide a space to exchange mutual insights of different stakeholders' beliefs, perceptions and knowledge which most actors normally do not share in their working environment. Such an exchange contributes to a better understanding regarding different recreational preferences and attitudes of glacier site recreation which is valuable input for their future planning and management and further cooperation.

Furthermore, the PGIS methodology enabled the combination of science based knowledge in form of land-cover dynamic modelling with lay knowledge on land-use practices in order to co-produced land-use scenarios. In this manner, local stakeholders got informed how scientific data is generated and can be employed for practical uses and, at the same time it generates on the side it gives glacier site planners and management a valuable insight into lay knowledge of local stakeholders.

In addition, the use of scenario maps next to story-lines contributed considerably a better understanding of spatial distribution land-use issues, challenges and opportunities among local stakeholders and stimulated their participation and discussion.

The constructing a representative and cooperative stakeholder group is a crucial element of the planning approach. Using an existing network as basis to identify and compile the local stakeholders group in this case-study contributed considerable to the cooperative attitude of the group members and their willingness to attend the workshops. Furthermore, the role of the regional university centre of southeast Iceland (which is situated in Höfn) as the mediator of workshops increased the trust in the process among the stakeholders because it is considered as a part of the local community and a 'neutral' interlocutor regarding recreation development of glacier sites by the stakeholders.

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Annex I

Identified issues (opportunities and challenges) current land-use study area (Pröng)

Issues	Stakeholder	Categories	Opportunities/ Challenges
Combine tourism with sheep grazing	Entrepreneur	Destination management/planning	Challenge
Bad roads to and within Pröng site	National Park	Destination management/planning	Challenge
Geology bedrock	NGO	Education	Opportunities
Important to protect natural phenomena especially biologic succession following glacier retreat	National Park	Nature conservation	Challenge
Allowing access through land by land owners of glacier tours	Entrepreneur	Tour operation development	Challenge
Business development on based outdoor recreation (winter)	Entrepreneur	Tour operation development	Opportunity
Ice cave tours	Entrepreneur	Tour operation development	Opportunity
Business development on based outdoor recreation (summer, spring, autumn): glacier hikes, ice climbing	Entrepreneur	Tour operation development	Opportunity
Ice cave tours, glacier hikes, ice climbing, grazing land, goose hunting, fishing	Entrepreneur	Tour operation development	Opportunity

Identified issues (opportunity/ challenge) current land-use in geographical context of study area (Breiðamerkusandur)

Issues	Stakeholder	Categories	Opportunity / Challenge
Importance and meaning of VNP among inhabitants of southeast Iceland	Expert	Communication	Opportunity
The meaning of Tourism and agriculture importance in the mind of Icelandic nation	Expert	Communication	Opportunity
Social media opens opportunity to discover previously unknown areas	Expert	Communication	Opportunity
Cooperation between park and entrepreneurs	Municipality	Cooperation	Opportunity
Development of hiking paths require cooperation of many different stakeholders	Municipality	Cooperation	Opportunity
Dispute between landowners retarding necessary development to deal with tourism increase	Municipality	Cooperation	Opportunity
Definition and marking of trails	DMO	Destination management/ planning (Facilities)	Opportunity
Eco friendly walking paths well defined	Municipality	Destination management/ planning (Facilities)	Opportunity
Non-systematic development of hiking paths with unforeseen effects	Expert	Destination management/ planning (Impacts)	Challenge
Tour company pressure to facilitate	Municipality	Destination management/	Challenge

recreational tours (road extension)		planning (Impacts)	
Off road driving by public or unexperienced companies	Entrepreneur	Destination management/ planning (Impacts)	Challenge
Few versus many people	National Park	Destination management/ planning (Impacts)	Challenge
Silence and motor noise	National Park	Destination management/ planning (Impacts)	Challenge
Road or not road	National Park	Destination management/ planning (Impacts)	Challenge
Fjarsárlón: tourism pressure on society and nature	Expert	Destination management/ planning (Impacts)	Challenge
Jökulsárlón: tourism pressure on society and nature	Expert	Destination management/ planning (Impacts)	Challenge
Mining by the road commission	Entrepreneur	Destination management/ planning (Impacts)	Challenge
Glacier hikes that does not have much impacts on landscape quality	Municipality	Destination management/ planning (Impacts)	Challenge
Quality of ice caves	Municipality	Destination management/ planning (Impacts)	Challenge
Off road driving	NGO	Destination management/ planning (Impacts)	Challenge
Lack of planning in land-use recreation tourism companies	National Park	Destination management/ planning (Lack of)	Challenge
Lack of planning and guidelines in resource utilizations	National Park	Destination management/ planning (Lack of)	Challenge
State own land acts like no man's land	Municipality	Destination management/ planning (Lack of)	Challenge
Increased number of tourism and little management	National Park	Destination management/ planning (Lack of)	Challenge
How can we insure positive experience for all in habitants and visitors	Municipality	Destination management/ planning (Lack of)	Challenge
Responsibility of development of areas	National Park	Destination management/ planning (Lack of)	Challenge
Sheep grazing	Entrepreneur	Destination management/ planning (Lack of)	Challenge
Need to define which areas remain untouched	Municipality	Destination management/ planning (Lack of)	Challenge
Safety of Ice-caves	Municipality	Destination management/ planning (Safety)	Challenge
Safety level in front glacier because of high dynamic	National Park	Destination management/ planning (Safety)	Challenge
safeguard safety and experience	National Park	Destination management/ planning (Safety)	Challenge
Nature conservation and safety of tourists	DMO	Destination management/ planning (Safety)	Challenge
Risk of accidents and death in Ice cave tours by unguided journey	Entrepreneur	Destination management/ planning (Safety)	Challenge
Teaching area for natural science	NGO	Education	Opportunity
Skúmey (island) research area in danger of extermination	NGO	Nature conservation	Challenge
Define and restrict breeding areas	NGO	Nature conservation	Opportunity
Breeding area of great Skúia and Arctic Stern	DMO	Nature conservation	Opportunity
Conservation of landscape because of tourism pressure	Municipality	Nature conservation	Challenge

Protection of biota of area has to increase more than what is done at this moment	Municipality	Nature conservation	Opportunity
Nature conservation along with land-use	National Park	Nature conservation	Challenge
Nature conservation where there is great tourism pressure	NGO	Nature conservation	Challenge
Research measurement	Entrepreneur	Research	Opportunity
Long time monitoring (Jökulsárlón)	NGO	Research	Opportunity
Opportunity for rural development in areas vicinity VNP	Municipality	Rural development	Opportunity
Uncertainty regarding ice-cave existence	Entrepreneur	Tour operation development	Challenge
Rapid change of glacier landscape large influence on tourism companies	Municipality	Tour operation development	Challenge
Glacier hikes	NGO	Tour operation development	Opportunity
Glacier hikes	DMO	Tour operation development	Opportunity
Glacier hikes	Entrepreneur	Tour operation development	Opportunity
Ice cave tours	Entrepreneur	Tour operation development	Opportunity
Ice-caves	DMO	Tour operation development	Opportunity
Ice cave tours	NGO	Tour operation development	Opportunity
Hiking on the Breðmerkusandur	NGO	Tour operation development	Opportunity
Glacier hikes	Entrepreneur	Tour operation development	Opportunity
Increased opportunities for tourism operations	Municipality	Tour operation development	Opportunity
Business development linked to outdoor recreation in the winter	Entrepreneur	Tour operation development	Opportunity
Business development based on recreation, sailing services, Northern Lights	Entrepreneur	Tour operation development	Opportunity
Fishing	Entrepreneur	Tour operation development	Opportunity

Annex II

Description of the scenarios in story-lines

A. Scenario *Business as usual*

In 2026, the Icelandic tourism sector is still characterized by an increasing inbound tourism market, although not as rapid as between 2010-2020. Tourism has become the main economic sector in Iceland. The tourism market is focused on nature-based tourism in which packaged short holidays outside the summer period are prevailing while semi-organized round trips are most common itinerary in the summer season. Although the southeast part of Iceland has 1.600.000 visitors in the summer season (April – September) of 2026, the area of Þröng is visited by a minority of the tourists (1%).



Land management policy: National Park policy is still focused to integrate outdoor recreation development with education and nature conservation, although lack of funding to maintain the huge extent of protected land causing a serious underdevelopment of the last two tasks. The Þröng site is not marketed as tourist site. There are no restrictions regarding tour operations except that companies need to be an official registered tour operator and certified by Vakinn.

Visitor infrastructure: There is only a single dirt track which ends at the same place as in 2017. The site does not have any facilities except a parking sign by at the end of the road.

Tourism demand: During the summer, the number of tourists is low in comparison with similar glacier sites in the region such as Heinabergsjökull or Hoffellsjökull. Around 15.000 tourists has visited the site during the summertime (April-September) from which 90% took a guided tour. The bad road conditions, the non-promoted and marketed area only attracts tourists interested in guided adventure hikes on difficult terrain and tourists searching for outlet glaciers without visitor group in the background. There were approximately 1.000 unguided tourists that visited the site in 2026.

Tourism supply: At the Þröng area, 3 local companies and 1 specialized adventure tour companies from Reykjavik offer guided hiking tours both short (1 hr on the ice) and medium long (2,5 hrs on the ice)

B. Scenario *Hot spot*

In general, Iceland has become a ‘mass’ nature outdoor tourism destination due to cheap flights connecting all major cities in North America with Europe and Asia, strong marketing, easy attending package tours, and a huge investment in infrastructure and overnight possibilities of the last 5 years (2019-2024). In addition, during the summer of 2022 the world most downloaded and followed Chinese vlogging (video blog)/performance artist collective Thi4U has taken a Youtube special (three days/night special directly near and on the glacier) in Þröng where they were followed, through life stream, by 1,5 billion viewers worldwide. After their stay at Þröng, the demand to visit the area is sky rocking the next summer.



Land management policy: Several 'hot spots' in the park are appointed to 'gather' the high number of tourists that come to southeast Iceland (3.000.000 visitors during summer season) and Þröng is one of them. The area is mapped and market (following the strong demand) and infrastructure is improved and extended. Overnight stay possibilities have been built along the ring road in the direct vicinity of the junction to Þröng.

Visitor infrastructure: The dirt track to the glacier margin is improved into a build-up gravel road suitable for non 4-wheel drive and medium sizes coaches. Furthermore, the park increased the visitor facilities substantially including a parking, toilet facilities, food shop, pick-nick tables and a marked trail from the parking to the glacier lake along the margin of the glacier.

Demand: The demand to visit Þröng has increased exponential after 2023. Þröng has become a major tourist destination site in southeast Iceland. In 2026 the area is visited by 250.000 people during the summer period (April-September). Due to improved infrastructure, marketing and promotion 70% of the visitors are non-guided site-seeing tourists.

Supply: Special Thi4U tours are organized, helicopter tours offered from hotels in the vicinity of Jökullárlon and Höfn. Many transport companies offer south coast tour including Þröng. About 25 companies offer transport to the area for site seeing, while 10 companies offer special hiking/ice-climbing tours on the glacier.

C. Scenario *Green tourism*

Due to some critical environmental events and disasters at a global and on national level, green thinking parties got the majority of the parliament and have formed a government in 2024. Their general policy is to 'green' the tourism sector of Iceland by discouraging motorized packaged mass-tourism and stimulating local small-scale eco-tourism based on slow recreation and education/ information.



Land management policy: the park has established different non-recreational zones at the most vulnerable part of the park, including a part of Þröng): the dynamic forefields of the glacier margin. There is a general ban on fossil fuel engine driven vehicles in Icelandic protected areas. The government has establishment an agreement with local electric shuttle bus services to provide limited access into protected areas.

Visitor infrastructure: There is only one dirt road for non-fossil fuel vehicles which ends at same place as in 2017. There is a small eco mountain hut with a small camping ground for trekking with minimum service near end of the dirt track that is only open during the summer. A small network of marked geo-heritage educative walking trails is established and the Þröng site is connected to the long-hiking /biking route network between Skaftafell and Lónsöræfa which the national and regional authorities have supported, marketed and facilitated intensively.

Tourist demand: There is a moderate demand for long hike and bike trekking. The site is visited by 50.000 visitors during the summer most of them as part of a four-day hike between Halli and Skaftafell (30.000 visitors) or education 'climate change' guided hiking tours (20.000 visitors).

Tourism supply: The amount of tour operating companies is limited due to restriction of the park in form of a quota of permitted companies that comply with some strict eco-tourism criteria. Not more than 5 licenses are provided per year to operate in Pröng

Annex III

Opportunities and threat per scenario

A. Business as usual scenario	
Opportunities	
Research	De-glaciated areas form a valuable source for (geological, biological) research
<i>Passive nature conservation</i>	<i>Lack of and bad quality of infrastructure prevents tourism impacts and conserves nature</i>
Tour diversity and availability	The area provides opportunities for more diverse tours and continuation of the development of tours availability.
Poor accessibility experience	The difficult accessible area provides opportunities for specialized (slow) adventure tours.
Threats	
Conflicts (wild west)	Lack of rules will cause conflicts concerning sustainable management and operation rights.
<i>Poor access</i>	<i>The increased distance between parking and margin of the glacier is a burden for the tours</i>
Lack of planning	No visitor planning of the area will result in conflict situation
<i>Risk of accidents</i>	<i>The increase of visitors in de-glaciated areas causing increased risks of accidents and other dangers.</i>
Lack of visitor planning-policy	There is no clear policy how regulate and manage ice-cave tourism and prevent chaos

B. Hot-spot scenario	
Opportunities	
Economic growth-Increased income	Increased visitation demand will lead to more tourism related local jobs and increase in livelihood and household income
Increased business opportunities	Increase visitation demand will lead to increased opportunities for tour companies
Increased accessibility to the area	Growth of infrastructure to and within Pröng increase accessibility to the area
<i>Educating public</i>	<i>Information and education opportunities to visitors about the socio-historical, geological heritage and climate change.</i>
Threats	
<i>Increased pressure both on nature and society</i>	<i>Deterioration of natural environment and social cohesion of local community which transfers into a goldmining community</i>
Decreased wilderness experience	Crowding of visitors will lead to deterioration of remoteness and tranquility of the area
Risk of accidents	Increase risk of accidents among visitors and companies can lead to reduced safety of visitors and pollution of the area
<i>Increase conflicts</i>	<i>Increased conflicts between landowners, park and entrepreneurs where land-use planning is most limited</i>
Bubble phenomenon	Can lead to bubble economy phenomena: an accelerated growth crossing its carry capacity followed directly by an total collapse.

C. Green tourism scenario	
Opportunities	
Holistic planning	The planning would involve local stakeholder, municipality and park authority that focus on park area and direct vicinity.
<i>Eco tourism</i>	<i>Development of eco-tourism creates local employment and entrepreneurship, reduces environmental degradation and promote local natural-cultural heritage of area.</i>
Wilderness experience	Stimulation of wilderness, landscape experiences, peace and quite
Research	Include science (regarding e.g. experiences, innovation) into travel industry
Threats	
Wishful thinking	Not realistic to become reality.
Conflicts due to great changes	Non-motorized and non-visitors zone will lead to conflicts with tour operators and local community.
<i>Excessive management</i>	<i>Limited recreation opportunities due to excessive management control and partly area prohibition.</i>
<i>Limited market group</i>	<i>Reduced economic prosperity due to the attraction of a too limited marketing group</i>

Annex IV

Measures regarding future threats and opportunities per scenario

SENARIO BUSINESS AS USUAL			
Treats/ opportunity	Measures-measures	Actor	Interventions type
T1 Poor access	Use of helicopters	Park-Comp	Policy-licensing, Planning-itinerary
	Repair and extend the roads to the glacier	Park	Planning- Infrastructure
	Market for those who want challenging trips	Comp	Promotion-marketing
T 2 Risk of accidents	Fix and extend roads for rescue forces	Park- Municipal	Planning- Infrastructure
	Rescue helicopters on stand-by	Municipal	Policy - working procedure
	Mandatory to go with a guide	Park-Comp	Policy-regulation
O1 Passive nature conservation	Working closely with the local community members and exclusively with local companies	Park- Comp- Municipal	Cooperation
	Only walking travelers allowed (no motorized traffic)	Park	Policy-regulation
	Setting standards and protocols for rules of ethics	Park	Policy-regulation
	Manage by means of contracts for specific companies (only walking tours)	Park	Policy-regulation
	Marketing the area as a difficult / unique area and more expensive	Park-comp	Promotion-marketing

SCENARIO HOTSPOT			
Threat/ Opportunity	Measures-measures	Actor	Interventions type
T3 Pressure on environment and cultural heritage	Cooperation venue developed by government	Park-Comp- Municipal	Cooperation
	Courses for guides.	Comp	Education
	Conditions for operating licenses – license fee on commercial activities	Park	Policy- licensing
	Few trips per company, steering the tourists	Park - Comp	Policy - regulation
	Developing a wilderness area.	Park - Comp	Policy - planning
	Learn from experience, / comprehensive vision, from the beginning	Park-Comp- Municipal	Planning/Policy - monitoring
	Development of trails	Park	Planning- Infrastructure
	Demarcate the borders (with markers)	Park	Planning- Infrastructure
	Infrastructure development	Park	Planning- Infrastructure
	Maximum number of guests	Park	Policy - regulation
	Increase the number of tourists that are allowed to go to pristine area with a guide	Park-Comp	Policy - regulation
	No parking-just can go by shuttle bus into the area	Park	Planning- infrastructure
	Control areas - Specific areas you do not go except with the	Park	Policy - permits

	guide, certain areas completely open		
	Apply fines for violations by tourists	Park	Regulation - enforcement
	More research on potential pressures	Science	Research
	Increase the number of park rangers for maintenance and enforcement	Park	Maintenance-enforcement
T4 Stakeholder conflicts	Promote a diverse group of tourists with a broad field of interest	Park-Municipal	Promotion-marketing
	A limited number of visitors and number of companies allowed	Park	Policy-licensing
	It should be clear who is allowed to operate in the park	Park	Communication
	Strengthen Act on VJP (VNP)	Park	Regulation - enforcement
	Clarify the Act on VJP (VNP)	Park	Communication
	Increase the number of stops at the roadside	Park	Planning-Infrastructure
	Increase toilet facilities	Park	Planning-Infrastructure
	Maintenance of infrastructure,	Park	Infrastructure - maintenance
	Communicate public education in different languages	Park-Comp	Communication
	Clear rules for infrastructure / access	Park	Communication
	Better communication towards visitors of what is allowed and what is not	Park	Communication
	Conversation with stakeholders and the community in general - informed about what is going on	Park	Communication
	Education of tourism sector will reduce conflicts between companies, increased professionalism and education in the sector	Park-Comp-Municipal	Education
	Reduce lack of knowledge among tourists how to behave in natural environment	Park-Comp	Education
Preparing, from the start, to have an open conversation with stakeholders, residents, farmers, national parks and others.	Park-Comp-Municipal	Communication	
O2 Educating public	Education should be component of online marketing.	Comp	Promotion-marketing
	Work permits for companies when they teach during their tours	Park	Policy-licensing
	Construct a visitor center	Park	Planning - facilities
	Public free education on nature integrity and visitation behavior	Park-Municipal	Education
	Increase education on organized tours.	Comp	Education
	Implement mandatory education to tourist how to behave in nature in park shuttle bus service.	Park	Education

SCENARIO GREENTOURISM			
Threat/ Opportunity	Measures-measures	Actor	Interventions type
T5 Excessive management	Change visitors' attitudes to nature and the environment is becoming the norm	Park	Education
	Cooperation venue between companies and the VNP	Park-Comp	Cooperation
T6 Limited market group	The state strengthens the development and innovation in the ecotourism	Municipal	Policy -subsidy
	New view on subsidies for agriculture, they should be directed to sustainable / eco-tourism	State	Policy - subsidy
	Opportunity for promotion individual products utilization	Comp	Marketing

O3 Eco Tourism	Establish relationship to a long cycle-hiking market	Park-comp-municipal	Promotion- marketing
	Market a unique-expanded audience	Park-comp	Promotion- marketing
	License based on assessment of company performance	Park	Policy-licensing - monitoring
	Develop a good environment for small local businesses	Municipal	Policy - subsidy, Promotion