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Implications of Climate Change on Nature-Based Tourism Demand: A Segmentation Analysis of Glacier Site Visitors in Southeast Iceland

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Received: 27 May 2020; Accepted: 29 June 2020; Published: 1 July 2020

Abstract: Since the end of the 20th century, glaciers are shrinking at an accelerated pace worldwide. This fuels the concern that increased glacier recession will lead to changes in the accessibility, safety, and amenity of many popular glacier tourist destinations—which may, in turn, affect the number of tourists visiting these areas. However, tourist responses to climate-induced environmental changes are still not well understood. Therefore, this study assesses the effects of the implications of glacier recession for glacier site visitation demand and examines the heterogeneity of tourists' responses to these implications for visitation, combining a contingent behavior approach with multivariate cluster analysis. Data were generated from a quantitative survey of 565 visitors to Vatnajökull National Park in southeast Iceland. The results show that climate change induced environmental changes greatly affect nature-based tourism demand, and that the responses of glacier visitors to those changes vary considerably across visitation implications and visitor segments. In order to facilitate future glacier site visitation demand in a sustainable manner, decision-makers and practitioners need to act more proactively and incorporate visitor segment differences into their planning, education, communication efforts and product development.

Keywords: glacier tourism; climate change; tourism demand; sustainable tourism; Iceland; visitor segmentation

1. Introduction

Climate change has been identified as global tourism's greatest challenge with respect to sustainability [1]. Due to its influence on key travel motivations, such as travel costs, infrastructure and landscape quality, climate change already has a considerable impact on tourists' destination choices [2]. Tourist destinations in glacial environments are particularly vulnerable to climate change, due to their dependency on ice for their attractiveness [3,4]. However, since the end of the 20th century, glaciers worldwide have receded in size and volume at an accelerated pace [5–7]. According to the Intergovernmental Panel on Climate Change [8], glaciers worldwide, outside Greenland and Antarctica, lost mass at an average rate of 220 ± 30 Gt yr–1 from 2006–2015. Recent studies [9–11] show that climate change forms a serious challenge for nature-based tourism in glacial environments because it triggers glacier hazards, hampers glacier accessibility and affects the aesthetic value of the scenery. Such implications can lead to a reduction of glacier-based tour operations and in the number of visitors. Furunes and Mykletun [3] show that in Jostedalsbreen National Park in Norway the number of participants in glacier tourism went down by 38% between 2003–2009, mainly due to changes in the morphology of the glaciers and their accessibility. Conversely, other studies argue that the prospect of

vanishing glaciers constitutes an important motivation for tourists to visit glacier destinations as a form of 'last chance tourism' [12,13], or that even a total glacier disappearance at a destination does not automatically lead to a structural reduction in demand [14].

In order to secure the sustainability of the glacier tourism sector, the sector needs to understand climate change impacts in terms of the markets' behavior responses to changing natural conditions under future outlooks of climate change. However, tourist responses to environmental change are still not well understood, and even less so in the context of climate change [15,16]. Kaján and Saarinen [17] and Pröbstl-Haider et al. [16] stress that knowledge concerning tourists' reactions to (bio)physical changes in destinations can be an effective way of assisting destinations in designing appropriate adaptive strategies and destination planning. Landauer et al. [18] furthermore point out that due to variable responses to climate-induced implications by different visitors, it is crucial for destination planners and tour operators to better understand the heterogeneity of visitors by defining different visitor segments and examining the variation in the behavior of such segments. In this context, this study attempts to gain insight into how glacier tourism demand responds to climate change induced implications. Therefore, this paper aims to a) examine how climate change induced environmental changes affect the intended behavior of glacier site visitors, and b) examine the extent of variation in visitors' behavior towards these implications.

2. Literature Background

2.1. Visitors' Coping Behavior Towards Climate Change Impacts

How individuals respond to changing conditions induced by climate change has been scrutinized in several studies [19–21]. In the context of outdoor recreation, Miller and McCool [22] argue that recreationists cope with changing conditions through a tiered process. First, recreationists appraise whether changed conditions of a natural area are relevant, benign-positive, or undesirable (i.e., harmful, a threat or a challenge). Then, when confronted with undesirable conditions, recreationists are likely to change their behavior by substituting the visited site, the timing, or activities at the sites, using technical means, such as specific gear, equipment or specialists to overcome the situation, or otherwise reevaluate the situation in a more favorable light.

Such cooping behaviors can be viewed as 'adaptive responses' in a broad sense, as they involve adjustments that tourists make when faced with undesirable conditions. Perceptions play a key role in these adjustment choices by influencing the actual result of the individual tourist's personal appraisal of reported or experienced change, as well as their judgement of the effectiveness of response options, or their ability to perform them [15,21]. However, such perceptions vary considerably among visitors depending on a broad scale of personal attributes, such as age, gender, preferences, lifestyle, travel motivations, or the visitors' type of vacation and experiences of previous travels [15,23,24]. The actual choices that tourists make can both (directly and indirectly) influence the responses of other actors, in particular those of tour operators and site managers. Directly by deciding not to visit destinations or sites which are impacted by climate change, changing the demand for these destinations; and indirectly by inciting product development as tour operators and site managers try to anticipate changes in demand and respond to these by implementing different adaptation measures [25–28].

2.2. Glacier Tourists' Responses to Climate Change

Several studies show that climate change induced thinning and recession of glaciers has led to significant impacts on tourism operations and activities in glacier landscapes, such as an increase in the occurrence of natural hazards [29,30], the reduction of the accessibility to glaciers or within glacier sites [10,31], and a change in the landscape due to increased debris coverage [11] or a reduction in glacier size [32]. To alleviate or eliminate such implications, several glacier destination managers and tours operators have implemented a broad range of adaptation measures [33]. Numerous studies [3,30,31,34,35] show that adaptive responses to climate-induced changes in a glacier landscape

are relatively easily incorporated by the glacier tourism supply side into daily management, or operation practices, until a certain threshold is passed. When such a threshold is passed, the actions applied seem to lead to a more radical change in adaptation, such as closing off areas, changing destinations, or introducing new transportation means, which can have considerable implications for the visitor in this regard.

A limited number of studies have, on the other hand, examined how potential climate-induced changes in glacial landscapes might affect their future visitation. Existing studies suggest that demand for glacier destination visitation would be affected considerably by such changes. Using a visitor survey with visitors of Lijing region in China, Yuan et al. [36] reveal that a substantial part (19,6%) of the visitors would not have visited the area if its famous Yulong glacier had melted away completely. Similar results were found in Canada by Scott et al. [37], where 25% of the respondents indicated that they would not be willing to visit two Canadian national parks once all the glaciers in these parks would disappear. Focusing on the effects of glacier landscape changes on potential visitations to the Westland Tai Poutini National Park in New Zealand, which includes two popular glacier sites (Fox glacier and Franz Josef glacier), Steward et al. [38] found that 46% of all respondents indicated that they would not have visited the park if it were not for the glacier view. Exploring the potential influence of climate-induced environmental change on visitation to the Athabasca Glacier in Jasper National Park in Canada using a visitor's survey with photorealistic environmental visualizations of an impacted glacier site in 2050, Groulx et al. [32] revealed that 23% of the respondents would not like to visit the site if they were to experience changed glacial environmental conditions. Groulx et al. [32] further investigated the impacts of adaptation responses to changing environmental conditions in the form of motorized tours (snow-coach and helicopters tours), walking paths, bridges and fences by destination managers or tour operators. Their results show that a large proportion of the current visitors (41%) stated that they would likely not have made the journey if the conditions at the site included both potential impacts and potential adaptations. The percentage of visitors who were unwilling to visit was considerably higher when the scenery had been changed by both environmental conditions and adaptations (47%), than when it was altered only by natural changes (23%). Weber et al. [39] explored visitor satisfaction among visitors of the Athabasca Glacier sites using combined tourism development and glacial landscape change scenarios. Their results reveal that visitor satisfaction with changed landscape features in the future scenarios decreases compared to the visitors' current satisfaction with their experience. In particular, future landscape scenarios that showed more commercialized recreation activities were considered less satisfying in comparison with future landscapes with hardly any signs of such activities. These studies suggest that there are underlying variables that influence visitors' perceptions and consequently determine the differences in the degree of willingness to (re)visit a glacier destination. For example, Scott et al. [37] conclude that it is the first-time visitors and the ones who have to travel a long distance that are most likely to be negatively affected by climate-induced environmental changes. This is further supported by Steward et al. [38], who demonstrate that the willingness to visit glacial destinations under changed environmental conditions is significantly higher among local visitors (65%) in comparison to international visitors (51%). In addition, Groulx et al. [32] show that visitors' landscape preferences and perceived naturalness of the glacier landscape has a moderate to strong correlation to the likelihood of a return visit to a glacier site.

The existing studies provide valuable information for future planning and management of glacier destinations. They do, however, have some limitations, such as a lack of multiple implications. Some studies address only a single implication for future visitation, namely, changes in the current scenery. In contrast, several studies have revealed e.g., that changes in accessibility to and within glacier sites, or alterations in the occurrence of hazard [3,10,31], are also important implications for glacier destination visitation. Furthermore, the time scale of the future scenarios employed in most studies is multidecadal—which, thus, relates to environmental conditions that future generations of visitors will encounter, rather than contemporary visitors [37]. In addition, some studies do not take into account adaptive responses by destination managers or tour operators to the long-term landscape

changes. Implemented adaptation measures, such as the establishment of a safety zone or the rerouting of trails, can decrease the climate change induced risk of hazards to a minimum for mainstream glacier site visitors [10,40]. However, as stressed by Groulx et al. [32] and Weber et al. [39], these types of measures can, in turn, lead to negative consideration of future visitation and experiences.

3. Materials and Methods

3.1. Study Area

Iceland has numerous glaciers—of which only a few are exploited for recreational purposes (Welling and Árnason, 2016). The largest share of glacier sites is located in southeast Iceland, around the edge of the Vatnajökull icecap, which makes up the study area for this research (Figure 1).

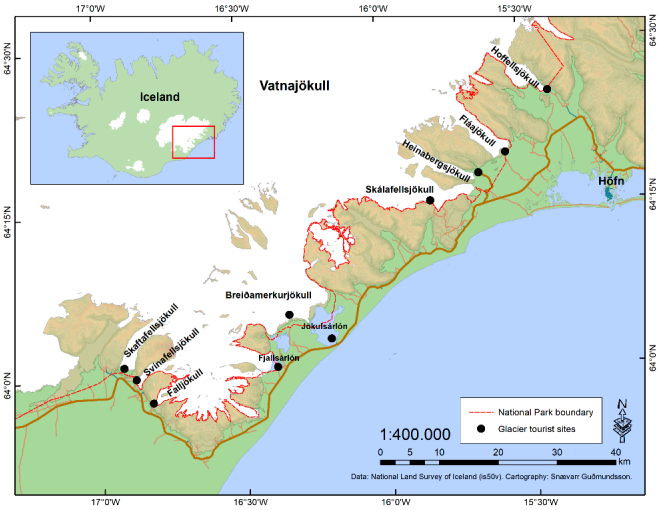

Figure 1. Map of the study area encompassing the southeast part of the Vatnajökull icecap. The black dots refer to the main glacier sites of the study area.

Vatnajökull ice cap, the largest glacier in Europe (by volume), plays a central role in the regional tourism sector in southeast Iceland [41]. The ice cap contains multiple outlet glaciers and pro-glacial lakes, of which several have been developed into glacier tourism sites suitable for tourism and recreational activities. The total ice cap is part of Vatnajökull National Park (VNP) which was established in 2008 [42]. All the glaciers in Iceland are temperate or warm-based, meaning that their ice temperature is close to 0 °C throughout the year, and they are therefore highly dynamic and sensitive to climate variations, resulting in rapid responses (advance or retreat) to changes in temperature and precipitation [43]. The recession of the outlet glaciers in the southeast part of Vatnajökull has been especially pronounced since the 1990s, with all monitored ice caps retreating and thinning at an unprecedented pace [44–46].

There are 10 glacier sites within the study area, where different outdoor recreation activities can be conducted, from sightseeing to motorized activities. Some of these glacier sites are easily accessible for all tourists, such as the well-known pro-glacial lake, Jökulsárlon, which was visited by 770,800 visitors in 2017 [47]. Glacier tourism in Iceland is still highly seasonal with the large majority of guided glacier tours being provided in the summer months, i.e., June to August. However, the exceptional increase in tourist numbers in Iceland in the off-season in the past few years, as well as the enhanced effects of climate change on glacier sites, have prompted the extension of existing and new glacier-based products to the shoulder and winter seasons [48].

3.2. Data Collection

Data were collected by means of a visitor survey conducted at two popular tourist sites within the study area, i.e., Skaftafell and Jökulsárlón (Figure 1). The survey was administered to visitors around the visitor center in Skaftafell and the cafeteria at Jökulsárlón. These two sites were selected as they are the most visited destinations in southeast Iceland during the whole year [47]. The survey was implemented during the first week of August 2015 and the second week of February 2016 to obtain data from both summer and winter visitors. A total of 631 visitors were approached and asked to fill in a questionnaire; of these, 574 (91%) agreed to take part in the survey. Of this sample, 96.9% of the respondents (N = 556) completed the questionnaire and visited one or more glacier sites during their trip to southeast Iceland. The survey consisted of self-completion questionnaires that were distributed randomly to visitors. The questionnaire was available in three languages (English, German and French) because visitors of these language groups constituted the largest groups of foreign visitors at the time the questionnaires were administered [49].

3.3. Survey Design

The questionnaire was composed of 17 closed-ended questions concerning: Visitors' personal and visitation characteristics, their motivation and experience of glacier sites, and their perception of climate change (the English version of the questionnaire is provided as Supplementary Material). To examine the effects of climate change induced environmental changes on glacier visitors' behavior, a contingent travel behavior (CTB) method was applied. This method uses hypothetical questions to obtain knowledge about travel behavior in constructed scenarios by asking visitors directly for the changes in their intended behavior contingent to changed conditions [50]. Different studies [51,52] have demonstrated the validity of the CTB method to examine visitor behavior in response to qualitative changes of recreational sites, indicating that CTB is an appropriate indicator of actual behavior. The method is directly linked to the theory of Planned Behavior [53], that posits that most social behavior is under the volitional control of the individual actor. As a result, the intention or willingness to engage in a particular behavior constitutes the best direct predictor of that behavior [54,55]. Therefore, one of the survey questions consisted of eight statements presenting hypothetical, but plausible, implications for visitors to glacier sites in the near future (2–4 years), using a 5-point Likert scale to understand respondents' willingness to visit a site under each statement. These statements were based on findings from different studies [3,10,11,28,56], and emphasize that the impacts of climate change for glacier site visitors are mostly caused by a combination of changes to glacier landscape attributes (e.g., glacier recession and surface debris cover) and managerial adaptation means (e.g., close-off access or rerouting trails). Nevertheless, they manifest themselves mostly in practical implications for the visitors, such as increased walking time to a glacier margin, reduced proximity to the glacier, or mandatory use of commercial guides or transportation to travel to or within glacier sites (Figure 2).

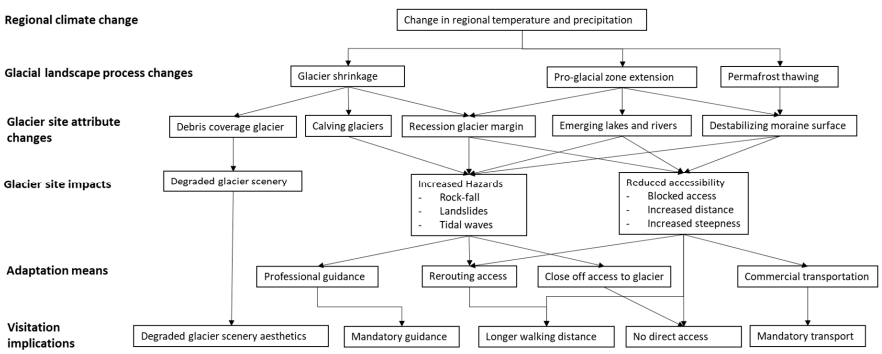

Figure 2. Relations between (regional) climate change, glacier site attribute change and impacts, and visitation implications highlighted in the questionnaire, modified from [3,10,11,28,56].

3.4. Data Analysis

In order to examine the extent of variation in visitor behavior towards climate-induced environmental changes of glacier sites, a segmentation analysis of the glacier site visitors' behavior was conducted considering the results of visitation implication statements. Instead of using a pre-processed segmentation method, a data-driven segmentation by means of cluster analysis, as is recommended by different scholars [57–59], was employed. To examine the internal consistency of the variables, and to avoid the problem of multicollinearity, a reliability measurement analysis using Cronbach alpha reliability coefficients [60] was further conducted for the eight visitation implication statements in the second stage of the analysis (Table 1). An alpha coefficient greater than or equal to 0.65 and that item total correlations greater than or equal to 0.40 indicate variables that are reliably measuring the same concept, and thus, justifies combining them in further analyses was used [61]. The reliability measurement revealed that several statements (three times two statements) were measuring the same concept, and were therefore, on the basis of their mean value, combined for further analysis.

Table 1. Reliability measurement of the visitation implication statements.

Willing to Visit a Glacier Site When … [1]	Mean	Std. Dev.	Item-Total Correlation	Cronb. Alpha	Implication Variables
The walking to the glacier edge is 45 min	3.79	1.178	0.731	0.84	Walking time
The walking time to glacier edge is 1.5 hrs.	3.44	1.267	0.731		
It is not possible to come within 150 m of the glacier	3.20	1.237	0.767	0.87	Proximity
It is not possible to touch or stand on the glacier	3.18	1.259	0.767		
It is necessary to use motorized (jeep/truck) transport	2.53	1.219	0.653	0.79	Commercial Transportation
It is necessary to take a boat for crossing a lake	2.74	1.261	0.653		
The glacier is considerably covered with debris and mud [2]	2.68	1.11	<0.4	n.a.	Scenery
It is necessary to take a guided tour for a safe passage [2]	3.06	1.31	<0.4	n.a.	Safety Guidance

[1] All statements measured on a five-point Likert scale of 1 "not willing at all" to 5 "very willing; [2] The statement variables 'Willing to visit when the glacier is considerably covered with debris' and 'Willing to visit when it is necessary to take a guided tour for safe passage' did not inter-correlate with any of the other statements, hence, were retained and not combined with other variables in a further analysis.

The measurement resulted in the following five visitation implication variables: Walking time, proximity, scenery, commercial transportation and safety guidance (Table 1). The visitors (respondents) were finally clustered based on the five visitor implication variables. Following the recommendation of Hair et al. [62], this study conducted a two-stage clustering sequence method on the five visitor implication variables using the IBM SPSS statistical software package. In the first stage, a hierarchical cluster analysis using Ward's method with squared Euclidian distance was applied to identify the number of clusters by an agglomeration schedule on the cluster analysis. A range of a possible three to six cluster solutions was examined from which the three-cluster solution was considered the most meaningful and interpretable result.

In the second stage, a K-means clustering analysis to classify the samples according to the intended adaptation behavior that best discerns them was applied. To validate the results of the cluster analysis, a multivariable discriminant analysis obtained from Hair et al. [62] was applied. This analysis examines the differences among the identified clusters, determines discriminant functions that differentiate them and assesses the accuracy level of classification of segment membership.

In the last part of the analysis, cross-tabulation with chi-square analysis and post hoc testing, using the adjusted residual method [63] and Analysis of Variance (ANOVA) with Tukey's post hoc testing, were applied. This was to explore the difference between the clusters in terms of categorical

variables (such as socioeconomic background), travel behavior, and continuous variables (such as visitors' motivation to visit regional glacier sites and their perception of climate change).

4. Results

4.1. Descriptive Overview of Glacier Site Visitor Characteristics and Their Travel Pattern

The gender division of the sample is fairly equal, 50.9% male and 49.1% female. Nearly two-thirds (65.4%) of the respondents are under 35 years old, and the average age is 34.1 years. Almost all respondents (98.5%) are non-residents of Iceland, and most reside in West Europe (France, Germany and Benelux countries) (46.1%) and North America (20.2%). Most respondents are staying between two and four days in the region (49.6%), travelling in couples (36.3%), and interested in sightseeing (71.9%), hiking (71.4%), and/or a guided glacier tour (61%) (Table 2). Almost half of the respondents (49.5%) had never visited a glacier site before. Most of them stayed between 5–10 h at each glacier site they visited (47.8%).

Table 2. Glacier site visitors' personal characteristic and conducted activities (N = 556).

Variables	Categories	N	%	Variables	Categories	N	%
Gender	Female	273	49.1	Country of residence	Iceland	8	1.5
	Male	283	50.9		Western Europe	256	46.6
Age	Under 25 years	123	22.1		UK	53	9.7
	25–34 years	241	43.3		Eastern Europe	42	7.7
	35–44 years	78	14.0		Southern Europe	46	8.4
	45–55 years	61	11.1		USA/Canada	111	20.2
	66 years and older	53	9.5		Asia/Oceania	25	4.6
					Rest of the world	8	1.5
Length of stay in region	1 day	72	16.6	Travel party	Individual	41	7.4
	2–4 days	276	49.6		Couple	202	36.3
	5–10 days	122	21.9		Family	59	10.6
	11 days or more	21	3.8		Small group	181	32.6
					Big group	61	11.0
Previous times at a glacier site	First time	275	49.5		Other	12	2.2
	1–3 times before	195	35.1				
	4–10 times before	59	10.6	Activities interested in doing in the region [#]	Sightseeing	400	71.9
	11 times or more before	27	4.9		Hiking	397	71.4
					Glacier tour	339	61.0
Hours spent at glacier sites	1 h or less	29	5.2		Swimming/bathing	189	34.0
	2–4 h	215	38.7		Camping [1]	175	31.5
	5–10 h	266	47.8				
	11 h or longer	44	7.9	Activities done at glacier sites [#]	View glacier from distance	421	75.7
					Guided walk	204	36.7
					Glacier lake boat tour [1]	84	15.1
					Ice cave tour [2]	63	11.3

Multiple responses were possible, [1] only included in the summer version of the questionnaire; [2] only included in the winter version of the questionnaire.

Regarding the conducted activities of the respondents, the results show that a large majority had viewed glaciers from a short distance (75.7%), while guided glacier hikes (36.7%), boat tours on glacier lakes (15.1%) and ice cave tours (11.3%) constitute the most popular guided glacier tours (Table 2).

On average, the respondents have a neutral stance regarding the importance of glaciers for their visit to Iceland (mean = 3.5) and for visiting southeast Iceland (3.8). The most important motivations to visit the glacier sites of the southeast part of Vatnajökull are 'Experiencing new things' (mean = 4.45), 'See a glacier in real-life' (mean = 4.34) and 'Be close to nature' (mean = 4.31). The least important motivations are 'Develop personal and spiritual values' (mean = 2.79), 'A story to tell' (mean = 3.26) and 'Visit a glacier before it disappears' (mean = 3.46) (Table 3).

Table 3. Visitor motivations and aspects important for their experience (N = 556).

Variables	Categories	Mean	SD	Variables	Categories	Mean	SD
Important motivation for glacier visit #	Experience new and different things	4.45	0.84	Importance aspects for visit experience #	Scenery	4.31	0.83
	See a glacier in real-life	4.33	0.93		Unique environment	4.29	0.83
	Be close to nature	4.31	0.90		Being in an untouched natural environment	4.16	0.94
	Thrilling Experience	3.94	1.14		Come close to glacier	3.99	1.05
	Have a change from everyday life	3.87	1.19		Seeing glacier attributes	3.95	1.08
	Experience peace and calm	3.80	1.19		Being in a challenging environment	3.68	1.15
	Friends and Family	3.51	1.36		Learning about glaciers	3.55	1.13
	Visit a glacier before it disappears	3.46	1.27		Seeing real-life impacts of climate change	3.45	1.17
	A story to tell	3.19	1.31		Weather conditions	3.43	1.17
	Develop personal. spiritual values	2.78	1.39		Size of the glacier	3.23	1.05
The importance of a glacier for #	A visit to Iceland	3.46	1.17	Climate change perception *	Climate change is happening now	4.56	0.76
	A visit to the region	3.79	1.16		Climate change is the result of human activity	4.26	0.94
					Climate change is the result of natural causes	2.99	1.17
					I am concerned about climate change	3.97	1.02

Based on Likert-scale (1 = not important at all—5 = very important); * Based on Likert-scale (1 = totally disagree at all—5 = totally agree).

Furthermore, most important for the respondents' experience during their visit to a glacier site are 'scenery' (mean = 4.31), 'unique environment (mean = 4.29) and 'being in an untouched natural environment' (mean = 4.16). These general nature values were perceived of greater importance for the respondents' experience than glacier specific aspects, such as 'Seeing glacier attributes' (mean = 3.95) or 'Come close to a glacier' (mean = 3.99). The aspects 'Weather conditions' (mean = 3.43) and 'Size of the glacier" (mean = 3.23) were perceived as being the least important.

All respondents express high levels of agreement with the statements that climate change is happening now (mean = 4.56) and that it is the result of human activity (mean = 4.26). However, they also have a neutral stance regarding the statement that climate change is a result of natural causes

(mean = 2.99), revealing some uncertainty among the respondents regarding the anthropogenic source of climate change (Table 3).

4.2. Visitors' Behavioral Response to Visitation Implication Statements

The respondents were asked how willing they would be to visit a glacier site in the area that has different potential future visitation implications. The results show that a substantial part of the respondents (46.7%) would not be willing to visit any glacier site if it was covered largely with debris (Figure 3), which supports the previously mentioned results from this study that scenery is the highest valued aspect for the visitor experience of glacier sites. The results further reveal that a considerable part of the respondents would not be willing to visit a glacier site if they would not be able to come within 150 m of the margin of the glacier (27.2%), or would not able to touch or stand on a glacier (28.2%). These results are supported by the fact that almost 76% of the respondents' activity at a regional glacier site was to view a glacier from a short distance. The implication that constrains the respondents' intended visitation the least is the amount of walking time to the glacier margin. Only a small proportion of the respondents (22.5%) were not willing to visit a glacier site if they had to walk 1.5 hrs to the glacier margin. In addition, a large part of the respondents were not willing to visit glacier sites if it was necessary to take a commercial jeep or truck to access the glacier sites (52.2%), cross a glacier lake with a commercial boat (41.9%), or take a guided tour for a safe passage to and on the glacier (31.3%) (Figure 3).

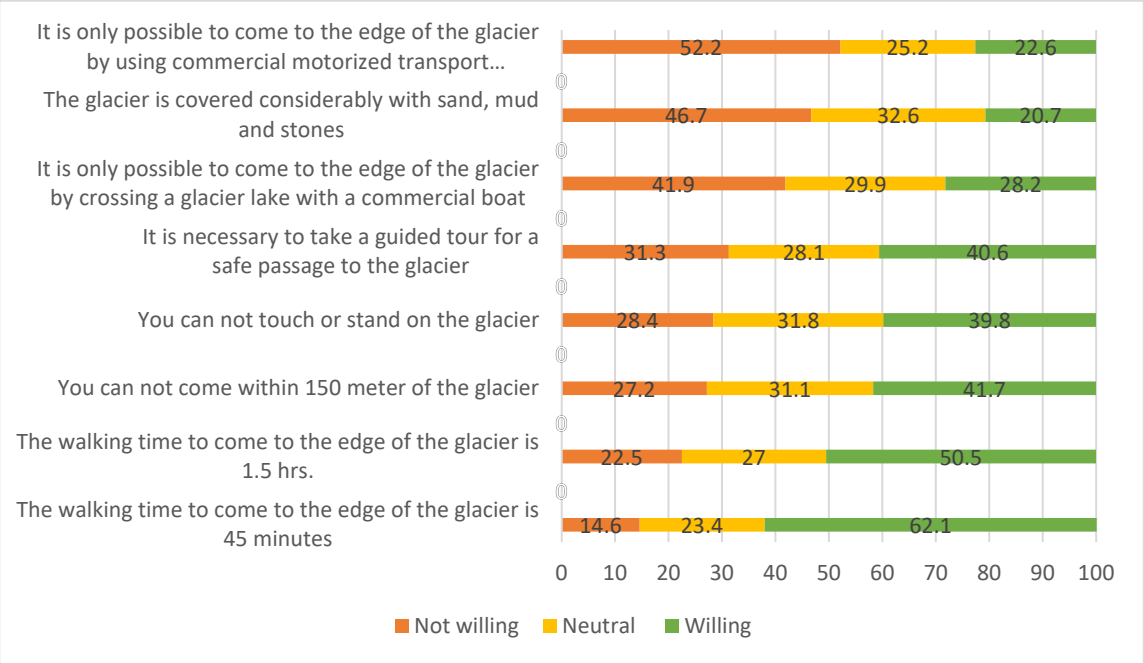

Figure 3. Respondents' willingness (in %) to visit a regional glacier site under climate-induced landscape visitation implications (N = 556). Based on a 5-point Likert scale: Not willing includes "not willing" + "not willing at all"; Neutral; Willing includes "willing" + "very willing").

4.3. Glacier Site Visitor Segments on Their Intended Visitation Behavior

The cluster analysis used to classify the visitors' responses according to the visitation implication variables that best described them, resulted in a three-cluster solution (Table 4). The results of the ANOVA tests further revealed that all five visitation implication variables contributed to differentiating the three clusters ($p < 0.001$) which were named: *Susceptible visitor*, *Resistant visitor* and *Adaptive visitor*.

Table 4. Non-hierarchical cluster analysis of visitation implications variables based on K-means clustering (N = 556).

Visitation Implication Variables	Cluster 1 (N = 169)	Cluster 2 (N = 186)	Cluster 3 (N = 201)	F	Sig.
	Susceptible visitor	Resistant visitor	Adaptive visitor		
Walking-Time	3.49	4.42	2.99	109.040	<0.001
Proximity	2.89	4.12	2.58	135.304	<0.001
Scenery	2.26	3.32	2.28	64.362	<0.001
Com.-Transportation	1.62	3.13	3.02	153.209	<0.001
Safety-Guidance	1.61	3.9	3.68	368.879	<0.001

The multivariate discriminant analysis extracted two statistically significant discriminant functions. Function 1 explained 73.7% of the variance (eigenvalue = 2.11, Wilks' Lambda = 0.183, $\chi 2$ = 934,962, Sig. = 0.000). Function 2 explained 26.3% of the variance (eigenvalue = 0.75, Wilks' Lambda = 0.57, $\chi 2$ = 309,758, Sig. = < 0.001). The classification results showed that almost all (97.2%) the 556 grouped cases were correctly classified, representing a very high rate of accuracy and reliability.

The *Susceptible visitors* constitute the smallest cluster segment (30.4%), and is the most susceptible visitor type to the climate-induced visitation implications. This segment exhibits a relatively low willingness to visit a glacier site regarding all visitation implications except walking time (mean = 3.49, 25% were unwilling to visit). This segment is inclined to avoid a glacier site when they are obliged to take a guided tour for safety reasons (mean = 1.62, 86% were unwilling to visit) or has to use motorized transport to come to the glacier margin (mean = 1.62, 92% were unwilling to visit). In addition, this type of visitor will avoid a glacier site where the scenery is degraded, due to a considerable mud and debris coverage of the glacier (mean = 2.26, 62% were unwilling to visit) or can only be viewed from a considerable distance (mean = 2.89, 38% were unwilling to visit) (Table 4).

The second cluster, the *Resistant visitor*, comprises a third of the respondents (33.5%). This segment represents the least vulnerable visitors as regards climate-induced visitation implications. These visitors are tempted to visit a glacier site without the possibility to physically encounter the glacier (mean = 4.12, 3% unwilling to visit), has an enlarged walking distance to its margin (mean = 4.42, 1% unwilling to visit), or requires professional guidance (mean = 3.9, 9% unwilling to visit). Furthermore, the resistant visitor shows a more neutral stance regarding the use of commercial transport to access a glacier site (mean = 3.13, 35% unwilling to visit) (Table 4).

The third and last cluster, the *Adaptive visitor*, is the largest (36.1%) segment and consists of visitors that are on average not willing to visit a glacier site where scenery has been considerably degraded (mean = 2.28, 57% unwilling to visit), direct access to the glacier itself is impassible (mean = 2.58, 50%unwilling to visit) and has a long walking distance to reach the glacier (mean = 2.99, 35% unwilling to visit). However, the adaptive visitor is moderately willing to visit a glacier site when they had to take commercial guidance (mean = 3.68, 6% unwilling to visit) and has a neutral stance regarding the use of commercial transportation (3.02, 34% unwilling to visit) to adapt to climate-induced safety and accessibility implications outlined in the scenario statements (Table 4).

4.4. Profiling the Segments with External Variables

The differences between the segments were further examined in terms of personal and travel behavioral attributes of glacier site visitors. The results show significant differences ($p < 0.01$) between the visitor segments in terms of socio-demographic characteristics, activity performance, visitation motives and experiences, as well as climate change perceptions.

4.4.1. Visitor Segments' Socio-Demographic Characteristics

Cross-tabulation with t-testing revealed a significant difference ($p < 0.01$) between the clusters regarding gender (Table 5). Chi-square post hoc analysis indicated that there are significantly more male respondents among the *Susceptible visitors* (59%) and significantly more female ($p < 0.008$) respondents among the *Resistant visitors* (59%).

Visitor segments also differ significantly in terms of the visitors' residence. Chi-square post hoc analysis revealed the *Susceptible visitors* group contains a significantly higher proportion of visitors ($p < 0.002$) that live in North and Western Europe (61%) in comparison with the *Resistant visitors* (49%) and the *Adaptive visitors* (33%). The *Adaptive visitor* cluster has a relatively low proportion ($p < 0.002$) of visitors from North and Western Europe (33%), but a significantly high proportion of visitors from Eastern Europe (12%). In comparison, the *Resistant visitor* cluster consists of the largest proportions of visitors from the UK (15%) and Asia (8%).

Table 5. Socio-demographics of visitor segments (N = 556).

Visitor cluster Profile (*Variable*/Categories)	Susceptible Visitor	Resistant Visitor	Adaptive Visitor	$\chi 2$	*p*-Value	Cramer's V
Gender				11.15	0.01	0.142
Female	70 (41%) *	109 (59%) *	94 (47%)			
Male	99 (59%) *	77 (41%) *	107 (53%)			
Country of residence				52.02	<0.001	0.231
N-Western Europe	101 (61%) **	89 (49%)	66 (33%) **			
USA/Canada	29 (17%)	32 (18%)	50 (25%)			
UK	7 (4%) **	27 (15%) **	19 (10%)			
Southern Europe	15 (9%)	15 (8%)	16 (8%)			
Eastern Europe	6 (4%)	13 (7%)	23 (12%) **			
Asia/Oceania	3 (2%)	6 (3%)	16 (8%) **			
Iceland	3 (2%)	0 (0%)	5 (3%)			
Rest of the world	2 (1%)	1 (1%)	5 (3%)			

* Significant at the adjust Bonferroni corrected significance level ($\propto = 0.008$); ** Significant at the adjust Bonferroni corrected significance level ($\propto = 0.002$).

4.4.2. Visitor Segments' Regional Travel Characteristics

Interests in recreational activities differ significantly between the three cluster segments. That also applies to the number of days the different visitor segments stayed in southeast Iceland (Table 6). A significantly higher percentage of visitors in the *Adaptive visitor* segment were one-day visitors (33%) of the region in comparison with the other two visitor segments, while the visitors of the *Resistant visitor* segment consist of a significantly larger proportion of visitors that stay five days or more in southeast Iceland (31%).

Visitors that are most interested in non-guided recreation activities, such as to camp and visit a museum, are significantly more numerous in the *Susceptible* and *Resistant visitor* segments than in the *Adaptive visitor* segment. Furthermore, a relatively smaller proportion of the *Susceptible visitors* is interested in different guided nature-based outdoor recreation activities, such as glacier hiking tours and snowmobile tours, in comparison with the other two segments. Furthermore, statistical tests did not reveal a significant difference between visitor segments regarding respondents' number of previous visits to glacier sites and their visitation period (summer or winter).

Results from the one way ANOVA test (Table 6) suggest that the *Susceptible visitors* spent on average significantly more time at the glacier sites (6.9 h) than *Adaptive visitors* (5 h), which is not surprising considering the significantly longer period the Susceptible visitors spends in the region compared to the *Adaptive visitor*.

The significant differences in activity interest in southeast Iceland between the visitor segments have an effect on their activity participation at glacier sites in the study area. The test results show, e.g., that *Susceptible visitors* have the largest proportion of visitors that did not take any guided tours at

a regional glacier site (63%), while this proportion was significantly smaller among *Resistant visitors* (45%) and *Adaptive visitors* (43%). Looking at the five recreational activities that most of the respondents participate in the results reveal a significantly higher percentage of *Susceptible visitors* taking part in non-guided activities, such as viewing glaciers from a distance and hiking, than the other two segments. There is a significant difference between the visitor segments with regards to their participation in guided glacier tours and viewing glaciers from a short distance. Half of the *Adaptive visitors* participated in a guided walk, compared to only 15% of the *Susceptible visitors*. On the other hand, a non-guided activity, such as viewing a glacier from a short distance, was significantly more often undertaken by *Susceptible visitors* (86%) than by the other segments.

Table 6. Visitor segments' travel characteristics (N = 556).

Visitor Cluster Profile (*Variable*/Categories)	Susceptible Visitor	Resistant Visitor	Adaptive Visitor	$\chi 2$	*p*-Value	Cramer's V
Number of days respondent stays in region				25.116	<0.001	0.150
1 day	37 (22%)	33 (18%)	67 (33%) *			
2–4 days	88 (52%)	96 (52%)	92 (46%)			
5–10 days	34 (20%)	55 (30%) *	33 (16%)			
11 days or more	10 (6%)	2 (1%)	9 (4%)			
Regional activities interested in						
Interested in camping #	53%	44%	33%	12.636	0.002	0.139
Interested in glacier tour	47%	61%	73%	29.996	<0.001	0.216
Interested in snowmobiling	11%	25%	27%	7.611	0.001	0.162
Interested in museum visit	12%	21%	10%	9.485	0.009	0.131
Tour participation				17.213	<0.001	0.240
Did not participate in guided tour	106 (63%)	83 (45%)	86 (43%)			
Did participate in guided tour	63 (37%)	103 (55%)	115 (57%)			
Activities done at glacier sites						
View glacier from a short distance	145 (86%)	142 (76%)	134 (66%)	18.338	<0.001	0.182
Guided glacier walk	25 (15%)	78 (42%)	101 (50%)	52.996	<0.001	0.309
Hiking (non-guided)	29 (17%)	22 (12%)	12 (6%)	12.573	0.003	0.144
				F-value	Sig.	Eta
Amount of time spent at glacier site(s) in the region (on average)	6.9 h [a]	6.4 h	5.0 h [a]	4.602	0.01	0.128

* Significant at the adjust Bonferroni corrected significance level ($\propto$ = 0.003); [a] Means with the same letter are significantly different on Turkey's Post Hoc test ($p < 0.05$); # Only included in the summer version of the questionnaire.

4.4.3. Motivation, Experience Aspects and Climate Change Perception

Based on the one-way ANOVA, followed by Tukey's post-hoc test, the results show significant differences in glacier visit motives between the visitor segments, as well as in aspects that contribute to the visitors' glacier site experiences (Table 7). *Adaptive visitors* find glaciers significantly more important for their visit to southeast Iceland than the visitors of other segments. They also value the motive 'A story to tell' significantly higher and the motive 'Be close to nature' significantly lower than the other visitor segments. On the other hand, *Susceptible visitors* find the motive a 'Thrilling experience' and 'Have a change from everyday life' significantly less important in comparison to the other visitor clusters. Regarding their experiences, the *Resistant visitors* found the aspects 'Scenery', 'Learning about glaciers' and 'Seeing real-life impacts of climate change' significantly more important than the other two segments.

Table 7. Visitors' cluster differences based on visitation motivation and climate change perception (N = 556).

Visitor Cluster Profile (*Variable*/Categories)	Susceptible Visitor	Resistant Visitor	Adaptive Visitor	*F*-Value	Sig.	Eta
Importance of visiting a glacier when visiting the region [1]	3.60 [a]	3.73 [b]	4.00 [ab]	5.709	0.004	0.142
Motivation to visit glacier site [1]						
Be close to nature	4.35 [a]	4.50 [b]	4.09 [ab]	5.472	<0.001	0.192
Thrilling experience	3.67 [ab]	3.96 [a]	4.14 [b]	7.967	<0.001	0.168
Have a change from everyday life	3.62 [ab]	4.02 [a]	3.93 [b]	5.472	0.004	0.140
A story to tell	2.87 [a]	3.17 [b]	3.49 [ab]	10.437	<0.001	0.192
Aspect for experience on a glacier site [1]						
Scenery	4.23 [a]	4.47 [ab]	4.24 [b]	4.811	0.008	0.132
Learning about glaciers	3.40 [a]	3.79 [ab]	3.46 [b]	6.474	0.002	0.152
Seeing real-life impacts of climate change	3.17 [a]	3.73 [ab]	3.42 [b]	10.581	<0.001	0.194
Perception of climate change [2]						
Climate change is happening now	4.57	4.70 [a]	4.41 [a]	6.983	0.001	0.157
Climate change is the result of human activity	4.28	4.40 [a]	4.11 [a]	4.533	0.01	0.127
I am concerned about climate change	3.87 [a]	4.19 [ab]	3.86 [b]	6.5	0.002	0.152
Climate change is the result of natural causes	2.73 [ab]	3.08 [a]	3.12 [b]	6.02	0.003	0.146

[1] Variables measured on five-point Likert scale of 1 "not important at all" to 5 "very important"; [2] Variable measured on five-point Likert scale of 1" totally disagree" to 5 "totally agree"; [ab] Means with the same letters are significantly different on Tukey's Post Hoc test ($p < 0.05$).

Comparisons of the segments with respect to the respondents' general perceptions towards climate change show that the *Resistant visitors* express significantly more concern regarding climate change than those in the other two segments (Table 7). On the other hand, *Susceptible visitors* agree significantly less with the statement that climate change is the result of natural causes than the other two segments.

5. Discussion

5.1. Glacier Tourism Demand Responds to Climate Change Induced Implications

The results of this study reveal that glacier site visitation demand is highly impacted by climate change. By examining multiple practical implications for the visitors on a site scale in the foreseeable future, this study goes beyond previous research on glacier visitor behavior under climate change [36–38]. This approach provides a relevant and necessary complement to the often top-down and abstract impact assessments based on multidecadal timescales, which often do not take into account the heterogeneity of visitor demand [31,64]. By translating climate change induced environmental change into various practical implications for the visitor, this study furthermore reveals that glacier site visitors' responses differ considerably between implications. These range from a limited number of visitors (27%) not being willing to visit a glacier with an increase in walking time, to a considerable number of visitor (52%) not being willing to visit a glacier when commercial transportation to reach the glacier is needed. The latter result is in line with recent studies [32,39], which indicate that management measures (such as an increase in transportation modes to adapt to changed conditions) are evenly, or more detrimental, to visitation demand than the implications that these measure attempt to abate. These studies showed that many visitors perceive the degradation of a glacier site's naturalness more negatively than the natural changes of a glacier site. An aspect highly relevant in the context of management of the glacier sites in southeast Iceland, considering the relatively high importance of the aspects 'Scenery' and 'Being in an untouched natural environment' for visitors' experience observed in this study. This corresponds with studies concerning visitor experiences in

natural areas in Iceland [65,66], supporting the importance of naturalness and limited anthropogenic impacts for visitors.

5.2. Variation in Glacier Tourists' Intended Behavior

The results furthermore show significant differences between the glacier site visitor intended behavior. This study discerned three more or less evenly divided, but significantly distinct visitor segments, i.e., *Resistant visitors*, *Susceptible visitors* and *Adaptive visitors*, that can be interpreted on the basis of Miller and McCool's [22] recreationist appraise and response framework to changed conditions. *Resistant visitors* may seem to appraise the perceived visitation implications not as undesirable or otherwise, however, when confronted with these implications they might change their perception of the implications in a more favorable manner (cognitive coping). The *susceptible visitor,* on the other hand, appears to appraise most visitation implications as undesirable, and therefore, will presumably substitute the site by conducting the same or other planned activities somewhere else, or plan their visit at a different time when conditions have improved. *The adaptive visitor* seems to appraise implications as undesirable if they include reduced proximity, lengthened walking time, or scenery degradation, but is willing to exert technical coping, i.e., using vehicles or expert skills/knowledge, in order to overcome the accessibility and safety implications of glacier sites. The results demonstrate furthermore that these three visitor segments differ significantly in demographic and cross-cultural characteristics, length of stay, activity interests and performance, motivation and climate change perception. These visitor attributes constitute underlying variables that can explain differences between the segments' intended climate-related coping behaviors. Several studies [23,24,36,67–71] support that these variables determine differences in tourist climate change adaptation behavior. On the other hand, the results also show that some attributes (i.e., previous glacier visits, period of visitation) did not significantly differ among the segments, and therefore, cannot explain glacier tourist climate-related coping behaviors that are contrary to findings in other studies, such as [24,37]. In addition, finding regarding the attribute *country of residence* reveal a significantly lower percentage of national visitors (1.5%) than similar studies that investigate glacier tourism demand [36,38]. Place of residence can have a profound influence on the visitor's perception of climate change impacts at a destination level [15]. Therefore, more research is needed to clarify how, and to what extent, these visitor attributes influence visitor adaptation behavior at glacier sites. By doing this, adaptation measures that are tailored to the type of visitors that come to those sites can be developed.

5.3. Management Implications

The results of this study will benefit both site managers and tour operators when it comes to the organization of their practices under the impacts of climate change. Being aware of the heterogeneity of glacier site visitors is important to be able to plan and manage the dynamic glacier destinations and better meet environmental, as well as visitors' demands. The results from this study indicate that visitor segmentation can reveal potential trade-offs between strategies to facilitate glacier site visitors under environmental changes in the near future. For example, to overcome visitor implications, such as safety and accessibility, measures like monitoring, extending, and adjusting walking paths to the glacier margin would be acceptable management options to accommodate the *Susceptible* and *Resistant visitors*. However, such measures can have negative consequences for the *Adaptive visitors*, who are (on average) less willing to walk long distances. Moreover, such measures are both time-consuming and labor-intensive, and hence, can absorb a considerable part of area management's financial and labor capacity. On the other hand, the permittance and build-up of road transportation or aircraft carrier infrastructure instead of walking path networks are likely to keep the *Susceptible visitor* away and can have negative consequences for both visitors' visitation satisfaction and the natural environment [39,72]. Disclosure of these trade-offs underlines the necessity to consider climate change adaptation as an integral part of the organization's sustainable development strategies. Nevertheless, Welling and Abegg [28] point out that the current climate change strategies of glacier tour operators and area

management to cope with changing environmental conditions in southeast Iceland are a combination of wait-and-see and reactive adaptation. These reactions are likely to be common at other glacier sites. Such a strategy most probably falls short to accommodate *Susceptible* and *Adaptive visitors* under rapidly emerging environmental changes when pro-active adaptation is needed to achieve safe direct access to a glacier margin in the future.

Pro-active strategies, such as the implementation of a recreational zoning system based on recreational preferences to accommodate different visitor types and prevent land-use conflicts can overcome potential trade-offs, as described above. This is supported by several studies [73–75]. However, in a dynamic environment, such as rapidly changing glacier sites, a more effective solution is to stimulate the diversification of tour products. Considering visitors' diverse interest in non-glacier-based activities, such as hiking, sightseeing and camping, tour product diversification is a sound adaptation in dynamic glacier sites. In addition, the results indicate that receding glaciers present an opportunity to educate visitors about the realities of climate change considering that almost half of the respondents found the aspects learning about glaciers and seeing real-life impacts of climate change important for their experience at glacier sites. Stewart et al. [38] came to a similar conclusion based on comparable results of their visitor survey. In addition, Lemieux et al. [13] argue that tourists' interest in visiting climate change impacted destinations and their desire to learn about environmental change can be used in planned communication and education strategies at glacier sites to promote climate change awareness. Similar to findings in [32,38,72], the results in this study show that a relatively high percentage of the respondents agree that climate change is caused by natural sources (33%). This indicates that explaining the link between glacier recession and the anthropogenic emission of greenhouse gases is necessary information in visitor communication strategies. Tour operators should attempt to fuse this growing interest in 'last chance tourism' and learning about glaciers into new recreational products that will inform visitors about climate change, in order to broaden their understanding of the topic, while enhancing their stewardship towards glaciers or the cryosphere in general. *Resistant visitors*, in particular, consider educational aspects significantly more important for their glacier site experience than the other two segments, proving to be a market segment for such educational tour products.

This study is determined by its regional context as it only includes glacier site activities conducted in southeast Iceland. The limited scope of the glacier activities makes generalization of glacier site visitors' behavior under climate change on a global level challenging. A comparative study between visitors of glacier destinations worldwide is therefore recommended to draw general conclusions on the impacts and responses of glacier site demand towards climate change induced changes of glacier destinations. This study is furthermore based on a limited number of questions of an in-situ visitor survey, as suggested by Veal [76]. This caused a certain limitation as the scenario statements were not composed of multiple visitor implications, or implications that arise from socioeconomic change, such as crowding or an increase in visitor facilities. Hence, an integration of multiple socioeconomic and natural environmental changes into future outlooks is a more effective and realistic way to analyze the impacts of climate change on, and responses from, recreational demand than examining these in isolation [77,78]. This study stresses the critical importance that glacier site stakeholders need to be alerted about how to best manage and organize glacier destinations. It supports that further research on the impacts of climate change on glacier visitation should implement choice experiments methods [79] or participatory scenarios planning methods [80] to address multiple natural and socio-economic implications.

6. Conclusions

Over the last decades, climate change has led to widespread shrinking of the cryosphere, which has affected many glacier destinations around the world. Despite the urgency for glacier destinations to adapt to climate change, so far, only limited research has examined the responses of glacier site visitors to climate change impacts. This study is one step towards filling that knowledge gap. It demonstrates

that climate change induced environmental changes greatly affect nature-based tourism demand, and furthermore that the responses of glacier visitors to those changes vary considerably across visitation implications and visitor segments. This study benefits both site managers and tour operators when it comes to organizing their practices under the impacts of climate change. It may be concluded that potential shifts in tourism demand can be abated by the implementation of adaptation measures that are in line with visitor segments' behavior. This study demonstrates that visitors are critical actors in socio-ecological systems, such as glacier destinations. Therefore, to facilitate future glacier visitation, sustainability should be continually considered by decision-makers and practitioners, and thus should incorporate visitor segment differences into their planning, education, communication efforts, and product development.

Supplementary Materials: The following are available online at http://www.mdpi.com/2071-1050/12/13/5338/s1, Supplement S1: Visitor survey questionnaire.

Author Contributions: Data collection, data analysis and writing—original draft preparation, J.W.; writing—review and editing, R.Ó. and Þ.Á. All authors have read and agreed to the published version of the manuscript.

Funding: This research was supported by the University of Iceland Eimskip Fund [Háskólasjóðir Eimskipafélags].

Acknowledgments: The authors are grateful to the Vatnajökull National Park for allowing the conduct of a visitor survey inside the park and accommodate the first author during the survey period.

Conflicts of Interest: The authors declare no conflict of interest.

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