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Does witnessing the effects of climate change on glacial landscapes increase pro-environmental behaviour intentions? An empirical study of a last-chance destination.

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Does witnessing the effects of climate change on glacial landscapes increase pro-environmental behaviour intentions? An empirical study of a last-chance destination

Due to the effects of climate change, tourist locations such as glacial landscapes are increasingly becoming last-chance tourism (LCT) destinations. LCT is paradoxical: although visitors to such locations possess high environmental awareness, their travel generates greenhouse gas emissions that threaten these destinations. However, visiting LCT destinations and observing glacial landscapes threatened by climate change may positively affect pro-environmental behaviour. This article aims to explore how experiencing receding glaciers can influence intentions to adopt pro-environmental behaviour. A quantitative survey of 284 visitors to a major glacier tourism site in France (Montenvers-Mer-de-Glace) was caried out to test the influence of landscape, emotions, satisfaction, and LCT-related motivations on intentions to adopt pro-environmental behaviours. The results show that landscapes perceived as symbolic of climate change, LCT motivations, and overall satisfaction positively influenced pro-environmental behaviour intentions. To further encourage such intentions, stakeholders should promote practices based on education and experience.

Keywords: Glacier Tourism; Climate Change; Last-Chance Tourism; Pro-environmental behaviour; Landscape; Sustainability

Introduction

Last-chance tourism destinations have become an important aspect of tourism during the current age of climate change (Lemelin & Whipp, 2019). Last-chance tourism can be defined as "a niche tourism market where tourists explicitly seek vanishing landscapes or seascapes, and/or disappearing natural and/or social heritage" (Lemelin et al., 2010; p. 478). Polar bear tourism was the first form of LCT to be thoroughly

investigated (e.g., Hall & Saarinen, 2010), and more recently, glacier tourism has emerged as a form of LCT (e.g., Lemieux et al., 2018). LCT is paradoxical: visitors travel long distances to see landscapes and ecosystems endangered by climate change; however, the GHG emissions emitted while traveling to such destinations threaten these very landscapes and ecosystems (Dawson et al., 2010). In addition, people who visit such locations are climate change conscious and environmentally aware (Eijgelaar et al., 2010; Dawson et al., 2011). Flying to remote destinations contradicts their beliefs and values regarding climate change and the environment. As a result, LCT is associated with cognitive dissonance (Salim & Ravanel, 2020). Therefore, it is questionable whether LCT can promote environmental awareness when considering LCT's negative impact on landscapes and ecosystems (Dawson et al., 2011). Moreover, there is little research on whether visiting areas affected by climate change leads visitors to better understand the consequences of their actions on the environment (Miller et al., 2020; Salim & Ravanel, 2020).

LCT, and especially glacier tourism, may play a role in promoting pro-environmental behaviour (PEB), which is defined as "an action by an individual or group that promotes or results in the sustainable use of natural resources" (Halpenny, 2010; p. 410). Regarding glacier tourism, Groulx et al. (2019) demonstrated that even the most climate-aware visitors were not willing to pay a tax to offset the carbon footprint of their trip. However, place attachment, which is defined as the emotional and symbolic meanings attributed to a place by a visitor (Manning, 2011), promotes acceptance of carbon offsetting (Groulx et al., 2019). Additionally, it has been shown to be a significant predictor of the intention to adopt PEB (Halpenny, 2010; Ramkissoon et al., 2012). Visitor's relationship with nature also influences their behaviour. For example, Goldberg et al. (2018) demonstrated that the more connected to nature visitors

to the Great Barrier Reef feel, the more likely they are to behave in a way that protects the reef. Scenic landscapes, both virtual and real, also appear to influence behaviour (Sheppard, 2005), as do the interpretive and learning elements that managers develop (e.g., Powell & Ham, 2008). Moreover, because glaciers are visually spectacular and "emotionally charged" landscapes (Farber & Hall, 2007; Metro-Roland & Soica, 2018), and because emotions have a strong impact on behaviour (Halpenny, 2010; Notaro et al., 2019), visiting an endangered glacier tourist site could impact visitor's PEB.

Therefore, this article explores the following question: Can observing glacier landscapes increase visitors' intentions to develop PEB? This study assesses the correlation between visitors' intentions to implement PEB and their perception of landscapes; it also examines which variables explain intention to adopt PEB. More generally, this work tests the hypothesis that visiting glacier tourist sites ("climate sentinels" and LCT destinations) influences PEB.

Literature review

Several theoretical approaches have been used to study pro-environmental behaviours, ranging from the theory of planned behaviour, which states that behaviours result from intentions, to the value-belief-norm theory of environmentalism (VBN), which considers values, norms, and ecological worldviews as antecedents of PEB (Steg & de Groot, 2018). Our study is embedded with VBN theory and attempts to clarify the influence of scenic landscapes, which serve as indicators of the effects of climate change, on behavioural intentions.

Pro-environmental behaviour intentions

Recent studies show that even the most environmentally engaged people "forget" their commitments to environmental sustainability during the holidays (e.g., Juvan &

Dolnicar, 2014; Juvan et al., 2016). In response, tourism operators have developed carbon offset tourist experiences. Although carbon offset systems are highly controversial (Gössling et al., 2007), it has been used as an indicator of the proportion of tourists willing to make a financial commitment to "protect" a destination (Mair, 2011; McLennan et al., 2014). However, the ability of carbon offsetting to reflect PEB is limited. Measuring the adoption of certain behaviours as a result of an experience is costly; however, research in environmental psychology has focused on measuring the pro-environmental behaviour intentions (PeBI) that appear to be indicators of future behaviour (Fishbein & Ajzen, 1975; Kraus, 1995). Place attachment has mainly been used to predict such intentions, and a consensus has formed regarding the positive influence of place attachment on PeBI (Halpenny, 2010; Ramkissoon et al., 2012). Wildlife experiences, which result in improved connections between humans and nature, are also affective at promoting PeBIs (Clark et al., 2019). Moreover, recent research demonstrates that nature-based experiences that provide opportunities to reflect on the environment are likely to increase PeBIs. Accordingly, we hypothesize that encounters with glaciers and glacial landscapes enable visitors to reflect on environmental issues and, in turn, increase visitors' PeBIs.

Last-chance tourism in the context of glacier tourism

LCT is a concept that has been employed by Dawson et al. (2010), Eijgelaar et al. (2010), Hall and Saarinen (2010), and Lemelin et al. (2010). Building on the classical definition of Lemelin et al. (2010) provided in the introduction, Fisher and Stewart (2017; p. 514) define LCT as "tourism motivated by the belief that the things of interest (places, people, or objects) may either cease to exist or may not be possible to visit, in the future, prompting a sense of loss". This tourism niche was first conceptualized in the context of polar cruises (Eijgelaar et al., 2010) and polar bear tourism (Dawson et al.,

2010); however, the term can also be applied to glacier tourism (Groulx et al., 2016; Stewart et al., 2016) and other tourist destinations, such as the Great Barrier Reef (Piggott-McKellar & McNamara, 2017). Although LCT is primarily related to landscape and ecosystems, a recent study linked it to the emergence of LCT in a village threaten by dam construction (Cakar & Seyitoglu, 2021).

In the context of glacier tourism, LCT includes four motivational dimensions: the urgency to see a glacier before it disappears, the desire to observe a retreating glacier, the wish to understand the implications of climate change on the environment, and the drive to witness an endangered landscape (Salim & Ravanel, 2020). These different motivational dimensions suggest that visitors to LCT destinations may be receptive to measures to mitigate climate change. However, a recent study conducted on the Athabasca Glacier in Canada demonstrated that most glacier tourists are unwilling to purchase carbon offsets despite their awareness of climate change issues (Groulx et al., 2019). Another study that reviewed the carbon footprint of polar bear tourism in Churchill, Canada, a popular LCT destination, found that its carbon footprint has increased in the past 10 years, and that visitors to Churchill still possess a limited understanding of the environmental impact of their travel since the 2007 survey (D'Souza et al., 2021). In contrast, a study on the potential pro-environmental outcomes of LCT in Kaktovik, Alaska found that observing polar bears can increase intentions to adopt environmentally friendly behaviours (Miller et al., 2020). Another recent study on the Mont Blanc massif suggests that glacier landscapes are considered symbols of climate change (Salim, Ravanel, & Gauchon, 2021). It is therefore possible that emotions felt during LCT experiences may affect behaviour.

Following research on LCT that focused on its negative aspects or paradoxical nature (Lemelin & Whipp, 2019), a new field of research emerged that aimed to

understand the potential positive outcomes of this tourism niche (Groulx et al., 2019; Hindley & Font, 2018; Miller et al., 2020; Salim, Ravanel, & Deline, 2021). To the best of our knowledge, no study has examined the influence of LCT-related motivations on PEBs. However, studies (e.g., Hoberg et al., 2021) have shown that nature-based tourism motivations are correlated with increased critical reflection on the state of the natural elements in question. Thus, since LCT motivations are related to the perception of the natural world as being endangered, we hypothesise (H1, Figure 1) that a strong LCT motivation will be correlated with a strong PeBI.

Landscape perception and emotions

Emotion has no strict definition; however, it is often understood as the result of an evaluation of a lived experience (Frijda, 1988). Emotions are the result of a complex interaction between different factors mediated by the neural and hormonal systems. Emotion can "(1) give rise to affective experiences such as feelings of arousal, pleasure/displeasure; (2) generate cognitive processes such as emotionally relevant perceptual effects, appraisals, labelling processes; (3) activate widespread physiological adjustments to the arousing conditions; and (4) lead to behaviour that is often – but not always – expressive, goal directed, and adaptive" (Kleinginna & Kleinginna, 1981). Scenic landscapes elicit emotions (Farber & Hall, 2007) that are essential to tourism experiences (Bigné & Andreu, 2004); such emotions can also have behavioural outcomes (Kleinginna & Kleinginna, 1981). Among the two main paradigms that exist in research on scenic landscapes, we adopted the subjectivist paradigm, which argues that landscapes exists only in the mind of the observer (Jacobsen, 2007).

Despite the importance of landscapes in glacier tourism, few studies exist on this topic; even fewer studies have been conducted on the emotional aspects of glacier tourism. The few published studies show that visitors to glacier tourist sites are aware of

glacier changes (Moreau, 2010; Garavaglia et al., 2012; Stewart et al., 2016) and that the ecological integrity of the sites is important regarding their satisfaction linked to the landscape (Groulx et al., 2016; Weber et al., 2019). A recent study found that visitors to the Mer de Glace in the French Alps had a positive perception of the landscape despite its rapid change. Negative perceptions were directly linked to the change of the glacier itself but did not significantly affect visitors' overall satisfaction (Salim, Ravanel, & Gauchon, 2021). Moreover, glacier landscapes seem to generate emotions that can influence PEB (Salim, Ravanel, & Deline, 2021). Considering that landscapes symbolic of climate change can raise awareness regarding the consensus of climate change science (Metag, 2020), viewing and experiencing glaciers, which can be considered symbols of climate change, may be a vehicle for improving PEB. That is, because intentions to adopt environmentally friendly behaviours can be linked to emotions and perceived elements in the landscape, we hypothesize (H2; Figure 1) that a visitor's perception of glacial landscapes as symbolic of climate change is positively correlated and explains PeBI.

Furthermore, Salim, Ravanel, and Gauchon (2021) found that visitors' satisfaction with the landscape can be explained by various factors, including the perception of the rate of glacier retreat and the experience of mountain sports. Therefore, we propose a secondary hypothesis: landscape satisfaction is related to the perceived elements of a landscape, and this satisfaction is correlated with PeBI (H3 and H5; Figure 1). Finally, we hypothesize that travel and sociodemographic characteristics may influence PeBI (H4; Figure 1).

Materials and methods

This study aims to clarify whether the experience of a glacial landscape influences visitors' PeBIs. Two main hypotheses were tested: The first hypothesis (H1) is that LCT

motivation influences PeBI. The second hypothesis (H2) is that emotions and perceiving glacial landscapes as symbolics of climate change influences PeBI. Three additional secondary hypotheses were also tested. The third hypothesis (H3) is that satisfaction with a visit influences PeBI. The fourth hypothesis (H4) is that characteristics of the visit influence PeBI. Finally, the fifth hypothesis (H5) is that perception of a landscape influences satisfaction (Figure 1).

Characteristics of the study site

To test these hypotheses, we selected the Montenvers Mer de Glace as a test site. Located in the Mont Blanc massif in the European Alps, the Mer de Glace is the largest French glacier (~30 km²) and one of the most visited glaciers in the French Alps with approximately 400,000 visitors per year. From Chamonix, which receives 7.7 million overnight tourist stays per year and composed of 49% of international visitors before the COVID-19 pandemic (G2A consulting, 2019), the site is reachable via cogwheel train. Various activities can be enjoyed on site. Visitors can tour an ice cave drilled into the glacier, visit Glaciorium, a glacier learning centre, or hike. The Montenvers is open year-round but 75% of visitors come during summer (*Compagnie du Mont Blanc* data).

A study by Salim and Ravanel (2020) demonstrated that many visitors come to see the glacier because it is retreating. The shrinkage of the glacier has been rapid: its thickness at Montenvers has shrunk by 32%, and its length decreased by 1.5 km between 1900 and 2018 (Vincent et al., 2019). The most recent model estimates that the glacier will no longer be visible from the Montenvers by 2050 (Peyaud et al., 2020). Changes in the landscape are already evident, including the loss of glacier volume and the expansion of its debris cover (Figure 2).

Survey design

A quantitative survey was designed to test our hypotheses. The questionnaire included nine parts: place attachment, PeBI, nature relatedness, landscape perception, emotions, LCT motivation, satisfaction, trip characteristics, and socio-demographic characteristics.

Place attachment contains five items from Manning (2011). PeBI contains eight items from Halpenny (2010), and it was designed to measure general and place-based intentions. The nature relatedness scale is based on the work of Dunlap et al. (2000) on the New Ecological Paradigm framework; the five items were redesigned according to a study by Bernstein and Szuster (2019) to better conform to the current worldview. The 11 items used to measure landscape perception, and the six emotion items were all based on a study by Salim, Ravanel, and Gauchon (2021). LCT motivations were measured using two items from Salim and Ravanel (2020). The five items for measuring satisfaction and revisit intention were based on the authors' knowledge of the location and other glacier tourism studies (Groulx et al., 2016; Welling et al., 2020). All items used a Likert scale (1 = totally disagree; 5 = totally agree). Fourteen additional items were included to capture socio-demographic and trip characteristics. Finally, we added a question for measuring visitors' willingness to pay for carbon offsetting. The survey included 86 questions and required an average of 8 minutes for participants to complete.

Data collection and analyses

The survey was conducted by a team of one to three researchers using tablet computers and SphinxMobile software (Ganassali, 2014) during the summer of 2020. Field campaigns took place on 6 sunny days during July and August, the season of highest attendance. During opening hours (9 a.m.–5 p.m.), visitors were invited to participate

either in French or English, after a brief explanation of the purpose of the survey. Due to a limited number of tablets, when a group was approached, a maximum of 3 people were given the opportunity to participate. Because the purpose of the study was to understand potential positive outcomes of visiting a glacier site, we did not approach alpinists bypassing the viewing area to reach one of the five mountain huts of the Mer de Glace basin.

Data obtained were analysed using SPSS v26 (Cronk, 2019). The analyses performed included descriptive statistics, exploratory factor analyses, Spearman correlations, T-tests, ANOVAs, and regression analyses.

Limitations

The COVID-19 pandemic represented a limitation for this study. During normal times, approximately 50% of visitors to the Montenvers come from abroad. The current dataset shows that only 20% of respondents were foreigners, and only two participants (0.9% of the total sample) lived outside Europe. However, the number of visitors to Chamonix during July 2020 was relatively high considering that the number of international visitors was expected to have decreased.[1] This implies that a new domestic market, which is driven by yet unknown motivations, has emerged. This could impact perceptions of nature and motivations that have not yet been measured. Despite this limitation, we assumed that the main elements of the survey related to the perception of the landscape remained largely unaffected, and that the survey would provide initial insights into the influence of these elements on intentions to adopt PEB. It is crucial to note that the results underrepresented non-European visitors; in a previous study at this

[1] Interview with Chamonix Tourist Office representative, 29/07/2020.

site, non-Europeans comprised 11.8% of all respondents (Salim & Ravanel, 2020).

Results

The dataset contains 301 completed surveys, among which 17 (5.64%) were removed because of missing values or because the respondent was under 16. Descriptive statistics (Table 1) show that respondents were 16–88 years old (median: 43) with an equal number of men and women. Among respondents, 63% were university graduates. Sixty percent had spent 2–7 days in the Chamonix Valley, and 90.5% had travelled from their homes via car. Among respondents, 85.5% had been aware of the existence of the Mer de Glace before travelling to the region. First-time visitors represented 63% of the respondents, and 48.1% of second-time visitors had last visited less than 11 years earlier.

Climate change perception, LCT motivation, and environmental worldview

A total of 268 respondents (94%) considered climate change to be a presently occurring phenomenon; moreover, 222 respondents (78%) thought climate change was anthropogenic. Additionally, 184 respondents (65%) reported the desire to see the glacier before its disappearance to be an important or very important motivation for their trip, and 117 (41%) respondents considered better understanding the significance of climate change as an important motivation. Cronbach's alpha was calculated to test the LCT motivation scale reliability; it provided an acceptable score of 0.700. The Spearman-Brown coefficient was calculated because this test is less biased for two-item scales, and it provided an acceptable score of 0.701 (Nunnally, 1978).

To reduce the number of variables for further analysis, exploratory factor analysis (EFA) was conducted with nine items. With an acceptable Kaiser-Mayer-Olkin (KMO) of 0.625 and a significant Bartlett's test of sphericity of 0.000 (Andy, 2013), the

analysis produced three different factors after removing cross-loaded items (Table 2). Factor 1 includes items related to climate change perception and was labelled accordingly. Factor 2 includes items related to technological solutions and was labelled "techno-optimism". Factor 3 includes items related to nature-relatedness and was labelled "nature use". The reliability of the climate change perception scale was demonstrated with an acceptable Cronbach's alpha of 0.630; however, the scores for the two other factors were under the minimum reliability of 0.600 ($\alpha f2 = 0.543$; $\alpha f3 = 0.296$; Nunnally & Bernstein, 1994); therefore, these factors were removed from further analysis.

Pro-environmental behaviour intentions

When asked "would you agree to pay an (optional) supplement fee to your ticket if it would protect the glacier?", 81% of respondents answered either "yes" (34.9%) or "maybe yes" (46.5%), indicating that a price in the range of 1–115 € (mean = 15 €; median = 5 €) was considered a fair price. Results from the different items intended to measure intentions to adopt PEB demonstrated that most respondents were generally in favour of the intention to implement PEB. The intention to choose a destination closer to home for holidays was an exception, with only 47.9% of respondents stating that it was probable they would take such an action (Figure 3).

EFA was conducted to understand the underlying structure of PeBI and reduce the variable numbers for further analyses. After ensuring that no item loaded at more than 0.30 in different factors (Stevens, 2012), 10 items loaded in two different factors explaining 54.89% of the total variance (Table 3). EFA reliability was acceptable with a KMO of 0.881 and a Bartlett's test of sphericity of 0.000. Factor 1, which was labelled "general intentions", was comprised of seven items related to general behaviour. Factor

2, which was labelled “place-based intentions”, was composed of three items related to glaciers. The Cronbach’s alpha was calculated for each factor, and it produced acceptable results for f1 ($\alpha = 0.831$) and f2 ($\alpha = 0.686$).

Landscape perception and emotional responses

The scores for the items related to the perception of the landscape (Figure 4) demonstrated that more than 93.9% of respondents agreed with the statement that the landscape is being affected by climate change. Concerning aesthetic appreciation, 95.8% of respondents considered the landscape to be “wonderful”, and 76% considered the glacier to be “beautiful”. Such sentiments were coherent with landscape satisfaction as 75.9% reported that the landscape met their expectations, compared to the 61.1% who felt that the glacier met their expectations. Among respondents, 63.7% reported experiencing sadness, 62.1% experienced surprise, 49.5% experienced delight, 46.6% experienced anger, 41.3% experienced happiness, and 15.1% experienced optimism.

EFA was conducted on the 17 landscapes and emotion items to reduce the number of variables for further analyses. After removing cross-loaded items, 13 items remained; these items were loaded on four different factors and explained 67.3% of the total variance with a KMO of 0.747 (Table 4). Factor 1, which was labelled “sense of beauty”, included four items related to the beauty of the landscape. Factor 2, which was labelled “signs of climate change”, included four items related to the symbolic effect of climate change on the landscape. Factor 3, which was labelled “happiness felt”, was composed of three items about the positive outcomes of landscape viewing. Finally, Factor 4, which was labelled “landscape satisfaction”, included two items. Cronbach’ alpha was calculated for each factor, and the results indicated an acceptable reliability for each factor ($\alpha f1 = 0.742$; $\alpha f2 = 0.789$; $\alpha f3 = 0.714$; $\alpha f4 = 0.790$). Place attachment

was measured using a two-item scale, providing a reliable Cronbach's alpha and Spearman-Brown coefficient of 0.634.

Satisfaction and revisit intentions

In addition to the landscape satisfaction items presented above, several items were used to measure general visitor satisfaction. In total, 80% of respondents were satisfied or very satisfied with their visit to the Montenvers. Visitor satisfaction with the ice cave was lower, with only 64% of respondents reporting being satisfied or very satisfied. This was confirmed by the finding that 67% of respondents stated that they would have come even if there was no ice cave. In comparison, only 54% of respondents stated that they would have come even if there was no glacier. Finally, only 50% of respondents believed they would return to the Montenvers in the future.

Correlation analyses

The correlations between the various factors composed of continuous variables were assessed using Spearman's correlation; the results are presented in Table 5. As expected, LCT motivation correlates with general intentions ($r = 0.410$) and place-based intentions ($r = 0.275$). LCT motivation also moderately correlates with place attachment ($r = 0.403$), the perception of the landscape as beautiful ($r = 0.172$), and the perception of a landscape as symbolic of climate change ($r = 0.331$). A slight correlation was found between LCT motivation and general satisfaction ($r = 0.158$) and between LCT motivation and satisfaction with the ice cave ($r = 0.149$).

General intention to adopt PEB was positively correlated with the perception of the landscape as beautiful ($r = 0.166$), the perception of the landscape as symbolic of climate change ($r = 0.375$), climate change perception ($r = 0.318$), willingness to visit the site even if there were no ice cave ($r = 0.214$) or glacier ($r = 0.127$), place

attachment (r = 0.410), and general satisfaction (r = 0.189). Place-based intentions positively correlate with perception of the landscape as being beautiful (r = 0.227), the perception of the landscape as symbolic of climate change (r = 0.384), climate change perception (r = 0.341), general satisfaction (r = 0.237), place-attachment (r = 0.303), and willingness to visit the Montenvers even if there were no ice cave (r = 0.184).

Unsurprisingly, landscape satisfaction was correlated with the perception of the landscape as beautiful (r = 0.450) and the perception of the landscape as a vector of happiness (r = 0.401); moreover, it was also correlated with general satisfaction (r = 0.479), revisit intention (r = 0.387), and place attachment (r = 0.289).

The influence of trip and socio-demographic characteristics on PeBI was tested by conducting various analyses of variance (ANOVAs). The mean of general and place-based intentions was compared to academic degree, annual income, and the duration and type of accommodation during the stay. None of these ANOVAs yielded significant results.

For the two-element categorical variables, independent sample T-tests were carried out to compare the correlation of PeBI with gender, whether visitors' had prior knowledge of the Mer de Glace before arriving in the region, whether visitors visited the Glaciorium and ice cave, and whether it was a visitor's first visit. None of these tests proved to be significant.

Linear regression analyses

Results of the linear regression analyses provided models that significantly explain general ($F = 13.12$; $p < 0.001$; $R^2 = 0.36$; adj. $R^2 = 0.34$) and place-based intentions ($F = 10.95$; $p < 0.001$; $R^2 = 0.27$; adj. $R^2 = 0.24$). Multicollinearity issues can be rejected because the variance inflation factor (VIF) coefficient of all the predictors were <10 with a tolerance of <0.3 (Field, 2005).

The analyses demonstrate that LCT motivation, apparent signs of climate change in the landscape, and place attachment significantly predicted general intention. Signs of climate change, place attachment, and overall satisfaction significantly predicted place-based intention (Table 6). The results show that place attachment and the perception of climate change in the glacial landscape positively influence general and place-related intentions. Conversely, LCT motivations positively influence only general intentions, and satisfaction only positively influences place-related intentions.

Discussion

Overall, the results demonstrate that perceiving glacial landscapes as threatened by climate change positively influences PeBIs. This indicates that although LCT often results in high GHG emissions generated by visitors, it could also have positive effects if managed properly. Previous studies have shown that engagement in PEB drops during vacations (Juvan & Dolnicar, 2014); in this context, our study shows that reducing travel distance remains the least shared intention among the visitors.

Visit influence on PeBI

First, our findings validate former studies (Groulx et al., 2019; Halpenny, 2010; Ramkissoon et al., 2012) and demonstrate that place attachment positively influences PeBI. Several of our initial hypotheses were validated (Figure 5). Primarily, the first hypothesis was validated because LCT motivation was shown to be highly correlated with PeBIs. However, the linear regression showed that only general intentions were explained by this factor. In accordance with the claims of Salim and Ravanel (2020), LCT motivation was positively correlated with climate change perception, confirming that visitors who engage in LCT are aware of climate change. This awareness also correlated with PeBI, indicating that visitors who are aware of climate change have a

strong intention to adopt environmentally friendly behaviours. These results correspond with the finding that LCT visitors are more likely to engage in PEB, which has been suggested elsewhere (e.g., Miller et al., 2020).

The second hypothesis was also validated because significant evidence was found regarding the relation between perceptions of the landscape, the emotions visitors experience, and PeBIs. Positive perceptions and the experience of happiness did not correlate with PeBI despite a sense of beauty displaying a slight correlation with PeBI. However, the signs of climate change factor, which captures feelings and perceptions of the landscape, related to climate change, was correlated with PeBI, and it significantly explained both general and place-based intentions. That is, the more visitors perceived the glacial landscape as a sign of climate change, the more likely they were to implement behaviours to mitigate climate change. This element is directly related to the perception of climate change, which is demonstrated by the correlation of this factor ($r = 0.480$) with the signs of climate change factor. This result can be understood in terms of perceived threat: Seeing a changing glacial landscape as a direct consequence of climate change increases one's intention to act. This is consistent with a recent study on ski tourism in China that showed that the mitigation of a climate problem is seen as more urgent when a climate problem is perceived as posing a direct threat to skiing activity (Chen et al., 2020). Conversely, Miller et al. (2020) found that the PeBIs of visitors to Kaktovik in Alaska were negatively correlated with the number of bears seen; that is, seeing many bears made visitors feel that the threat to the bear population was low, which, in turn, diminished visitors' intention to act. Moreover, Groulx et al. (2019) suggested that witnessing a changing landscape can make people take notice of the implications of the carbon emissions that result from tourist activity and, in turn, enhance PeBI.

The third hypothesis was partially validated by the finding that general satisfaction is slightly correlated with PeBI, and it explained place-based intentions with a p-value of < 0.05. However, no relation emerged between PeBI and specific satisfaction or revisit intention. In their study, Ramkissoon et al. (2013) found that place satisfaction was positively correlated with low-effort PeBI. This difference between low- and high-effort PeBI did not appear in our study; however, the relation between place-based intentions and satisfaction suggests that visitors are more likely to implement behaviours that directly protect the place they visited. This assumption seems coherent with Lee et al. (2019), who found a moderate correlation between place loyalty and PEB in the context of tourism in China. More research is needed to further investigate these relations.

The fourth hypothesis was rejected because there was no significant relationship found between PeBI, trip characteristics, and socio-demographics. Therefore, it appears that the characteristics of visitors do not influence their intention to adopt environmentally friendly behaviours. This result contrasts with other studies that found that certain respondents' characteristics influenced PeBIs (e.g., Lindsey et al., 2007). Outside of the tourism context, Kahan (2010) and Kahan et al. (2012) suggest that one's concern for climate change is related to a conflict of interest linked more to cultural values than concrete variables, such as educational level. Therefore, popularizing information that demonstrates that the impacts of climate change threaten the individual interests of visitors can be effective in promoting PEB.

Unsurprisingly, for the fifth hypothesis, landscape perception was correlated with satisfaction and revisit intention. However, only positive perception displayed such a correlation. Conversely, the signs of climate change factor displayed no correlation

with satisfaction despite being correlated with PeBI. The perception of the landscape as a symbol of climate change is therefore related to PeBI but not to satisfaction.

Management implications for enhancing PeBI

Our findings confirm other studies suggesting that LCT may contribute to encouraging PEB (Powell & Ham, 2008; Eijgelaar et al., 2010; Miller et al., 2020). However, it remains the responsibility of the stakeholders of LCT destinations to promote these behaviours. Education and experiences are two key points to focus on to encourage PEB.

In this context, education is related to the cognitive abilities, rational thinking skills, and knowledge that visitors can obtain during visits. Seventy-eight percent of visitors to the Montenvers believe that climate change is a real phenomenon, which conforms to a national opinion poll that found that 79% of the French population was aware of climate change (Boy, 2020). However, in-depth knowledge seems crucial to ensuring that the processes are well understood. For example, visitors' PeBI in Kaktovik decreased when the number of polar bears viewed increased because of a lack of knowledge about why so many polar bears are seen at the same location at this time (Miller et al., 2020). Our finding that understanding the link between glacial landscape change and climate change, influences intentions to act suggests that on-site education about these dynamics can increase PeBI. A potential educational initiative could be to connect what visitors' see in a landscape with scientific knowledge. Furthermore, as Kahan et al. (2012) demonstrate, it is important to show how climate change – as reflected in glacier retreat – is a threat to visitors' interests and how visitors, as citizens, can act.

In addition to education, the experience may be an effective vehicle for promoting PEB. An environmental epiphany is defined as "an experience in which

one's perception of the essential meaning of her/his relationship with nature shifts in a meaningful manner" (Vining & Merrick, 2012; p. 497); such an experience can have a significant outcome in terms of PeBI (Miller et al., 2020). This is corroborated by Salim, Ravanel, and Deline (2021), who showed that emotional responses to the landscape correlate with PeBI. In addition, other studies have argued that people's relation to nature and their ability to understand it is key to promoting environmentally friendly behaviours (e.g., Kim et al., 2018; Martin et al., 2020). Furthermore, other studies have shown that environmental identity can accurately predict PEB (Clark et al., 2019; Goldberg et al., 2018). Promoting nature tours that combine educational instruction with nature experiences could elicit epiphanies and increase people's willingness to adopt environmentally friendly behaviours. In the context of glacier tourism, guided tours onto or around a glacier could be an effective way to achieve this goal. Such an approach is being developed by the association *ProNatura* at the Aletsch Glacier in Switzerland. Future studies should consider the experiences of participants of these tours and the potential benefits of such tours in terms of promoting PEB. Finally, despite the fact that the glacier itself can be negatively perceived by visitors (Salim, Ravanel, & Gauchon, 2021), it seems important to promote "an aesthetics of beauty" (Bennett, 2020) that can motivate people to protect glaciers; moreover, promoting "an aesthetics of beauty" could also lead to solutions that could be implemented on an individual and collective scale. The challenge is therefore to relay alarming messages while imbuing visitors with the desire and means to adopt environmentally friendly behaviours and accept environmentally friendly policies.

Although it is outside of the scope of this paper, the need to reduce GHG emissions requires a discussion about the role of the destination scale. The GHG emissions at Chamonix-Mont-Blanc are mainly generated by tourists' travel to the

destination (Clivaz & Savioz, 2020); therefore, promoting PEB via experiences of glacial landscapes must be theorized within the broader framework of GHG reduction. Otherwise, one-dimensional thinking will intensify the paradoxes associated with LCT.

Conclusions

This exploratory study investigated which theoretical constructs related to nature-based tourism can help clarify visitors' intentions to adopt environmentally friendly behaviours in the context of LCT. In addition to supporting the finding that LCT may promote PeBI, this study also confirmed that landscape perception, place attachment, and satisfaction are correlated with PeBI. Moreover, this study clearly demonstrated that signs of climate change in glacial landscapes explained PEB. Therefore, it is clear that glaciers, as endangered ice bodies, have an important role to play in the transmission of scientific knowledge related to climate change. To be effective, we argue that communications directed at the public must contain educational, experiential, and emotional aspects. This exploratory study is expected to facilitate further research on PEB. The relationship between PeBI and place attachment is increasingly well understood. However, future studies should be conducted to confirm the relationship between visit satisfaction and PeBI. Similarly, it is necessary to further explore how the perception of landscapes influences PeBI. Finally, how visitors perceive and understand environments may partially explain PeBI. For example, although the techno-optimism scale is statistically unreliable, analyses have demonstrated a negative relationship between techno-optimism and PeBI. A more in-depth understanding of how cultural cognition affects PeBI is necessary to better promote PEB. Moreover, the mechanisms related to PEB must be studied in the context of geographical scale, difficulty of implementation, and potential benefits. While navigating this vast field of research, it is important to identify concrete solutions that can be implemented to improve PEB.

Efforts must be made to provide visitors with clear and complete information to enable them to better interpret the landscape in light of current scientific knowledge. These actions can be carried out through both learning elements as well as visits led by experienced people in the field. It seems important that learning elements include information about the consequences of climate change for individuals and solutions that can be envisaged at this scale. Finally, conveying the idea of beauty and eliciting environmental epiphanies could be key to promoting PEB in the context of LCT and beyond.

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Figures

Figure 1. Research hypothesis

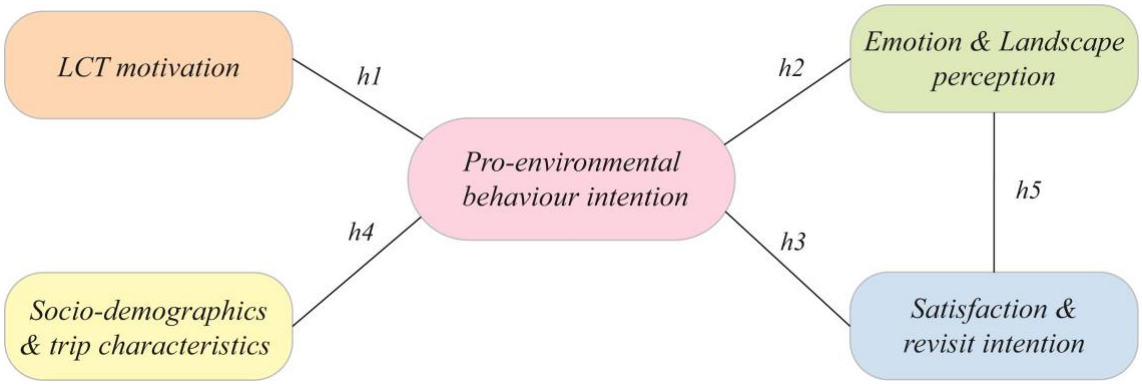


Figure 2. Landscape change from the Montenvers viewpoint (a: 1949 - coll. ETH Zurich; b: 2020)

Figure 3. Agreement of visitors with the various PeBI items

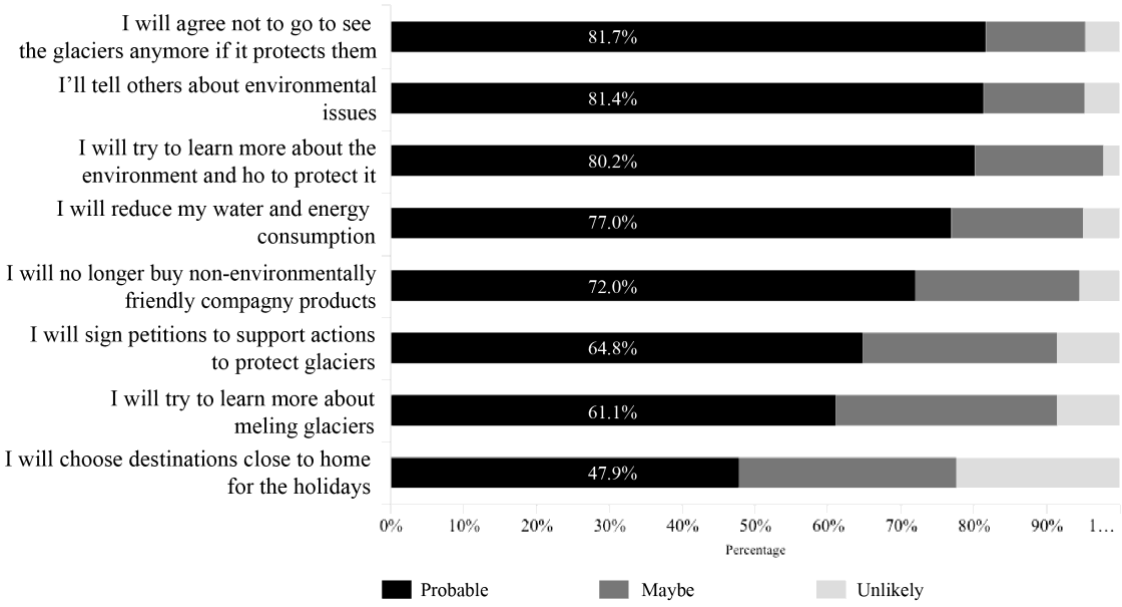


Figure 4. Agreement of visitors with the various landscape perception items

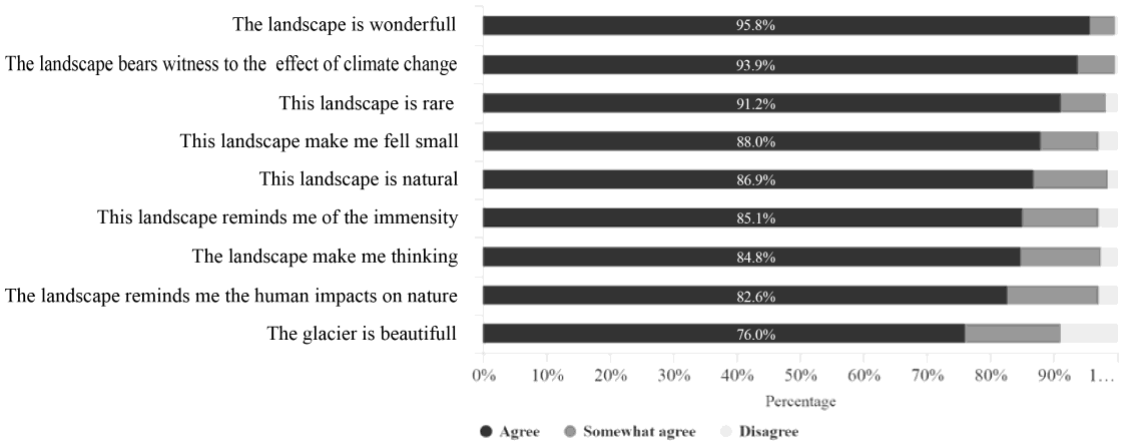
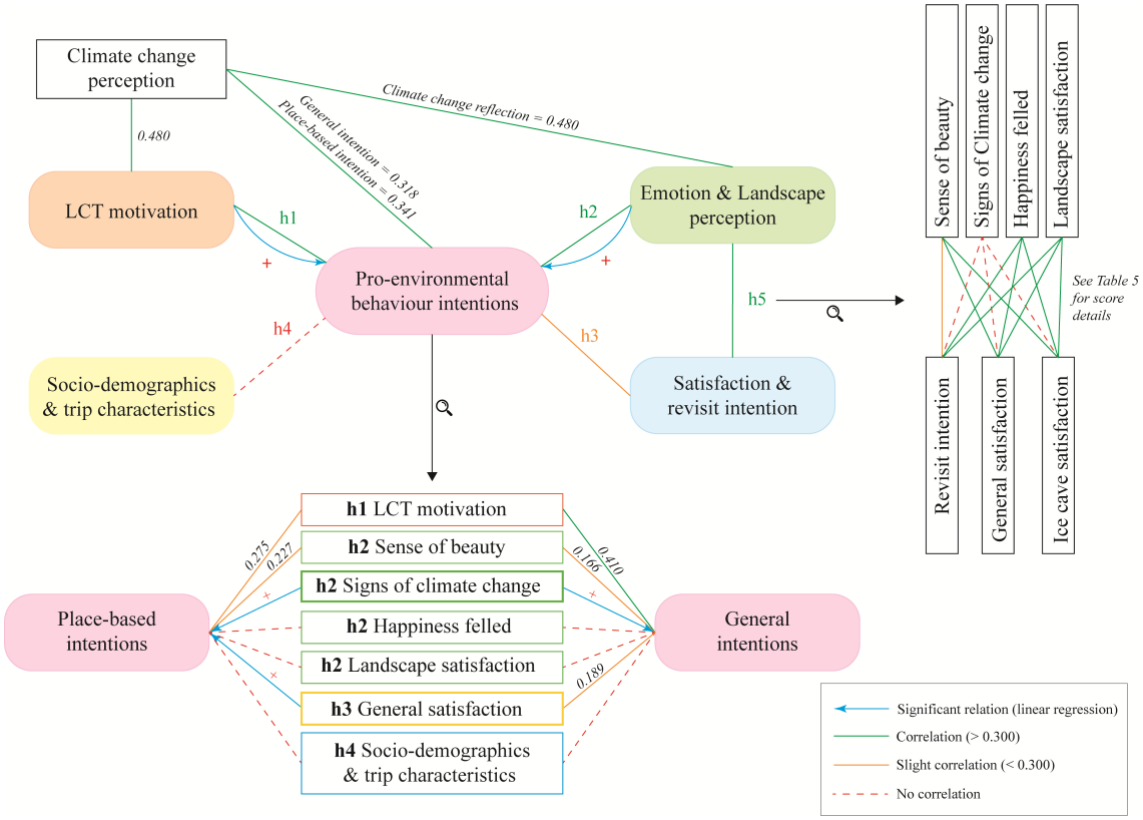


Figure 5. Synthesis of the results and hypothesis validation



Tables

Table 1. Demographics and visitation characteristics

Demographic	Categories	Sample *N = 284*
Sex		*n = 272*
	Female	135 (49.6%)
	Male	137 (50.4%)
Age		*n = 284*
	Range	16-88
	Median	43
Country of residence		*n = 281*
	France	224 (78.9%)
	Belgium	14 (5%)
	Netherlands	12 (4.3%)
	Germany	9 (3.2%)
	Switzerland	8 (2.8%)
	Other country	5 (1.8%)
First visit		*n = 284*
	Yes	179 (63.0%)
	No	105 (37.0%)
Visit of the Glaciorium		*n = 284*
	Yes	91 (32%)
	No	193 (68%)
Visit the Ice Cave		*n = 284*
	Yes	188 (66.2%)
	No	96 (33.8%)
Trip length		*n = 283*
	< 1 night	21 (7.4%)
	2 to 5 days	101 (35.7%)
	6 to 7 days	71 (25.1%)
	8 to 15 days	68 (24.0%)
	> 15 days	9 (3.2%)
	Local people	13 (4.6%)

Table 2. EFA from visitor's climate change perception and Environmental Worldview

	f1 Climate Change perception	f2 Techno-optimism	f3 Nature use
The current climate change is mainly human-driven	0,834		
Current climate change is real	0,642		
Glaciers like this are important for humanity	0,372		
Technology will solve environmental problems		0,655	
Humans are ingenious enough to ensure that the Earth does not become unlivable		0,609	
The answers to environmental problems must mainly come from the top (State, Europe)		0,401	
Humans are part of nature			0,453
Plants and animals have the right to exist as much as humans			0,451

Extraction Method: Principal Axis Factoring.
Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 7 iterations.

Table 3. EFA of pro-environmental behaviour intention items

	1 General intentions	2 Place-based intentions
I'll tell others about environmental issues	0,780	
I will try to learn more about the environment and how to protect it	0,777	
I will try to learn more about melting glaciers	0,765	
I will no longer buy non-environmentally friendly company products	0,703	
I will reduce my water and energy consumption	0,624	
I will choose destinations close to home for the holidays	0,446	
Seeing the glacier give me the willingness to act for the environment	0,431	
I will sign petitions to support actions for protecting glaciers		0,750
I agree not to go seeing the glaciers anymore if it protects them		0,576
Would you agree to pay an (optional) supplement fee to your ticket if it would help to protect the glacier?		0,571

Extraction Method: Principal Axis Factoring.
Rotation Method: Oblimin with Kaiser Normalization.

a. Rotation converged in 4 iterations.

Table 4. EFA of landscape perception and emotion

	1 Sense of beauty	2 Signs of climate change	3 Happiness felt	4 Landscape satisfaction
The glacier is beautiful	0,717			
This landscape reminds me of the immensity	0,700			
This landscape is rare	0,623			
The landscape is wonderful	0,590			
Seeing the glacier makes me sad		0,821		
Seeing the glacier makes me angry		0,813		
This landscape reminds me of the human impacts on nature		0,630		
This landscape bears witness to the effects of climate change		0,598		
Seeing the glacier brings me happiness			0,973	
Seeing the glacier enchants me			0,713	
Seeing the glacier makes me optimistic			0,381	
The landscape meets my expectations				0,835
The glacier meets my expectations				0,754

Extraction Method: Principal Axis Factoring.
Rotation Method: Oblimin with Kaiser Normalization.
a. Rotation converged in 6 iterations.

Table 5. Spearman correlation

	LCT motive	General intentions	Place-based intentions	Sense of beauty	Signs of Climate change	Happiness felled	Landscape satisfaction	Climate Change perception	Place Attachement	Visit without ice cave to see	Visit without glacier to see	Revisit intention	General satisfaction	Ice-cave satisfaction
LCT motive		**,410****	**,275****	**,172****	**,331****	0,006	0,034	**,295****	**0.403****	0,063	0,009	0,064	**,158****	**,149***
General intentions	**,410****		**,481****	**,166****	**,375****	0,009	0,106	**,318****	**0.410****	**,214****	**,127***	0,096	**,189****	0,017
Place-based intentions	**,275****	**,481****		**,227****	**,384****	-0,086	0,112	**,341****	**0.303****	**,184****	0,094	0,096	**,237****	0,055
Sense of beauty	**,172****	**,166****	**,227****		**,152***	**,317****	**,450****	**,279****	**0.404****	**,197****	**,167****	**,268****	**,359****	**,335****
Signs of Climate change	**,331****	**,375****	**,384****	**,152***		**-,206****	0,005	**,480****	**0.167****	**,156****	0,056	-0,059	0,084	-0,022
Happiness felled	0,006	0,009	-0,086	**,317****	**-,206****		**,401****	-0,084	**0.283****	**,226****	**,221****	**,301****	**,364****	**,303****
Landscape satisfaction	0,034	0,106	0,112	**,450****	0,005	**,401****		0,104	**0.289****	**,281****	**,226****	**,387****	**,479****	**,368****

**. The correlation is significant at the 0.01 level (bilateral).

*. The correlation is significant at the 0.05 level (bilateral).

Table 6. Results of the regression analyses

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
General intentions	(Constant)	1,049	0,357		2,939	0,004
	LCT motivation	0,160	0,039	0,249	4,045	**0,000***
	Signs of Climate change	0,204	0,049	0,254	4,140	**0,000***
	Climate Change Perception	0,106	0,073	0,088	1,456	0,147
	Place attachment	0,208	0,046	0,267	4,560	**0,000***
	How long is your stay in the region?	-0,048	0,030	-0,088	-1,611	0,108
	Is this your first visit to Montenvers?	0,130	0,075	0,096	1,735	0,084
	How old are you ?	0,003	0,003	0,061	1,144	0,254
	What is the level of the highest qualification acquired?	0,024	0,018	0,071	1,323	0,187
Place-Based intentions	(Constant)	0,653	0,479		1,362	0,174
	LCT motivation	0,084	0,046	0,115	1,812	0,071
	Sense of Beauty	0,047	0,080	0,038	0,585	0,559
	Signs of Climate change	0,201	0,061	0,219	3,286	**0,001****
	Happiness felled	-0,093	0,054	-0,112	-1,717	0,087
	Climate Change Perception	0,141	0,090	0,102	1,562	0,120
	Place attachment	0,173	0,063	0,194	2,761	**0,006****
	How long is your stay in the region?	0,062	0,036	0,100	1,738	0,083
	I think I will come back to Montenvers	-0,030	0,044	-0,045	-0,693	0,489
	I am satisfied with my visit to Montenvers	0,161	0,063	0,167	2,541	**0,011*****
	How old are you ?	0,002	0,003	0,027	0,474	0,636

* p < 0.001; ** p < 0.01; *** p < 0.05