Using AI to Tailor Image-Based Environmental Campaigns

The role of place attachment, sense of place, type and level of climatic effects shown

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Abstract

This research explores the significance of considering place attachment in attempts to evoke a response from individuals through environmental campaigns. The study utilizes artificially generated images to examine the effectiveness of different types and levels of climatic effects next to place attachment on campaign outcomes. The methodology involved generating images using stable diffusion, either from scratch or based on real-life photos. An electronic survey was conducted with two distinct participant groups located in Reykjavík and Groningen. The collected data was analyzed through multinominal regressions. The results indicated that participants with high place attachment tend to rank the images showing their location higher, while participants with lower place attachment in both countries tended to rank generic imagery higher. Analyses revealed significant correlations between the highest ranked image and factors such as sense of place, place attachment and the climatic effect of 'disaster'. However, no significant statistical relationship was found between the type of living environment and image setting in the highest-ranked image. The most frequently chosen images were related to pollution and extinction in the top rankings, and severe imagery was popular regardless of participants' level of climatic concern. These findings highlight the importance of considering place attachment in drafting environmental campaigns.

Introduction

As the world seems to be focused on activating people's awareness of environmental issues, there seems to be a struggle considering translating this awareness into active ecological behavior (Latinopoulos et al., 2018). Most image-based campaigns try to call upon human sentiments to care about the planet and climate change, conjuring images of particular natural areas or wildlife under distress (O'Neill & Smith, 2014). However, the role of place attachment when it comes to tailoring environmental campaigns is overlooked - especially in urban settings. One of the tools that may not come to mind immediately but which can be used in environmental initiatives is artificial intelligence (Cowls et al., 2021; Luccioni et al., 2021). There is an educational element in the existence of AI software in that it enables artists or researchers to visually generate the potential effects or aftermath of climate change in a specific landscape even if they have not happened yet. One way in which this can lead to a call-to-action response is by bringing climate change closer to home, underlining the personal relevance to whoever sees it. Artificially generated images, in this case, thus also enable us to test which type of potential climatic effect evokes the strongest reaction and whether a sense of place attachment seems to overrule the efficiency of disassociated imagery. This research will do so by means of generating images and subjecting participants to them. In turn, it is hoped to uncover the potential strength of personalized environmental campaigns. With modern algorithms enabling the possibility of various degrees of personalization in terms of content consumption, images could be adjusted in real-time tailored to the characteristics and preferences of each individual user. This individualization could be based largely on hardware information and social media usage (Campbell et al., 2020; Kietzmann et al., 2020; Schelenz, Segal, and Gal, 2020). This research aims to test the role of various variables in how to best tailor image-based environmental campaigns in order to evoke a call-to-action type of response. The main research question as such will be whether people's sense of place attachment translates into their emotional reaction to certain images – for example, whether people who feel attached to their place of residence respond more strongly to images of their place of residence undergoing a negative effect than to generic images. Additionally, it will be investigated whether urban respondents with high place attachment react more strongly to urban-coded imagery. The last sub-questions are whether any specific type of climatic effect (e.g. flooding, drought, pollution, disasters and the disappearance of certain natural features) and the strength of this effect will impact people's response. By having participants respond to a survey, it is hoped a specific combination of the four factors will have the strongest reaction. The research will be informed by a theoretical framework regarding emotional reactions to specific types of environmental imagery against which the survey will be tested. This includes a conceptual model and several hypotheses to be tested using statistical analyses. The discussion section will relate the results to all aforementioned concepts.

Theoretical framework

As mentioned before, the research questions will be answered by presenting the participants with the question to rank artificially generated images, three pools of twelve images to be precise, on the basis of how much it would incite them to support an environmental cause. Since the images will have been meticulously designed, it is important to set out the thought process behind the makeup of each image. The following section will discuss how the theory of place attachment and emotional response will be translated into the building of the specific images, and how image setting, type of climatic event and level factor into it as well.

There is evidence that place attachment, that being the physical, ecological, emotional and symbolic bond or connection between a place and its people, is an indicator of enthusiasm regarding environmental protection (Bartel & Graham, 2015; Hernández et al., 2010; Walker & Ryan, 2008). In testing perceptions of and reactions to climate change consequences, it has also been proven that psychological distance from the subject has the ability to influence the intensity of these emotional reactions (Ejelöv et al., 2018). With this, it is implied that the more distance a participant feels between themselves and the emotion-eliciting subject, the weaker the emotional response and pro-environmental sentiments are (Wang et al., 2018), as participants feel less likely to be affected by the depicted or described climatic effects. Moreover, research has demonstrated that when exposed to proximal threats, participants showed more basic emotions such as fear and anger (Giner-Sorolla, 2001). Such emotions, albeit perhaps negative, could be useful when it comes to spurring responsible ecological behavior. As proven by research, the factor of 'moral anger' was found to be the most significant predictor of pro-environmental behavior, encouraging people to protect their environment (Montada & Kals, 2000). It might therefore be compelling to determine whether negative climatic consequences depicted in landscapes close to where the participants live will correlate with a stronger emotional reaction. If this stronger reaction would translate into the participants placing these particular images higher in their personal ranking, it would imply that bringing the negative effects in closer mental proximity could indeed lead to increased relatability and spur pro-environmental behavior (Brügger et al., 2015; Wang et al., 2018). In literature, some difference is underlined between place attachment and sense of place. According to Jorgensen and Stedman (2001), the 'sense of place' is an umbrella term encompassing place attachment and other concepts, that denotes not only the subjective nature of the concept but also includes the geographical, historical and social context of the human connection between a locational bond and its sense, referring to aesthetics, rootedness, place identity, sense of dwelling and 'insideness' (Kyle & Chick, 2007). What has made research about place attachment and environmentalism complex in the past is that the concepts of place attachment and place identity were often used interchangeably, whereas the first pertains to emotional bonds while the latter to the cognitive development of one's own identity, both in regards to place (Hernández et al., 2007).

Based on research, the images generated for this study will display not only different settings, but also different types and levels of climate change. In regards to the setting, both urban and rural landscapes will be shown. This is because, especially when it comes to natural landscapes, there seems to be a strong correlation between attachment to even just natural resources and positive attitudes towards ecological behaviors. There seems to be less consensus about urban areas. While on one hand there is evidence that urban place attachment could possibly translate into an increased sense of community and social cohesion, in turn leading to increased involvement in pro-environmental behavior (Hernández et al., 2010; Walker & Ryan, 2008), it seems natural place attachment actually predicts pro-environmental behavior while urban or civic place attachment does not (Scannell & Gifford, 2010). Additionally, studies have shown participants more consistently exhibiting attachment to natural places instead of urban ones (Korpela et al., 2009). It has been suggested that further research on place attachment and environmentalism should consider these two dimensions separately for further understanding (Scannell & Gifford, 2010). For this reason, this research will take into account this urban-rural divide specifically.

The different types of climate change depicted in the presented images will be based on risks listed in Walsh-Daneshmandi & MacLachlan (2000), Böhm (2003) and Böhm and Pfister (2001), which focus on mental representations of certain types of climate change consequences. From these lists, effects such as 'species extinction', 'water pollution', 'air pollution', 'polar ice melting', 'natural disasters', 'floods' and 'adverse weather' (such as drought) were taken as inspiration for the pool of images generated for this research. These were all events that were differently ranked not only in cognitive awareness but also in the strength of emotional response (Böhm, 2003). According to Grob (1991), it is suggested that individuals who experience stronger emotional reactions are more likely to engage in pro-environmental actions. This reliance on emotions to drive behavioral change might be surprising, as common sense suggests that changing behavior can be challenging. Furthermore, the need for emotional involvement helps to explain why campaigns focused on protecting large, charismatic animals receive broader public support compared to more abstract issues like climate change. These campaigns are more relatable and tangible, whereas some parts of climate change, which is primarily understood through mathematical models, lack immediate and concrete perception (Kollmuss & Agyeman, 2002), such as drought and the disappearing of natural features. In order to create an effective environmental campaign, it would be helpful to know which type of climatic effect generates the strongest emotional reaction, hence why it is taken as a factor in this research.

Lastly, although images are a popular tool in environmental campaigns, stemming from their quality to provoke an emotion or collective action response, the effects of different types of images remain underreported (Gulliver et al., 2020). Essentially, the images used in this research might be considered a form of negative marketing. It must then be kept in mind that it is widely believed better to avoid evoking negative emotions that are too intense in nature (Kollmuss & Agyeman, 2002), but that rather subtlety can be more efficient (Meng and Trudel, 2017; White et al., 2019; Cialdini, 2003). The level of climate change effects depicted in the images will therefore range from subtle to severe as well to see if this claim holds true for this sample of respondents. Additionally, familiar visuals like pictures of deforestation or thin polar bears have proven to be easily understood but at the same time regarded with cynicism when discussed (Chapman et al., 2016). Building on this, another focal point will be to see whether participants with lower senses of either place attachment or sense of place tend to react to generic imagery more strongly as opposed to locational-specific imagery. In that case, they would place generic images higher up in their ranking order as opposed to participants with strong sentiments of place attachment. In general, there seems to be a knowledge gap regarding the most effective way of visually engaging individuals within the public and whether a personalized approach could be effective.

A conceptual summary of the theoretical framework can be seen below in Figure 1. The concept of 'emotional distance' refers to whether the image shown to the participant is either generic or location-bound. The location-bound images can then be further divided into locations that are either recognizably close to the participant's place of residence or explicitly showing imagery from a different specific location. In order to bring this distinction to fruition, it was decided to collect data from two geographically separated groups. The two locations chosen were The Netherlands, particularly the city of Groningen, and Reykjavík in Iceland. While these cities do not have strong social or cultural ties, therefore unlikely to cause much overlap, they were mainly chosen for the fact that data collection would be possible, as the researcher has lived in both cities.

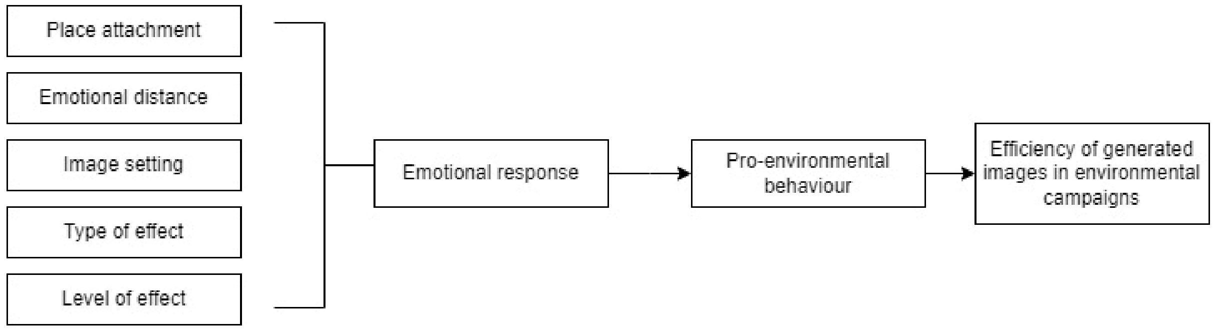

Figure 1 – Conceptual model displaying the core concepts of the study

Building on this theoretical foundation, there are several hypotheses to be tested. In terms of testing place attachment, the basic hypothesis is that participants who report high rates of enjoyment regarding the place they reside are more likely to rank the images higher that shows their city under climactic stress. The null hypothesis, in this case, is that place attachment rating and the particular type of image the participant ranks the highest are not related. The second hypothesis is that there are specific types of climate change effects that will evoke stronger reactions than others. Every region experiences climate change in a specific way, and depicting flood in an area where floods rarely occur or are not likely to occur in the future as a result of climate change is predicted to be less efficient as it may prove to be unrealistic and in turn counter-productive. Despite little social ties, both Reykjavík and Groningen are likely to experience similar effects; e.g. flooding (either from dike failure or glacial outburst floods) and droughts/heat waves. A third hypothesis is that the level of climate change effect in the images combined with self-reported environmental concern will have an effect on which images are highly ranked. The generated images differ significantly with regard to graphic range, with some portraying deceased animals and others subtle dried-up vegetation. It could be fruitful to determine whether showing severe effects might create a sense of exaggeration and in turn be less efficient.

Methodology

To conduct the research, an electronic survey was sent to two separate groups of students, spread by means of student WhatsApp groups and university email - via the Ugla portal in Iceland and the Brightspace portal in Groningen. While there were several options regarding survey platforms, the University of Groningen highly recommends the software Qualtrics (University of Groningen, 2023) for secure data collection. At the end of the survey, the participants were asked to share the link with others. It is important to note that this could be considered a method of convenience sampling (or 'snowball sampling') where one specific demographic group, namely students, is the dominant group in responding. This warrants an awareness of a possible bias in the data, as researchers have observed that whereas previously younger people showed higher levels of environmental concern, this has gradually transitioned into a positive relationship between age and level of concern (Liu et al., 2014).

In order to generate the images to be shown to the participants, Stable Diffusion was used. Stable Diffusion, published by StabilityAI in 2022, can be used to generate images based on conditioned textual input. The deep-learning model works with the LAION-5B database (meaning 5 billion available image-text pairs) and has other functions such as in- and outpainting and image translation (Borji et al., 2023). Generation was conducted by means of the open-source web interface called 'Automatic1111' (https://github.com/AUTOMATIC1111/stable-diffusion-webui), which is able to generate images either completely from scratch by means of textual prompts or an image-to-image basis where the user uploads an image to be altered using prompts. The interface was run from Google Drive via Google Colab, and a total of 36 images were created, which were then subdivided into three separate batches. All three batches consisted of four Iceland-related images, four images related to The Netherlands and four spatially dissociated images. The generic imagery was made solely from textual prompts, while the place-bound images were either altered using the 'inpaint' or 'img-2-img' function. In this way, AI was employed as a tool to create visual representations of possible scenarios that have not happened yet.

Since choice randomization within the image ranking led to problematic data export, the images were not randomized for each participant entry. Rather, the order of the images was exactly the same for every participant but was decided beforehand by means of dice throws, to ensure a random initial presentation. Nevertheless, caution is due as the lack of randomization may have influenced how participants perceived and responded to the options presented in the survey. After data collection, multinomial logistic regression was run over the data as the images shown have been coded with tags (such as [NL], [urban], [pollution] and [severe]).

Participants are asked where they live and how they would describe their living environment. For this, participants were able to select urban, suburban or rural, providing data for the hypothesis of whether their image ranking correlates with the living environment they indicate. Additionally, participants were presented with a series of statements to rate on the basis of a Likert 1-5 scale – with the indicated spectrum ranging from 'strongly disagree' to 'strongly agree'. The statements are taken from Semken & Freeman (2008) and Williams & Vaske (2003), and based on their research, questions 2, 3, 4 and 8 were taken as indicators for place attachment, with the other four for sense of place. After this section, participants were be asked to rank the three batches of twelve images. The question serving as the baseline during the process was "Which of these images would most likely make you support an environmental campaign?". The question was formulated in this manner explicitly to gauge how strongly an image would elicit an active pro-environmental call-to-action response. At the end of the survey, respondents are presented with final statements about personal feelings concerning climate change. This section follows the image ranking so as to not influence the participants beforehand. The statements can once again be answered on a Likert 1-5 scale and consist. The full makeup of the survey can be found in Appendix 1.

The data generated by the survey will be analyzed according to the conceptual model shown in Figure 1. The concept of image setting refers to the pool of images containing both 'urban' and 'natural' settings. The type of effect denotes one of the four types of adverse climatic ramifications, namely 'flood', 'drought', 'disappearance of natural feature/species', 'disaster' and 'pollution'. The level of the effect shown in an image will be coded as either 'subtle' or 'severe'.

Results

The survey yielded a total of 68 respondents, split relatively in the middle with 31 respondents from Iceland, 33 respondents from The Netherlands and four respondents from other countries. Had the survey yielded more respondents from countries other than Iceland or The Netherlands, a separate analysis could be performed on their ranking choices in regards to having no location-bound options to choose from. However, as such a small sample does not suffice, the five respondents were not included in the general analysis. The images referred to in the following sections can be found in Appendix 2. It is important to note that during the data collection, the format of the image ranking within the Qualtrics interface, namely dragging and dropping, was not experienced as mobile-friendly, leaving some people to terminate the survey before completion. The findings may therefore be limited by a relatively low amount of responses for particular variables, e.g. rural respondents. For the sake of brevity, place attachment and sense of place will henceforth be referred to as PA and SP in this section.

Place attachment

The top four most frequent rankings are visualized in Figure 2. For the first batch of images, participants living in the Netherlands that had high self-reported PA frequently chose to rank Dutch imagery higher than Icelandic imagery. For example, the image of a shopping street in Groningen flooded and a littered Noorderplantsoen both appeared in respondents' top-four 15 times. While the Icelandic imagery was overall ranked lower by Dutch participants with high PA, the generic images of the polar bear and the non-descriptive shanty town scored high. In the second batch, the polluted Dutch highway and generic image of a forest fire scored highest, followed by the image of a Groningen canal with algae. Lastly, in the third batch, the highest-ranked images were the dead whales, subsidence from flooding, the generic polluted river and heavy weather with a windmill. Both the Dutch imagery of a farmer looking over dead crops and a small forest fire scored below the 5th and 6th rank. The participants living in Groningen who report low levels of PA rank generic images higher more often than Dutch imagery, including for example the image of the urban landslide, the forest fire, the aerial picture of a flood and the polluted river.

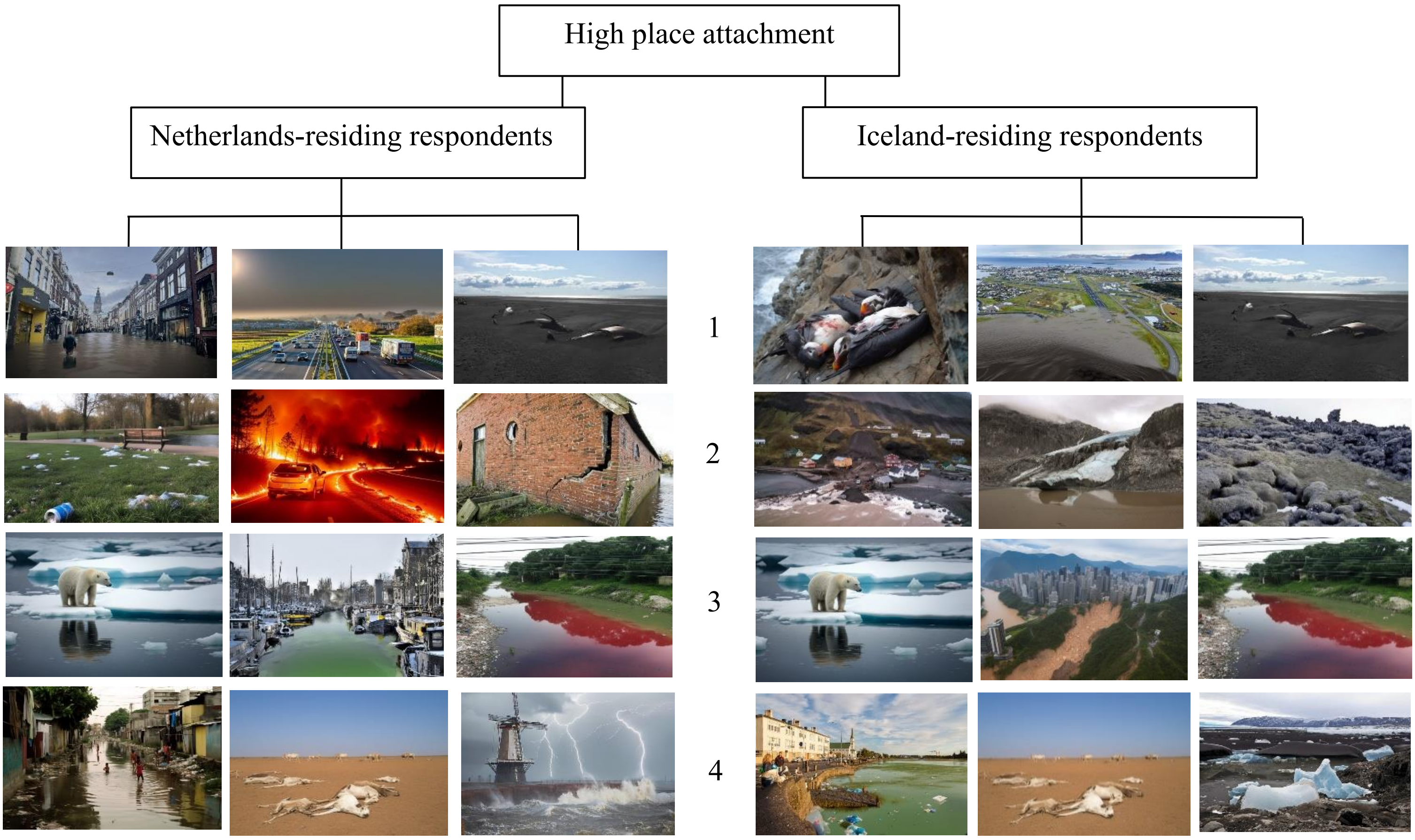

Figure 2 – The top four most frequent rankings of the two groups of participants with high rates of place attachments, across the three separate batches of images.

For the 21 Icelandic participants with high self-reported PA, the Icelandic imagery is clearly most often in the top four ranked pictures as seen in Figure 2. The most frequently highly ranked images were those of the dead whales, the dead puffins, the landslide in a fjord, a polluted Tjörnin city pond, the domestic airport flooded and a tie between the image of dehydrated Icelandic moss and melting glacier terminus, all between 12 and 15 top-four rankings. For participants living in Reykjavík with a lower self-reported PA (only 9 respondents), higher rankings consisted more of generic images as opposed to Dutch-themed ones. Highly ranked images for this group were the polluted shanty town, deforestation, the forest fire – all of which appeared six times – and the dead cattle with five hits.

The visualization in Figure 3 could already imply that some relationship between PA and the most highly ranked images might be present. For the graph, the category of lower place attachment consists of participants who reported attachment rates of 1 (strongly disagree) and 2 (disagree), whereas high attachment rates denote values of 4 (agree) and 5 (strongly agree). At first glance, it becomes visible that Dutch-residing participants who have high levels of PA most often choose either Dutch imagery or generic imagery in their top 4. Participants residing in Iceland that report high attachment rates even more profoundly seem to choose primarily Icelandic-themed images and, to a lesser degree, generic ones. Both Dutch and Icelandic residents with lower PA tend to veer towards the generic imagery in their top rankings.

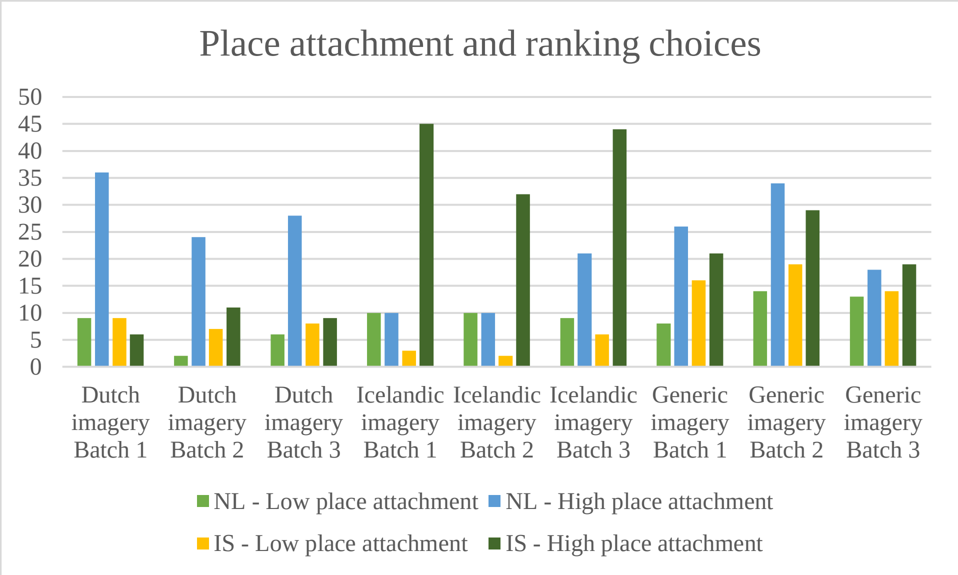

Figure 3 – Distribution of ranking choices within the three batches of images, sorted per country and self-reported level of place attachment

The data fits all assumptions of the multinomial logistic regression, that being a dichotomous dependent variable, one or more independent variables and independence of observations. Since there are only ordinal and nominal variables, the assumption of a linear relation between the logit of the dependent variable and any continuous independent variable is met. The dependent variable is the most frequently chosen option per participant in their top four rankings across all batches, with values of 'GE' (for general imagery), 'IS' (for Icelandic imagery) and 'NL' (for Dutch imagery). Next to testing image setting, type of effect and level of effect as main effects, the interactions of *country**PA* and *country**SP* have been added to the model. The null hypothesis would be that there is no relationship between the dependent factor of highest ranked image and the independent factors of living environment, level of effect, type of effect and a country's PA and SP. In turn, the alternative hypothesis would imply any sort of relationship between these factors. The statistical outputs are found in Appendix 3.

Testing the regression against an α-level of 95% (or p=0.05) shows that there are significant correlations between the imagery in the highest ranked image and it's corresponding country's SP and PA. Furthermore, significant p-values can be seen for the climatic effect of 'disaster' with all 2-tailed $p<0.05$. On the basis of these results, the null hypothesis of no relation between the variables may be rejected. For the other variables of specific types of climatic effects (namely drought, flooding, extinction of a natural feature and pollution, the p-values were higher than 0.05, meaning that the null hypothesis of no relation cannot be rejected for these variables. Now that a correlation has been found, a follow-up test can be performed in order to find out the strength of this relationship. Since the ordinal nature of the variables violates the 'level of measurement' assumption of the Pearson test, a non-parametric Spearman correlation test is computed. This test was conducted with the variables PA, SP, first place ranking, level and type 3 (disaster). The null hypothesis of this test is that there is no relationship between variables (or r=0), whereas the alternative hypothesis is that there is a relationship (r=/=0). This test yielded a correlation of 0.304 with the accompanying p-value of 0.017 between the variables first place ranking and PA. Similarly, the test produced a positive correlation of 0.448 between first place ranking and SP with a p-value of 0.000032. Lastly, the type 3 variable showed a correlation of 0.412 at p=0.001. This means that for all variables, the null hypothesis of no relationship may be rejected.

Image setting

Next, this research aims to find out whether urban imagery is more often ranked higher than natural images for participants who live in an urban environment with high PA. There are 48 respondents who consider themselves living in an urban environment. Out of those participants, 13 report low levels of PA while 35 show high levels. There are 12 participants living in a suburban environment, while only one person considers themselves living in a rural environment, complicating a chance for comparison or correlation test between participants' living environment and image setting. For both urban and non-urban settings, the results for the top 4 rankings can be seen in Figure 4. Given the low number of non-urban respondents, there was no participant who reported a non-urban environment and low PA.

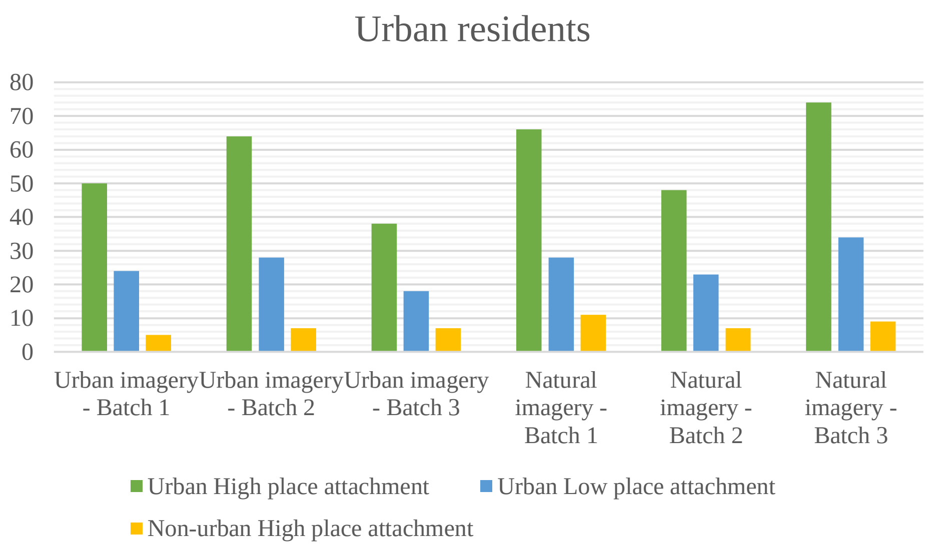

Figure 4 - Distribution of highly ranked images among urban residents

Looking at the visualization of the data, it could be expected that PA combined with the living environment does not hold a strong relation to the type of imagery most often ranked highly, as both urban and natural imagery seem to be chosen relatively equally. To test this, a binary regression model will be used on the data, as the outcome variable is either [urban] or [natural] setting of the image. The data fits all assumptions of the binary logistic regression. The null hypothesis is that there is no relationship between the dependent factor of the setting of the highest-ranked image and the independent factors of PA, SP and living environment. The alternative hypothesis would therefore mean that there would be a relationship between these factors. The regression model consisted of two interactions, namely between PA and living environment and SP and living environment.

Testing the regression against an α-level of 95% (or p=0.05) shows that there are no significant correlations between the setting of the highest-ranked image and the interaction between PA, SP, and type of living environment for either country. All 2-tailed p-levels yield numbers higher than 0.05. On the basis of these results, the null hypothesis of no relation between the variables cannot be rejected and it may not be assumed that there is a statistical relationship between the variables. Once again, it is important to note that the data does not offer a sturdy statistical foundation for comparison when it comes to living environments.

Type of effect

As mentioned before, the 36 images portrayed five different types of possible adverse climatic effects. Out of these five effects, 'flooding' scored the lowest amount of hits in participants' top 4 rankings with 86 times, whereas 'pollution' produced the most results in higher rankings, namely 176. The overall distribution of the type of effects can be seen in Figure 5.

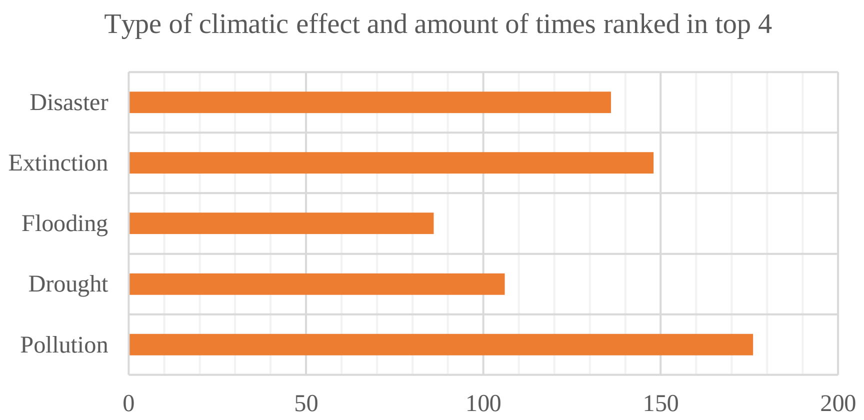

Figure 5 – Distribution of the different types of climatic effects among participants' top-fours

To see whether there was a relation between the type of climatic effect ranked first and PA, SP, living environment and climatic concern, another multinomial regression was performed over the data. The null hypothesis is that there is no relationship between the dependent factor of the specific type of the highest-ranked image and the independent factors of PA, SP, living environment and climate concern. The alternative hypothesis would indicate any relationship between these factors. Testing the regression against an α-level of 95% (or p=0.05) shows that while there seems to be one significant correlation between 'disaster' as the highest-ranked type of effect and sense of place for Icelandic respondents, the model in itself was not significant at $p > 0.05$. On the basis of these results, the null hypothesis of no relation between the variables cannot be rejected and a statistical relationship between the mentioned variables cannot readily be assumed.

Level of effect

Out of the entire sample, 49 participants reported a high concern for the negative effects of climate change as well as experiencing negative emotional consequences after seeing these changes happen in real-time. In total, 13 cases reported that their concern for negative effects was low or very low.

Table 1 – Distribution of subtle and severe imagery according to level of climatic concern

	Subtle	*Severe*
Climate change concern low	12	47
Climate change concern high	151	437

As is visible in Table 1, out of the participants who reported being concerned about the climatic consequences, the large majority ranked images showing severe effects within their top four, as opposed to subtle effects. This effect did not seem to be very different for those who showed low levels of concern, given that they, too, more frequently ranked severe or graphic images in higher places than subtle images.

Discussion

There are certain limitations concerning this research that should not be overlooked. As mentioned before, the majority of the respondents are likely to be students or people from a certain age group. Because of this student-to-student distribution, it is less likely that the survey will have reached elderly persons. While it was expected to slightly skew the data given Liu et al.'s (2014) research on age and environmental concern being positively related, the majority of the sample reported high levels of environmental concerns nonetheless. However, having targeted mainly students of universities in two cities, resulting in a disproportionate amount of respondents living in urban areas, unfortunately, no relationship could be found between an urban living environment with high place attachment and the higher ranking of urban-coded imagery. Therefore, in line with Scannell & Gifford's (2010) suggestion, further research might do well to focus on the different reactions specifically between urban and rural residents – possibly keeping age in mind. However, this non-significant result is not necessarily a negative outcome, as it implies respondents would support environmental campaigns on the basis of either natural or urban-coded imagery, as both appeared in respondents' top-four rankings.

In terms of the type of effect, it seems that pollution and extinction are the two types that appear most often in participants' top 4 rankings. The fact that flooding is the least frequent choice could be expected based on Böhm (2003) and Walsh-Daneshmandi & MacLachlan (2000) as flooding was listed as provoking an intermediate response, but is nonetheless surprising given the Dutch and Icelandic history regarding both current sea levels and future sea level prospectives, and (glacial outburst) floods. Interestingly, the variable of 'disaster' turned out to be the only one yielding a statistically significant result. Images showing this variable included large landslides, forest fires, and heavy weather such as storms. Given the fact that the amount of images coded as 'disaster' was substantially lower than other types of effect, but still showed a significant relationship and showed up in the most frequent top-fours, suggests that this is an effective type of imagery when it comes to evoking a response.

Tied to that is the severity level of the effect portrayed in the image. Whereas it was established in earlier research that it might be beneficial to avoid imagery that is too graphic lest it turns the reaction into a negative one, it is interesting to note that the more graphic images were chosen more frequently by the participants in the sample. This might falsify Kollmuss & Agyeman (2002), Meng and Trudel (2017), White et al. (2019) and Cialdini's (2003) argument that imagery should contain only subtle effects, as severity was thought to produce the opposite effect. The images exhibiting subtle effects might evoke less of an emotional reaction simply because, as mentioned before, a number of climatic effects are not distinct enough by themselves to be noticed in real-time. An example of this would be the graphic image of the dead whales as opposed to the dehydrated vegetation in an agricultural field, with the first being frequently ranked high and the latter scoring quite low across the board. Although this would seem to refute the established literature, two factors must be acknowledged. First, the distinction between subtle and severe remains relatively subjective, but more importantly, it is mainly students who have responded to the survey. Having been possibly over-exposed to negative climatic effects on social media, it is possible the threshold for an emotional reaction is only exceeded by an explicitly severe visual trigger. A re-examination of the severity theory could thus be worthwhile, especially recognizing the role of age. Another interesting observation is that the generic imagery was popular both amongst those with lower and higher place attachments, implying that Chapman et al.'s (2016) notion of cynic reactions to disassociated imagery may not always hold true. It could be that an increased sense of (virtual) globalization and geographical mobility has enabled the participants to care for other places than simply their own. The popularity of the generic imagery furthermore acts as a testimony to the advanced nature of Artificial Intelligence in photorealistic image generation, as those were the images produced solely by textual prompts, yet evoked equal reactions to images that were visually rooted in a real-world location.

Most importantly, motivated by previous researchers' assertions, this study hoped to corroborate the notion of a relationship between place attachment and highest image ranking choice, and after a statistical analysis, it has been able to do so. The positive coefficient of the variable interactions suggests that participants living in the Netherlands with high place attachment opt to rank Dutch imagery higher more frequently than those with low levels of place attachment, and that the same trend could be said about participants in Iceland regarding Icelandic imagery. Dutch participants with higher rates of place attachment and sense of place were subsequently less likely to rank generic imagery in high spots. For Iceland, this relation did not hold true for place attachment, but did for sense of place. This indicates that Icelanders who are not necessarily attached to the place they live in, but nonetheless are content with their place of residence, still show some care for their environment. Of course, it must be kept in mind that since some images might not have been perceived as being quintessentially Dutch or Icelandic, some participants might not have known whether they belonged to either group or whether it was a generic image. This means that some participants might have ranked place-bound imagery higher without knowing its corresponding location. However, the participants were not presented with any insight into which location was shown for any of the images, meaning they would either recognize the landscape or they would not. Not recognizing locational aspects of an image but still ranking it highly might still signal an emotional connection to whatever was pictured.

Conclusion

Ultimately, the main purpose of this study was to identify whether participants would respond more strongly to images tailored in a specific way, in order to spur pro-environmental behavior and inform policy about future environmental campaign shaping. The results of this research indicate that it would be beneficial to pay attention to place attachment and sense of place, as well as the specific type of effect portrayed. A positive discovery for campaign shapers is that participants do not seem to discriminate strongly between urban or natural settings, consequently both visuals could prove to be effective. Furthermore, in order to increase pro-environmental behavior in young people, it might be most efficient to show severe effects instead of subtle ones, as opposed to what previous literature asserts.

Future research could build on this study by shifting the focal point slightly away from place attachment and severity of effect towards investigating a possible rural-urban divide concerning emotional responses to climate change imagery. If future research is able to elucidate whether urban residents with high rates of place attachment have stronger emotional reactions to urban-coded imagery, campaigns could be tailored specifically for cities. Since urban and rural areas have their own climatic ills, it could also be useful to know whether the same effect holds true for rural residents in order to target them more specifically and bridge that gap. Moreover, while most specific types of effect did not produce a correlation with the order of the image ranking, repeating this research with a larger sample size and possibly more types of effect may shine a light on a possible relationship. With the consequences of climate change pressing down on our urban and natural landscapes, translating environmental awareness into active ecological behavior becomes increasingly vital. The effectiveness of artificially generated images in eliciting an emotional response shows how environmental campaigns and technologies (next to virtual dimensions such as social media) could be integrated in order to achieve this.

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Appendix 1 – Survey

Dear participant,

Thank you so much for wanting to fill in this survey! This survey is part of an academic research conducted by a student of the Faculty of Spatial Sciences. Your answers are given anonymously and your email-address will not be saved. The answers you give will be used for research purposes only. The survey should take no more than 10 minutes. You will be asked some questions about the place that you live in right now, after which you will be tasked with ranking three sets of images. Let's start with the questions!

Q1. Where do you live right now?

- Iceland
- The Netherlands
- Other, namely

Q1B. Where do you live in The Netherlands?

- Groningen
- Other place, namely

Q1A. Do you live in Reykjavík or outside of the capital area?

- Reykjavík
- Outside of the capital area

Q2. How would you describe your living environment?

- Urban (inner city or town, high population density)
- Suburban (just outside or adjacent to city or town, moderate to high population density)
- Rural (outside city or town, lower population density)

Q3. These statements concern the place that you live in right now

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I am happy to live in this place right now	○	○	○	○	○
This place means a lot to me	○	○	○	○	○
I feel at home in this place	○	○	○	○	○
I feel that this place is a part of me	○	○	○	○	○
Being at this place says a lot about who I am	○	○	○	○	○
I like the physical environment of this place	○	○	○	○	○
I like the social environment of this place	○	○	○	○	○
I am very attached to this place	○	○	○	○	○

You will now be asked to rank three sets of 12 images according to how strongly they would motivate you to support an environmental campaign. You can drag and drop the images and make your own ranking that way, with the image at the 1st place being the one that would motivate you the most, and the image at 12th place as the one that would incentivize you the least.

Q4. First batch of images

Q5. Second batch of images

Q6. Third batch of images

Q7. Please answer the final questions:

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Climate change and environmental issues concern me	○	○	○	○	○
I am confronted with environmental issues daily in my living environment	○	○	○	○	○
I feel a personal responsibility to help address environmental problems	○	○	○	○	○
Seeing environmental problems unfold has a negative impact on how I feel	○	○	○	○	○
The place I live in puts sufficient effort in tackling its environmental issues	○	○	○	○	○

End: That was the survey! Thank you again for taking the time to fill it in all the way from ${q://QID24/ChoiceGroup/SelectedChoicesTextEntry}, it is greatly appreciated. Your response has been recorded and will be used for research purposes only.

I would be really grateful if you could share this survey with your friends. To do that, simply copy this link: https://rug.eu.qualtrics.com/jfe/form/SV_0TkmGSTfMFi48nQ and send it to them.

Have a nice rest of your day!

Appendix 2 – Images

A. Batch 1





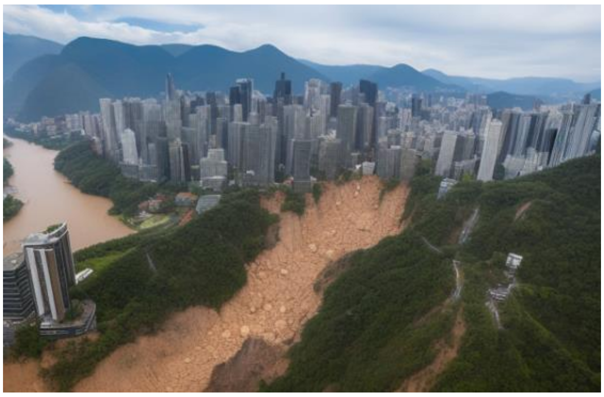






A. Batch 2


BLUE
WATER

A. Batch 3


P

Appendix 3 – Statistical Outputs

3A. Output multinomial regression including variables ‘place attachment’, ‘sense of place’, ‘living environment’, ‘level’ of effect shown and the different types of effects.

Model Fitting Information

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	127.945			
Final	41.039	86.906	18	.000

Pseudo R-Square

Cox and Snell	.765
Nagelkerke	.861
McFadden	.661

Likelihood Ratio Tests

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	41.039[a]	.000	0	.
Country * Place attachment	53.526	12.487	4	.014
Country * Sense of place	48.225	7.186	4	.126
B1_Setting2	41.039[a]	.000	0	.
B1_Type2	41.334	.295	6	1.000
B1_Level2	42.322	1.283	2	.526

The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.

a. This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom.

Parameter Estimates

Imagery[a]		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp (B) Lower Bound	95% Confidence Interval for Exp (B) Upper Bound
NL	[Country=Iceland] * Place attachment	.901	1.539	.343	1	.558	2.463	.121	50.295
	[Country=The Netherlands] * Place attachment	1.689	.725	5.422	1	.020	5.412	1.306	3.417
	[Country=Iceland] * Sense of place	.630	1.381	.208	1	.648	1.877	.125	28.123
	[Country=The Netherlands] * Sense of place	1.099	.618	3.168	1	.045	3.003	.895	4.077
	[B1_Setting2=0]	-14.278	6850.599	.000	1	.998	6.296E-7	.000	.[b]
	[B1_Setting2=1]	0[c]	.	.	0	.	.	.	.
	[B1_Type2=0]	-14.918	6850.599	.000	1	.998	3.321E-7	.000	.[b]
	[B1_Type2=1]	-.141	3.862	.001	1	.971	.868	.000	1684.239
	[B1_Type2=2]	0[c]	.	.	0	.	.	.	.
	[B1_Type2=3]	.582	.679	4.281	1	.038	1.139	.023	1.880
	[B1_Type2=4]	0[c]	.	.	0	.	.	.	.
	[B1_Level2=0]	-1.185	1.651	.515	1	.473	.306	.012	7.782
	[B1_Level2=1]	0[c]	.	.	0	.	.	.	.
IS	[Country=Iceland] * Place attachment	1.687	1.025	2.706	1	.047	5.401	.724	5.281
	[Country=The Netherlands] * Place attachment	12.339	767.582	.000	1	.987	228325.840	.000	.[b]
	[Country=Iceland] * Sense of place	.856	.651	1.727	1	.019	2.353	.657	8.434
	[Country=The Netherlands] * Sense of place	-21.020	1535.163	.000	1	.989	7.433E-10	.000	.[b]
	[B1_Setting2=0]	-42.276	1.427	878.107	1	.000	4.363E-19	2.663E-20	7.147E-18
	[B1_Setting2=1]	0[c]	.	.	0	.	.	.	.
	[B1_Type2=0]	-42.648	.000	.	1	.	3.007E-19	3.007E-19	3.007E-19
	[B1_Type2=1]	.607	2.553	.056	1	.812	1.835	.012	273.315
	[B1_Type2=2]	0[c]	.	.	0	.	.	.	.
	[B1_Type2=3]	.887	2.201	.162	1	.687	2.427	.032	181.268
	[B1_Type2=4]	0[c]	.	.	0	.	.	.	.
	[B1_Level2=0]	-1.389	1.531	.824	1	.364	.249	.012	5.008
	[B1_Level2=1]	0[c]	.	.	0	.	.	.	.

a. The reference category is: GE.

b. Floating point overflow occurred while computing this statistic. Its value is therefore set to system missing.

c. This parameter is set to zero because it is redundant.

Parameter Estimates

Model[a]		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp (B) Lower Bound	Upper Bound
GE	Intercept	6.577	3.196	4.236	1	.040			
	[Country=Iceland] * Place attachment	-1.191	.854	1.947	1	.163	.304	.057	1.619
	[Country=The Netherlands] * Place attachment	-14.303	1.004	202.861	1	.000	6.141E-7	8.579E-8	4.396E-6
	[Country=Iceland] * Sense of place	-1.139	.575	3.922	1	.048	.320	.104	.988
	[Country=The Netherlands] * Sense of place	25.379	.522	2365.562	1	.000	1.052E+11	3.783E+10	2.925E+11

3B. Statistical output multinomial regression: urbanity and image setting

Method: ENTER

Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	42.390[a]	.154	.206

a. Estimation terminated at iteration number 4 because parameter estimates changed by less than .001.

Classification Table[a]

Observed			Predicted B1_Setting1 Natural	Urban	Percentage Correct
Step 1	B1_Setting1	Natural	11	5	68.8
		Urban	4	15	78.9
	Overall Percentage				74.3

a. The cut value is .500

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Living environment by Place attachment	.119	.185	.413	1	.520	1.126
	Living environment by Sense of place	.253	.173	2.152	1	.142	1.288
	Constant	-2.124	1.135	3.501	1	.061	.120

a. Variable(s) entered on step 1: Living environment * Place attachment , Living environment * Sense of place .

3C. Statistical output multinomial regression: type of effect

Parameter Estimates

B1_Type2[a]		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp (B) Lower Bound	Upper Bound
Pollution	Intercept	-.188	1.320	.020	1	.886			
	[Country=Iceland] * [Living environment=0]	-4.721	5316.350	.000	1	.999	.009	.000	.[b]
	[Country=Iceland] * [Living environment=1]	-4.504	3.815	1.394	1	.238	.011	6.263E-6	19.555
	[Country=Iceland] * [Living environment=2]	-5.228	3.532	2.191	1	.139	.005	5.286E-6	5.443
	[Country=The Netherlands] * [Living environment=1]	8.068	41.325	.038	1	.845	3189.237	2.127E-32	4.781E+38
	[Country=The Netherlands] * [Living environment=2]	0[c]	.	.	0	.	.	.	.
	[Country=Iceland] * Place attachment	1.140	.885	1.659	1	.198	3.127	.552	17.717
	[Country=The Netherlands] * Place attachment	-.118	.442	.071	1	.790	.889	.374	2.113
	[Country=Iceland] * Sense of place	.054	.587	.008	1	.927	1.056	.334	3.337
	[Country=The Netherlands] * Sense of place	.251	.395	.405	1	.524	1.285	.593	2.786
Drought	Intercept	-5.813	5.249	1.227	1	.268			
	[Country=Iceland] * [Living environment=0]	23.181	3553.674	.000	1	.995	1.167E+10	.000	.[b]
	[Country=Iceland] * [Living environment=1]	5.999	6.202	.936	1	.333	402.845	.002	76564392.99
	[Country=Iceland] * [Living environment=2]	4.667	5.912	.623	1	.430	106.429	.001	11463970.67
	[Country=The Netherlands] * [Living environment=1]	1.467	95.129	.000	1	.988	4.336	4.602E-81	4.085E+81
	[Country=The Netherlands] * [Living environment=2]	0[c]	.	.	0	.	.	.	.
	[Country=Iceland] * Place attachment	.047	.984	.002	1	.962	1.048	.152	7.213
	[Country=The Netherlands] * Place attachment	.666	1.427	.217	1	.641	1.946	.119	31.915
	[Country=Iceland] * Sense of place	-.280	.738	.144	1	.704	.755	.178	3.209
	[Country=The Netherlands] * Sense of place	.311	1.157	.072	1	.788	1.365	.142	13.172
Flood	Intercept	-7.130	5.177	1.896	1	.168			
	[Country=Iceland] * [Living environment=0]	2.935	.000	.	1	.	18.823	18.823	18.823
	[Country=Iceland] * [Living environment=1]	-3.923	228.398	.000	1	.986	.020	7.645E-197	5.116E+192
	[Country=Iceland] * [Living environment=2]	-4.367	201.197	.000	1	.983	.013	6.983E-174	2.307E+169
	[Country=The Netherlands] * [Living environment=1]	1.478	86.535	.000	1	.986	4.383	9.619E-74	1.997E+74
	[Country=The Netherlands] * [Living environment=2]	0[c]	.	.	0	.	.	.	.
	[Country=Iceland] * Place attachment	.281	60.487	.000	1	.996	1.324	4.319E-52	4.060E+51
	[Country=The Netherlands] * Place attachment	.282	1.004	.079	1	.779	1.326	.185	9.491
	[Country=Iceland] * Sense of place	.147	42.995	.000	1	.997	1.158	2.925E-37	4.585E+36
	[Country=The Netherlands] * Sense of place	1.139	1.177	.937	1	.333	3.125	.311	31.405
Disaster	Intercept	-2.699	2.327	1.345	1	.246			
	[Country=Iceland] * [Living environment=0]	-2.622	7326.012	.000	1	1.000	.073	.000	.[b]
	[Country=Iceland] * [Living environment=1]	-2.184	5.422	.162	1	.687	.113	2.731E-6	4637.960
	[Country=Iceland] * [Living environment=2]	-3.031	5.471	.307	1	.580	.048	1.064E-6	2188.349
	[Country=The Netherlands] * [Living environment=1]	8.951	41.338	.047	1	.829	7712.194	5.016E-32	1.186E+39
	[Country=The Netherlands] * [Living environment=2]	0[c]	.	.	0	.	.	.	.
	[Country=Iceland] * Place attachment	-.673	1.062	.402	1	.526	.510	.064	4.091
	[Country=The Netherlands] * Place attachment	.986	.816	1.459	1	.227	2.680	.541	13.267
	[Country=Iceland] * Sense of place	1.729	1.144	4.283	1	.013	5.634	.598	3.063
	[Country=The Netherlands] * Sense of place	-.631	.669	.889	1	.346	.532	.144	1.974

a. The reference category is: Extinction.

b. Floating point overflow occurred while computing this statistic. Its value is therefore set to system missing.

c. This parameter is set to zero because it is redundant.

3D. Assumption multinomial regression: no multicollinearity

Collinearity Statistics	
Tolerance	VIF
.595	1.682
.581	1.722
.778	1.285
.860	1.163
.857	1.167
.894	1.119
.645	1.549
.629	1.590
.656	1.525