Engaging visitors to the Fox and Franz Valleys on Global Climate Change and Glacial Retreat Using Interpretation Boards.

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1. Executive Summary

1.1 Research question

How can we utilise interpretation boards to enhance visitors' environmental connection to the Franz Josef and Fox glaciers by increasing their understanding of climate change at a global scale?

1.2 Brief context for the research

The tourism industry generates a lot of income for the glacial region on the West Coast of New Zealand's South Island. One of the most significant visitor attractions is the Franz Josef and Fox Glaciers. The growing issue of global climate change is having a detrimental impact on the appeal and accessibility of these retreating glaciers. In partnership with the Department of Conservation for the Westland Tai Poutini National Park region, our group was tasked with creating interpretation boards for the Franz Josef and Fox glacier valleys to improve the quality of visitors' experience.

1.3 Summary of the method

Our work began with conducting individual research into related literature on glacial processes, climate change, and visitor experiences at the Fox and Franz Josef glaciers to better understand what people want from the experience. On a visit to Franz Josef and Fox glaciers verbal questionnaires and interviews were conducted with visitors and stakeholders. We walked both glacial valleys and recorded coordinates, GoPro footage, mobile phone coverage and timed the walks. The valley walks were analysed to determine ideal locations for the interpretation boards. On the return from the West Coast we processed our data, working on the content, delivery and design of the signs.

1.4 Key findings

From our background research and field work we have produced the following set of key findings:

- Human environment perception is based on life experience. Therefore we needed to cater to various levels of knowledge and openness to mitigation concepts.
- Signs needed to maintain a sense of simplicity, yet still be visually appealing in order to catch the attention of visitors.
- Upon experiencing first-hand the magnitude of the glacial retreat taking place in the valleys, visitors were open to and had an active interest in learning more about glacial retreat, climate change and their effects at a global scale.

1.5 Major short comings or limitations of research

Limitations of our research project included numerous design concepts that were pursued, but found impractical. The trip to the West Coast was delayed by a week due to hazardous weather, this was a set-back in terms of limited timing

with processing our data and providing drafts for our community partner to critique. Our trip to the West Coast although aptly planned and followed through, could, with the benefit of hindsight, have been structured more efficiently to maximize our data collection.

1.6 Suggestions for further research

The interpretation boards that were created as a result of this project should be analysed in situ to determine their effectiveness. Further research could be conducted into different types and effectivness of interactive boards. This should not be limited to boards with moving parts but should also include incorporating technology such as QR codes. These codes can enable written text to be displayed in multiple languages and provide more information via the Department of Conservation's website. To complement the QR codes, a mobile application that uses augmented reality to overlay a model of the glaciers and historic terminous locations onto the real world could be utilised. This could be downloaded simply by incorporating a QR code on the boards and at the information sites situated at both Franz Josef and Fox villages.

2. Introduction

Situated in the notoriously rugged West Coast of New Zealand, two of the country's most iconic natural features have reported ongoing mass loss and have retreated considerably back up the valley. The striking appearance and wonder of the glaciers has brought visitors in their thousands over the years, despite viewing of the glaciers becoming impaired by gradual retreat. In conjunction with our community partners', Wayne, from the Department of Conservation (DOC), and Brian Anderson, a senior research fellow from Victoria University of Wellington, we were tasked with creating two set of boards to feature on the valley walkways to Franz Josef Glacier, Ka Roinata o Hine Hukatere and Fox Glacier, Te Moeka o Tuawe.

The concept behind the boards is to promote a larger awareness of climate change for visitors that come to the area, especially as the glaciers are considered among the most accessible in the world. Our work with DOC provides an opportunity to send a message that will foster behaviour in carbon reduction and other environmental efforts.

3 Theory and Concepts

The success of this project relied on the merging of both human and physical geography. By combining these two fields we have successfully enhanced visitors' environmental connection to not only Franz Josef and Fox Glaciers but also to the surrounding environment by expanding their knowledge of climate change at a global scale.

To achieve our goals, we first investigated a broad range of related literature to learn what methods of scientific communication have been previously

practised and what insights have been gained from this process. Scientific literature relating to climate change and glacial landscapes globally was our focus research. The reviewed literature allowed us to refine our secondary research areas giving a directed interpretation outcome that will engage the public, providing a shift in mindset that favours the environment.

3.1 Human Geography Research

Understanding how to best communicate our concepts with the visitors to the Franz Josef and Fox area required us to recognise how people interacted with the physical environment. A core informing paper based on interviews with visitors was carried out by Wilson et al. (2014), which demonstrated the cognitive dissonance between the glacial retreat immediately in front of visitors and the acceptance that it was caused by human induced climate change processes.

Within our research question are a number of social components, specifically, epistemological, ontological and axiological influences that are involved in interpretation. Denniss & Davison (2014) found that even within the beliefs, practices and scales of individual human existence in relation to climate change, a multiplicity of competing processes emerged. Often confused by scientists as originating from such factors as ignorance and hypocrisy. This approach fails to recognise that scientific information is not presented to the public within a vacuum of knowledge. It is imbued with a lifetime of influences and redirected in any number of cognitive trajectories.

Similarly, within a meta-analysis of human-glacier relations globally, Gagne et al. (2014) surmised that due to climate change's effect on depleting glacial resources, the need to interrogate the topic is urgent: "As agriculture expands or recedes, tourist attractions relocate, water sources dry out and rivers turn violent, religious practices alter and new actors emerge, people continuously try to make do in everyday life. An understanding… becomes paramount for grasping and interpreting the changes that occur in the environment" (pp. 804-805).

3.2 Physical Geography Research

The physical data collected during our field work allowed us to relate physical glacial processes to global climate change in a way that is easy to understand for visitors by delivering the key points in a comprehensive manner. In order to develop a greater understanding of the glacier-climate relationship, rapid glacial retreat of a temperate glacier in Iceland is analysed (Bradwell et al., 2013). Looking into the effect supraglacial debris has on melt rates at Franz Josef Glacier (Brook et al., 2013) is of great relevance as the more a glacier retreats the greater the debris to ice ratio, as an increase of debris on the glacier less than 2-3 cm increases the melt rate of the glacier. These climatic induced glacial processes can be related back to a human perspective, by looking at what this means to visitors of Franz Josef and Fox glaciers (Wilson et al., 2014).

Secondly, “Debris cover and surface melt at a temperate maritime alpine glacier: Franz Josef Glacier, New Zealand”, (Brook et al., 2013) sets about proving the influence of debris cover on melt rates at Franz Josef Glacier. As Franz Josef Glacier retreats rapidly, the amount of supraglacial debris relative to ice has increased. This makes calculating the climatic aspect of glacial melt much more difficult, especially having to consider the nature of the debris, the lithology, topographic shadowing and local climate variations with latitude and altitude.

Glacial retreat is not an isolated event but one that is happening on a global scale and is of great concern, as detailed by Zemp et al. (2015), whose paper aimed to provide clear evidence that the centennial glacier retreat was a global event. Both glaciological and geodetic observation methods show that the rates of glacial mass loss are increasing significantly since the Little Ice Age. It concluded that even if the current climate were to stabilize, the strong imbalance affecting glaciers around the globe would still likely suffer further ice loss.

4. Methods

We have used a mixture of methods as no single method would have produced satisfactory results. As such, we decided to take techniques that are used in human geography, physical geography, as well as techniques that are based in design to create a well-balanced framework for our research. Robbins (2010) discusses how diverse approaches are often useful and how a great deal can be learnt by these approaches, although mixing techniques is not without its problems. It requires the formation of a strategy that has been tailored to fit the proposed research. These methods have supplied us with a number of important building blocks that when pieced together create a strong understanding of what is needed to accomplish a positive outcome for our community partner.

Group members critiqued scientific articles that are detailed above to educate ourselves on glacial processes, climate change, and human interactions, providing a solid foundation on which to begin the project. Questionnaires and semi-structured stakeholder interviews were created, along with information sheets and consent forms as part of our field research at Franz Josef and Fox glaciers. The survey and interview questions went through an ethics review to ensure the safety of participants and the questions would return high quality results.

4.1 Field work

Field work was conducted on the West Coast at both Franz Josef and Fox valleys. Our community partner Wayne joined us, providing an insight to the valley and how rapidly its environment changes. With the trail conditions changing on a regular basis due to rock fall, flooding and glacier retreat it was important to understand how the valley trail had been operated in the past, what changes had been made and how it is currently operated. A similar procedure took place at Franz Josef valley.

Research in each glacier valley involved:

- Timing return valley walks to ensure accuracy in stated walk time information
- Recording mobile phone coverage to assess the potential for interactive videos for visitors
- Analysing existing hazard boards for numbers and quality
- Recording coordinates and taking GoPro footage of potential interpretation board locations
- Taking photos to record information and for use in new interpretation board designs

A questionnaire was developed for use at both valley sites. The aim of the survey was to gain insight into the visitors' base knowledge about glaciers, glacial processes and how this is impacted by climate change. The secondary aim of the survey was to establish what information visitors want to see in the valleys and visitors attitude towards climate change. Randomly selected visitors answered nine survey questions using a ten-point scale, and open ended questions. All questionnaires were conducted or supervised by interviewers allowing any confusion about questions to be explained quickly and easily. At Franz Josef Glacier the questionnaires were undertaken on the walking track at the point where the track leaves the bush just before entering the riverbed. At Fox Glacier, surveys were also undertaken on the walking track, between the carpark and the riverbed. All questionnaires were undertaken as visitors returned from each glacier. The questionnaires were undertaken over a two day period in August, during which time interviews were also undertaken with key stakeholders in Franz Josef township.

4.2 Post field work

After completion of the field work, data from both the questionnaires and interviews were entered onto a spreadsheet (Microsoft Excel). This was then analysed providing conceptual direction for the interpretation boards. Further direction came from other collected notes and information gathered during the field work. Investigation into existing interpretation boards was undertaken to give the group insight into what design compositions could be applied to our project. The Wilson library archival photos of Franz Josef and Fox Glaciers were sourced as questionnaires revealed that a number of visitors were interested in seeing historical comparisons with modern day photographs.

Data related to historic glacial positions was sourced and used to determine positions for interpretation boards. These came in a shapefile format and was processed using ArcMap. Photoshop was used in the design of the interpretation boards, incorporating the existing mountain range design on existing valley boards.

5. Results

Our final output for the interpretation boards consisted of five boards for each valley trail, giving 10 boards in total. These will be placed in the locations annotated in the below maps in Figures 1 and 2. The significance of these locations is that they represent the location of where the glacier previously extended to.

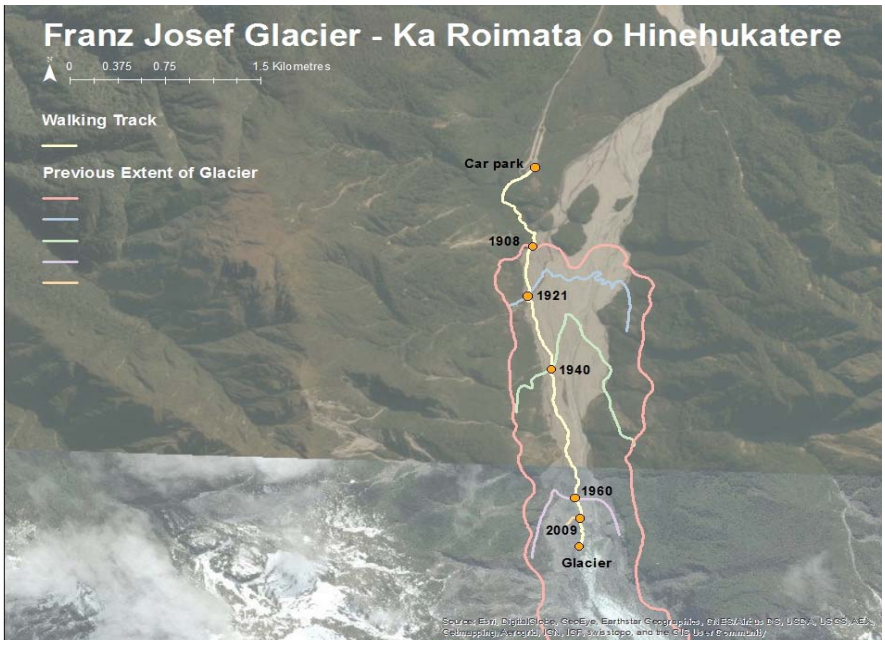

Figure 1. Previous lengths of the glacier at specific years and the walking track are mapped in the Franz Josef Valleys, Ka Roinata o Hine Hukatere.

Figure 2. The walking track to the glacier as well as the previous length of the glacier are shown in the Fox Valley, Te Moeka o Tuawe.

A theme was developed for the boards based on our community partners' requirements and what we had learnt through our research and the draft development process. We selected four central topics that are carried across each board:

- The year the end of the glacier was located at each sign
- CO_2 levels for that year
- What an individual can do to help counter climate change
- Question and answer section

These topics grow in magnitude for each board as you walk up the valley, starting at an individual level and moving to a global scale. This is to incorporate how different people relate to different scales of involvement. These show a clear relationship with growing CO_2 levels and the increasing need to do something about them.

Figure 3. Board number three of five in Franz Josef Valley, Ka Roinata o Hine Hukatere.

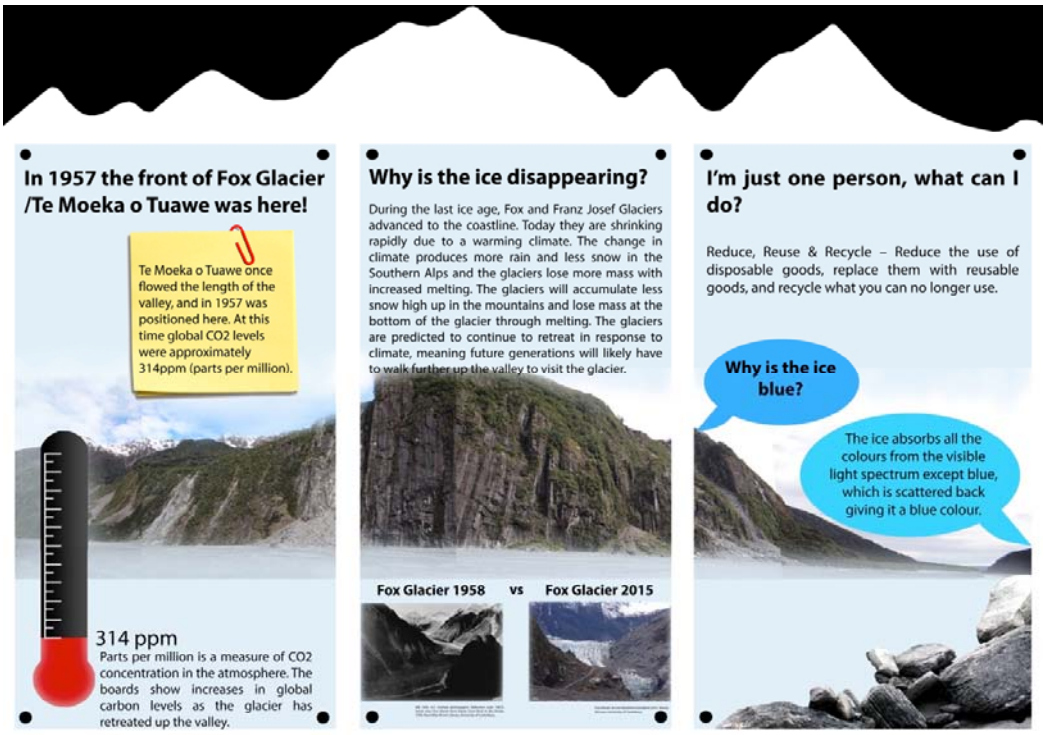

Figure 4. First board of five in Fox Valley, Te Moeka o Tuawe.

Two large boards will be placed in each valley, each consisting of three panels. These will go at either end of the walks with three smaller boards with two panels along each walk in the valleys, which are shown in Figures 3 and 4.

5.1 Discussion

We feel the results of our project which feature on the interpretation boards for the Department of Conservation will enhance the visitor's environmental connection to the Franz Josef and Fox glaciers by increasing their understanding of climate change at a global scale. As seen in Figures 3 and 4, the final interpretation boards have four central themes: the glacier terminus position in regards to sign placement, CO_2 levels, information on what individuals can do to help counter climate change, and the various questions that were asked by visitors.

Placement of the five signs has been correlated with natural stopping points along the valley walk, meaning visitors already stop for a short rest at these points due to the distance and terrain of the walking track. Research on each location has given us the years when the front of the glacier was at each point. These years are one of the four key features of our boards allowing visitors to walk backwards through time.

A CO_2 level for each sign location year allows visitors to see how greenhouse gasses are having an effect on the environment. By using the CO_2 levels and the glacier front location for each year it is easy to show a relationship between rising greenhouse gasses and glacial retreat in a way that visitors will

understand. This also relates into the next theme that is carried across each board and that is what individuals can do to help climate change. The ideas start small and grow in magnitude as you walk up the valley allowing for different levels of engagement. During our research we found that not all people respond to the same things in the same ways so we have allowed for this in the suggestions we have made as detailed in the Myers-Briggs type indicator and discussed by Neville et al.: (no date). The levels of engagement also grow in relation to the CO_2 levels rising and the need to make larger efforts to combat this.

The final theme is the questions we were asked during our time at the glaciers and in the valleys conducting surveys. These questions provided us with a unique insight to what visitors wanted to know about the glaciers, what they already knew and what they did not know. Some of the questions surprised us by just how little some visitors knew about what they were seeing. By including some of these questions on the boards we are providing knowledge that was directly asked for by the visitors.

5.2 Visual interaction and Developing a theme

When putting together our first draft of the signs we quickly realised that telling stories was not a compact way of distributing our message on glacial retreat and global climate change. To develop the information for the boards we used the 3:3:3 rule (Colquhoun, 2005), this gave focus to the key points, allowing the visitor to have a good understanding of the concepts put forward. The 3:3:3 rule stipulates you have three seconds to capture the attention of the visitor with the title, 30 seconds to impart one or two points to the reader and three minutes to give a good overview of the whole concept or point you are trying to get across. For us this rule is used in a way to get visitors to stop, take notice and take onboard the information supplied. This concept proved more challenging to master than initially thought, as it was a tough balancing act to simplify text to conform with the 3:3:3 rule while still being engaging and informative to read.

Several attempts were made to develop a layout that would be visually interactive, meaning that visitors would be intrigued by the boards and naturally move towards them for a better look. Visual interaction is not only important in getting visitors to the boards but it is also important for getting them to engage and become interested in the information and messages we are trying to convey. The boards needed to be created utilizing design concepts that are visually interesting, approachable, and incorporate our central themes. The interpretation boards needed to be able to fit in with existing interpretation boards and warning signs that are already in both valleys. A simplistic theme was developed in order to not oversupply visitors with information, which can be a deterrent, and a way to fit in with the existing boards. This comprised of using the mountain range backdrop and having removable panels that are easily replaceable. The panels themselves contain a balance of text to images. Colour has been used in several places to break up the boards and give focus to the four key themes.

5.3 Other concepts considered

The research and design process, although rewarding, was not a straightforward one. Our group pursued various ideas and concepts in order to benefit the boards. Many of these ideas were eventually labelled as 'dead ends' due to either a lack of data or the concept became irrelevant to our final output. Initial research into how people relate to climate change was not encouraging, in that people would not participate in the climate change issue if they were made to believe it was their fault. People were also unwilling to change their behaviours for a benefit that their generation would not see (Time, 2013).

One of our aims while on the West Coast was to collect survey data. One of our survey questions asked what information they would like to be presented within the valleys and based on the Likert scale 74% of respondents indicated they wanted to know more about climate change after seeing just how much the glacier had retreated. This was an unexpected yet positive response as previous literature had indicated people were unwilling to engage with the concepts of climate change.

Limitations were acknowledged when analysing our raw data collected on the West Coast and in developing our concepts for the boards. From the results of the survey, it was noted the wording in our surveys was difficult for some visitors to understand due to a limited knowledge of the English language. Due to this our survey responses should be treated with caution, as respondents may not have answered questions or answered questions with irrelevant information as they may have lacked an understanding of what was being asked. The potential for a results bias was also considered, as some visitors may have wanted to give the 'right' answer about climate change, given the number of us collecting the surveys and the institution we represented.

Interactive signs and videos were not viable due to lack of mobile phone coverage and potentially financial restrictions. Oblique signs were favoured within the group, but, as our community partner explained, they are subject to sun damage. Adding or improving hazard boards was assessed and deemed unnecessary as existing ones were sufficient in quality and numbers.

In order to express the magnitude of climate change on a global scale, we set out to create a scale of CO_2 emitted into the atmosphere for each year the signs represented. The fifth report from the Intergovernmental Panel on Climate Change (IPCC), stated that the 'safe level' of CO_2 the Earth can withstand is 1 trillion tonnes. Initially we wanted to have the cap of our scale set to 1 trillion. This would provide the visitors with an understanding of how much CO_2 had already been released into the atmosphere by the year of each sign. They would also be able to see the gap of the CO_2 already in the atmosphere approaching the 1 trillion tonne mark. When this scale is combined alongside the previous length of the glacier, it would highlight the unprecedented rate of climate change and hopefully instil a sense that urgent action was needed.

A lot of effort was put into tracking down a raw dataset of global CO_2 emissions with little success. A dataset was eventually sourced from the National Aeronautics and Space Administration (NASA), however our excitement in finding this dataset to work with was dimmed when we could not get our calculations to add up. In order to make our calculations work we needed to find the model or one similar that was used in conjunction with the calculations that provided the 1 trillion tonne 'safe limit' in order to maintain statistically accurate figures. A suitable model could not be found and in the interest of time we decided to use the NASA data for the global CO_2 levels for each year and we left off the cap at the top of our scale. We also looked into using symbols such as cars to represent the amounts of CO_2, however the number of variables included in calculating this made it highly complex and we risked misrepresenting data. We concluded that a scale in the shape of a thermometer would fit our means. The scale would be easily identified and understood by the wide range of visitors that visited the valleys, also importantly we could be confident that our figures were statistically viable.

6. Conclusion

Two sets of interpretation boards were produced for this project. They have been designed in such a way to enhance the visitors' environmental connection not only to both Franz Josef and Fox Glaciers but also to the wider surrounding environment. The four main concepts used throughout each interpretation board send an important message of the impacts from global climate change on Franz Josef and Fox Glaciers. This message is reinforced by the magnitude in which each of the four concepts grow as visitors walk up each valley. This is to incorporate how different people relate, to different scales of involvement.

7. Acknowledgements

We wish to acknowledge the following people for their input and guidance for the duration of this project:

Wayne Costello – Wayne has provided key information in terms of the processes involved in designing signs that effect their intended purpose. He has been generous with his time in giving us a guided tour of both valleys on his day off and has provided invaluable critique throughout our research process that has allowed us to refine our concepts for the interpretation boards for the better.

Brian Anderson – Brian became an additional community partner in the later part of our research process. Brian's advice on presenting scientific concepts and critiquing our draft boards was highly valuable and contributed to successfully refining our final interpretation boards.

Additionally we would like to thank the stakeholders of the Franz Josef and Fox community for taking the time to participate in our interview process.

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9. Appendices

In 1957 the front of Fox Glacier /Te Moeka o Tuawe was here!

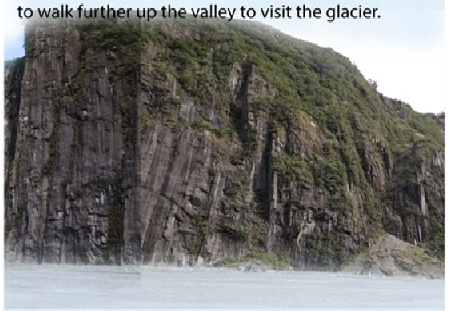
Te Moeka o Tuawe once flowed the length of the valley, and in 1957 was positioned here. At this time global CO_2 levels were approximately 314ppm (parts per million).

314 ppm

Parts per million is a measure of CO_2 concentration in the atmosphere. The boards show increases in global carbon levels as the glacier has retreated up the valley.

Why is the ice disappearing?

During the last ice age, Fox and Franz Josef Glaciers advanced to the coastline. Today they are shrinking rapidly due to a warming climate. The change in climate produces more rain and less snow in the Southern Alps and the glaciers lose more mass with increased melting. The glaciers will accumulate less snow high up in the mountains and lose mass at the bottom of the glacier through melting. The glaciers are predicted to continue to retreat in response to climate, meaning future generations will likely have to walk further up the valley to visit the glacier.



Fox Glacier 1958 vs **Fox Glacier 2015**

I'm just one person, what can I do?

Reduce, Reuse & Recycle – Reduce the use of disposable goods, replace them with reusable goods, and recycle what you can no longer use.

Why is the ice blue?

The ice absorbs all the colours from the visible light spectrum except blue, which is scattered back giving it a blue colour.

In 1940 the front of Franz Josef Glacier /Ka Roimata o Hine Hukatere was here!

At this time global CO2 levels measured approximately 311ppm (parts per million).

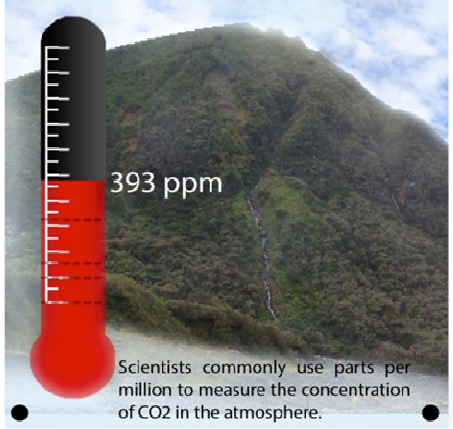
Parts per million is used to measure CO2 concentration in the atmosphere.

I'm just one person, what can I do?

Explore Locally – Find out what changes are taking place in your town or city, how these changes are affecting your community, and how you can mitigate or adapt to human induced climate change.

The front of Fox Glacier / Te Moeka o Tuawe was here in 2012!

During this time global CO_2 levels measured approximately 393ppm (parts per million).



Scientists commonly use parts per million to measure the concentration of CO_2 in the atmosphere.

What will happen to the glaciers?

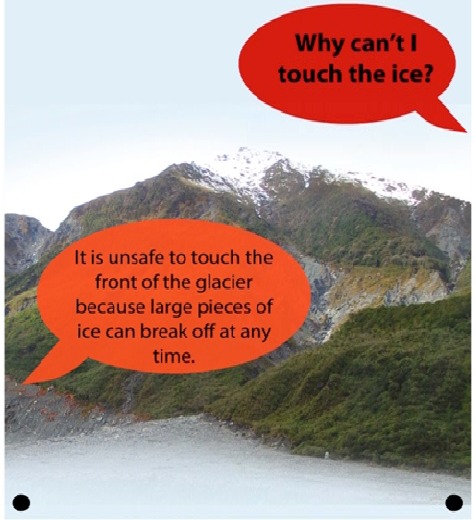
The World Glacier Monitoring Service show that globally, glaciers are retreating at an unprecedented rate.

Climate change records indicate that glaciers throughout the world would still experience large ice loss, even if the current climate stabilized. Even if climate warming stopped today, glaciers will still continue to retreat, because of the time lag that exists between changes in climate and the response of the glacier.

Fox and Franz Josef glaciers react quickly (3-4 years) to changes in climate, and are considered to be amongst the most responsive glaciers in the world.

I'm just one person, what can I do?

Engage with Government – Ask your local government what is being done to mitigate and adapt to human induced climate change, challenge government representitives to improve policy, and support those who do.



9.4 Franz Josef Glacier text for all boards

Franz Josef Valley Boards

Board 01

-Panel A

In 1908 the front of Franz Josef Glacier /Ka Roimata o Hine Hukatere was here!

Ka Roimata o Hine Hukatere once extended all the way down the valley, and in 1908 was positioned here. At this time carbon dioxide (CO_2) concentrations in the atmosphere were approximately 299ppm (parts per million).

You will see this increase number on the boards on your walk up the valley.

-Panel B

Why is the ice disappearing?

During the last ice age, Fox and Franz Josef glaciers advanced to the coastline. Today they are shrinking rapidly due to a warming climate. The change in climate produces more rain and less snow in the Southern Alps and the glaciers also lose more mass with increased melting. The glaciers will accumulate less snow high up in the mountains and lose mass at the bottom of the glacier through melting. The glaciers are predicted to continue to retreat in response to climate, meaning future generations will likely have to walk further up the valley to visit the glacier.

Franz Josef Glacier 1908 vs Franz Josef Glacier 2015

MB 1065, A.C. Graham photographs, Reference code 20057, Franz Josef Glacier, 1908. Macmillan Brown Library, University of Canterbury.

Franz Josef Glacier at river bed 2015, Olivia Sullivan, University of Canterbury.

-Panel C

I'm just one person, what can I do?

Clean Energy Use – Ask your electricity provider how they generate energy. Find a company using renewable energy or chose to generate your own solar or wind electricity.

Why is the glacier dirty?

As the glacier retreats it gets thinner as well as shorter. Rapid melting brings rock which is encased in ice to the surface, and more rock falls onto the ice from the valley sides.

Board 02

-Panel A

In 1921 the front of Franz Josef Glacier /Ka Roimata o Hine Hukatere was here!

At this time global CO_2 levels measured approximately 303ppm (parts per million).

Parts per million is used to measure CO_2 concentration in the atmosphere.

-Panel B

I'm just one person, what can I do?

Efficient Household Energy – By using energy saving light bulbs, insulating homes and using renewable energy we reduce our carbon use and save money over the long term.

Is the glacier solid?

Although the glacier looks solid, ice can have - crevasses, caves, and water channels within it. These features form due to changes in stress as the ice flows down the valley and changes in water input.

Board 03

-Panel A

In 1940 the front of Franz Josef Glacier /Ka Roimata o Hine Hukatere was here!

At this time global CO2 levels measured approximately 311ppm (parts per million).

Parts per million is used to measure CO_2 concentration in the atmosphere.

-Panel B

I'm just one person, what can I do?

Explore Locally – Find out what changes are taking place in your town or city, how these changes are affecting your community, and how you can mitigate or adapt to human induced climate change.

How fast does the ice flow?

Ice in the valleys can move very quickly, it can move up to 1000m in the space of a year.

Board 04

-Panel A

In 1960 the front of Franz Josef Glacier /Ka Roimata o Hine Hukatere was here!

During this time global CO_2 levels measured approximately 317ppm (parts per million).

-Panel B

I'm just one person, what can I do?
Strengthen Communities – By working together with others we can build community resilience, and use this to adapt to human induced climate change.

When the glacier is retreating does it flow back up the mountain?
The ice does not flow back up the mountain. The ice flowing down the glacier is melting faster than it can be replaced, resulting in the glacier getting shorter.

Board 05

-Panel A

In 2009 the front of Franz Josef Glacier /Ka Roimata o Hine Hukatere was here!

During this time global CO_2 levels measured approximately 386ppm (parts per million).

-Panel B

The World Glacier Monitoring Service shows that globally, glaciers are retreating at an unprecedented rate .

Research indicates that glaciers worldwide would still suffer ice loss, even if the current climate stabilized. This is due to the time lag that exists between changes in climate and the response of the glacier.

Fox and Franz Josef have quick reaction times of 3-4 years, making these two of the most responsive glaciers to climate change in the world.

-Panel C

I'm just one person, what can I do?
Invest for Change – The more we shift our investments from carbon producing companies to environmentally aware companies, the faster we shift to a low carbon economy.

How old is the ice?
The ice you see is about 40 years old. The age of the ice was discovered by measuring concentrations of a chemical called tritium. Large quantities were released into the atmosphere in the 1960s from nuclear bomb testing.

9.5 Fox Glacier text for all boards

Fox Valley Boards

Board 01

-Panel A

In 1957 the front of Fox Glacier /Te Moeka o Tuawe was here!

Te Moeka o Tuawe once flowed the length of the valley, and in 1957 was positioned here. At this time global CO_2 levels were approximately 314ppm (parts per million).

Parts per million is a measure of CO_2 concentration in the atmosphere. The boards show increases in global carbon levels as the glacier has retreated up the valley.

-Panel B

Why is the ice disappearing?

During the last ice age, Fox and Franz Josef Glaciers advanced to the coastline. Today they are shrinking rapidly due to a warming climate. The change in climate produces more rain and less snow in the Southern Alps and the glaciers lose more mass with increased melting. The glaciers will accumulate less snow high up in the mountains and lose mass at the bottom of the glacier through melting. The glaciers are predicted to continue to retreat in response to climate, meaning future generations will likely have to walk further up the valley to visit the glacier.

Fox Glacier 1958 vs Fox Glacier 2015

MB 1065, A.C. Graham photographs, Reference code 19875, Aerial view: Fox Glacier from below Cone Rock to the Divide, 1958. Macmillan Brown Library, University of Canterbury.

Fox Glacier at river bed from Gun Barrel 2015, Stacey McLean, University of Canterbury.

-Panel C

I'm just one person what can I do?

Reduce, Reuse & Recycle – Reduce the use of disposable goods, replace them with reusable goods, and recycle what you can no longer use.

Why is the ice blue?

The ice absorbs all the colours from the visible light spectrum except blue, which is scattered back giving it a blue colour.

Board 02

-Panel A

In 1998 the front of Fox Glacier /Te Moeka o Tuawe was here!

During this time global CO_2 levels measured approximately 366ppm (parts per million).

The level of CO2 concentration in the atmosphere is commonly measured in parts per million.

-Panel B

I'm just one person what can I do?

Value Local Ecosystems – Protecting and sustaining your regional ecosystems: sustainable care of ecosystems like restoration and planting efforts, can help to reduce the effects of human-induced climate change.

Are the glaciers here all year round?

The glaciers occupy the valley all year round but continue to adjust their size depending on how much snow they receive and how much ice is melting.

Board 03

-Panel A

In 1973 the front of Fox Glacier /Te Moeka o Tuawe was here!

During this time global CO_2 levels measured approximately 329ppm (parts per million).

Parts per million is used to measure CO_2 concentration in the atmosphere.

-Panel B

I'm just one person what can I do?

Local Food – If communities collectively share food production and purchasing efforts, it can support lower carbon economies and overall healthier citizens.

How many glaciers are left?

Although rapidly retreating, Fox and Franz Josef are not the only glaciers left. There are over 130,000 glaciers around the globe, and more than 3000 in New Zealand.

Board 04

-Panel A

In 1965 the front of Fox Glacier /Te Moeka o Tuawe was here!

During this time global CO_2 levels measured approximately 320ppm (parts per million).

Parts per million is used to measure CO_2 concentration levels in the atmosphere

-Panel B

I'm just one person what can I do?

Low Carbon Transportation – By using public transport, bicycles and walking, we reduce carbon pollution, become healthier and save money.

How cold is the ice?

Fox and Franz Josef are wet-based (temperate) glaciers, so the ice is at 0°C. This is why they are great indicators of climate change.

Board 05

-Panel A

The front of Fox Glacier /Te Moeka o Tuawe was here in 2012!

During this time global CO2 levels measured approximately 393ppm (parts per million).

Scientists commonly use parts per million to measure the concentration of CO2 in the atmosphere.

-Panel B

The World Glacier Monitoring Service show that globally, glaciers are retreating at an unprecedented rate.

Climate change records indicate that glaciers throughout the world would still experience large ice loss, even if the current climate stabilized. Even if climate warming stopped today, glaciers will still continue to retreat, because of the time lag that exists between changes in climate and the response of the glacier.

Fox and Franz Josef glaciers react quickly (3-4 years) to changes in climate, and are considered to be amongst the most responsive glaciers in the world.

-Panel C

I'm just one person what can I do?

Engage with Government – Ask your local government what is being done to mitigate and adapt to human induced climate change, challenge government representitives to improve policy, and support those who do.

Why can't I touch the ice?

It is unsafe to touch the front of the glacier because large pieces of ice can break off at any time.

9.6 Survey Data