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Adapting CoastSnap to engage the local community

A CASE STUDY OF THE COASTSNAP STATIONS IN CHRISTCHURCH, NEW ZEALAND

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Abstract:

The communities of Taylors Mistake and New Brighton have had limited interaction with the CoastSnap community science initiative that was set up by Environment Canterbury (ECan) and the Christchurch City Council (CCC). In this project, we investigated the community understanding of CoastSnap, ways to improve engagement, and potential uses for the data. To assess these concepts, a qualitative community survey was undertaken, as well as primary data analysis in MATLAB using code by Mitchell Harley, the founder of CoastSnap, which produced a series of CoastSnap outputs. Our research determined that the community was lacking knowledge about CoastSnap and local coastal processes in general. Our recommendation to ECan and the CCC is to utilise CoastSnap data outputs through education within existing educational sites and programs across the region, such as the Surf Life Saving New Zealand Beach Education Program. We also recommend increasing social media advertising, as well as updating signage in the Taylors Mistake and New Brighton areas to foster community engagement. Further research would involve increased engagement with mana whenua and designing a webpage or educational system that would incorporate MATLAB and survey results produced.

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1.0 Introduction and Background Context

Coastal environments are dynamic areas that undergo many natural and anthropogenically induced changes (Rajasree et al., 2016). Change occurs through physical processes, including tide change, waves, sea level variability, sediment transport, wind, and currents (Bryan et al., 2008). The shoreline changes that these processes create are environmentally significant for maritime and terrestrial populations (Masselink et al., 2014). These shoreline changes are particularly important as the shoreline is the line of contact between land and sea, acting as a barrier to marine movement and a buffer against storm waves.

There is increasing research and literature on the effects of climate change on the marine environment and surface of the ocean. Many studies note that climate change alters the biogeochemical and physical processes of the ocean, with particular emphasis on how this will negatively affect oceanic services to people (Bopp et al., 2013; Law et al., 2018; Cheung et al., 2016; Sweetman et al., 2017). Much of the ocean focussed climate change literature centres on the effects of ocean warming and associated Sea Level Rise (SRL). Crowell et al. (1997) recognise the strong relationship between long-term shoreline retreat and SLR. Shoreline position is a function of coastal erosion and accretion, and sediment input can be a controlling factor (Mukhopadhyay et al., 2012). Increased frequency of extreme weather events and SLR will have the greatest impacts on sandy shorelines. Coastal erosion increases the susceptibility of coastal communities to coastal change due to the minimisation of flood resilience post-erosion events (Stive et al., 2009; Haughey et al., 2021).

The dynamic nature of coastlines, as well as the current and future impacts of climate change, delineate the importance of multi-decadal monitoring of shoreline change (Scavia et al., 2002; Mukhopadhyay et al., 2012). Physical records of coastal change over an extended period help coastal scientists understand the phenomena – allowing for the impacts of climate change on coastlines to be measured and observed.

CoastSnap is a mobile phone application that allows for photos of beach width and morphology to be captured and collected by the public. Photogrammetry is the technique used to capture the changing coastline; an official CoastSnap phone cradle aligns the camera with the desired coastline, providing similar accuracy to professional coastal surveys (CoastSnap, n.d.) (Figure 1, 2 & 3). Publicly taken photos are then rectified using MATLAB and code written by Mitchell Harley, the founder of CoastSnap, to create various outputs that can be used for coastal education. This project is commissioned by Environment Canterbury (ECan) and the Christchurch City Council (CCC) and will monitor shoreline change at New Brighton and Taylors' Mistake beaches. Resilient communities and healthy environments are a key focus for both ECan and the CCC (Christchurch City Council, 2019; Environment Canterbury, n.d.b). The strategic direction of both entities closely aligns with the purpose of CoastSnap and this project.

Figure 1 (top left): CoastSnap station at New Brighton Pier, Christchurch, New Zealand – facing South. Figure 2 (top right): CoastSnap station at New Brighton Pier, Christchurch, New Zealand – facing North. Figure 3 (bottom middle): CoastSnap station at Taylors Mistake, Christchurch, New Zealand.

1.1 Project Objectives

The project research is split into two main objectives:

1.) To analyse already collected data, to create a variety of outputs, including, time-lapse videos, rectified images, shoreline position images, and beach plots.

2.) To understand the community's current coastal knowledge and how engagement can be improved at CoastSnap stations in Christchurch.

2.0 Mana Whenua Engagement

This project acknowledges Ngāi Tahu and Ngāi Tūāhuriri as the mana whenua of the land, and both Christchurch CoastSnap locations (Ngāi Tahu, n.d.). Obligations under Te Tīriti o Waitangi are also acknowledged, and this project endeavours to engage with rūnanga around signage and tikanga.

The Ministry for Business, Innovation and Employment's 'Vision Mātauranga Plan' was used as a framework to engage with mana whenua for this project (Ministry for Business, Innovation and Employment, n.d.). This project and the Ministry for Business, Innovation, and Employment (MBIE) both recognise the importance of Māori as partners in science and innovation. Collaboratively, we hope to build the capacity of Māori entities and communities to allow them to engage with and contribute to the CoastSnap citizen science community. Through this project, we are hoping to join Western and Māori knowledge systems to inform the public about coastal processes. Engaging mana whenua and Māori as partners in this project is imperative to overall success. The relationship between Māori and the Crown is also of immense importance, as we are representing ECan and the CCC - both Crown-commissioned entities.

To engage mana whenua, we hope to enhance platforms to capture, share and learn about images using Te Reo Māori and traditional history. We believe that using the whakapapa of the whenua will aid in the engagement of both Pākeha and Māori individuals. We are using the ECan and Ngā Rūnanga *Tuia Programme* to help guide engagement and interactions with mana whenua. This program is a partnership based on relationships, mutual respect, and shared understandings and values (Environment Canterbury, n.d.). Like the Tuia Programme, we hope to use this project as an opportunity to create a sustainable environment while improving community engagement and knowledge.

3.0 What was already known about the topic?

3.1 How the Canterbury Coast is Responding to Climate Change and Coastal Hazards:

The NIWA climate change projections for the Canterbury region explores the current and projected climate position of Canterbury. The report notes a projected increase in mean temperature of 0.5-3.5°C by 2100 for New Zealand under Representative Concentration Pathway 8.5 (RCP 8.5) (Macara et al., 2020). This increase in temperature connects to a +2.5°C increase in sea surface temperature (Law et al., 2018). Increases in mean temperature cause the melting of glaciers and ice sheets, as well as the thermal expansion of water – all contributing to SLR (Nicholls & Cazenave, 2010). Comparative analysis of satellite altimeter measurements shows that SLR in New Zealand's Exclusive Economic Zone from 1993 to 2015 has been 4.4±0.9 mm/year. The sea level in Lyttelton Harbour is expected to rise 1 meter by 2100 under RCP8.5 projections (Allan et al., 2017; Macara et al., 2020).

Taylors Mistake and New Brighton are both sandy beaches (Kirk, 1980) which are particularly sensitive to the impacts of climate change, including SLR, increasing frequency and intensity of extreme events, waves, and sediment input changes (Hein & Ashton, 2020). A 2021 report by Tonkin & Taylor for the CCC explores the impacts of SLR on the Canterbury coast. Methods of data collection included LiDAR, aerial imagery, ECan beach profiles, water, and tide levels, and NIWA and Metservice wind data. The report focuses on coastal erosion, inundation, and rising groundwater levels of several beaches including Taylors Mistake and New Brighton. Short- and long-term components, as well as dune stability, were measured for erosion assessment. The Christchurch open coast has high rates of accretion due to sediment input from the Waimakariri River. In the future, a 28% increase in sediment could cause the projected 1.5m SLR in 2130 to be pushed seawards by 27m (Haughey et al., 2021). Under low SLR, Taylors Mistake dunes are projected to erode -13 to -22m. In 2130 under high SLR, this erosion could reach -47 to -96m. Analysis of wave run-up, extreme water levels, combined storm, and tide effects, and future erosion was used to determine the inundation probability of the Christchurch open coast (including Taylors Mistake). The assessment shows that Taylors Mistake is susceptible to static inundation under 0.4m SLR, and most townships are susceptible under 1.5m SLR.

Coastal modelling of SLR based on 2013 IPCC predictions for the Christchurch coastal environment (Eaves & Doscher, 2015), uses numerical models incorporated into the ESRI ArcGIS interface (BeachMMtool) to simulate SLR and the effect on coastal communities. Results show that regional and district coastal designations do not meet the statutory requirements outlined in the 2010 New Zealand Coastal Policy Statement. The research notes that while progradation will likely still occur along the Christchurch open coast due to net sediment flux, extreme events and continual SLR will cause coastal inundation.

3.2 Existing Environmental Education and Research Methods:

Environment Education (EE) through a citizen science project, such as CoastSnap, would help provide residents and the wider community with knowledge and awareness, as well as the education they need to influence their attitudes towards the environment (Ghilardi-Lopes et al., 2019). Existing knowledge bases include online resources hosted by organisations such as Coastal Restoration Trust, Regional Councils, New Zealand Coastal Society, NIWA, and DOC. EE also exists within the New Zealand curriculum, with the Ministry of Education pushing for 'Education for Sustainability' with a range of resources available for teachers (Ministry of Education, 2020). A wide range of literature showcases that there is collaborative and outdoor interactive learning (like that of CoastSnap) already in existence, such as the Kaikorai Stream Initiative in Dunedin (McMillan & Binns, 2011), and the Nga Waihotanga Iho in Northland. These initiatives allow for the formation of win-win partnerships, as well as allow the community to have more thoughtful management of their local resources. Literature states that Māori-led collaborative education can also be a powerful vehicle for strengthening indigenous knowledge, priorities, and approaches within the current post-colonial education system (Dodson & Miru, 2021).
From this literature review, a reflection-based and collaborative approach to learning was decided to be the most used in the education space - where an event was held and surveys or interviews took place afterward (Santos et al., 2018). CoastSnap has essentially already had a trial run, with an opportunity

to see the community's thoughts on the initiative, and to determine why existing signage or promotional attempts have not been as successful as hoped.

3.3 Exploration of Similar Coastal Citizen Science Initiatives:

Coastal community science initiatives have increased in popularity as the digitalisation of the 21st century continues to grow. Despite the undeniable benefits of utilising citizens to engage in scientific research, there are several barriers, such as reliability, accessibility, and longevity. Longevity is key to ongoing coastal investigations such as CoastSnap, where data over an extended time allows for increased accuracy in predicting shoreline changes (Pecl, et al., 2019). CrowdWater, RedMap, and similar crowd-Sourced photogrammetry worldwide, all require citizens to capture photographs of environmental changes, hazards, or phenomena over an extended period (Pecl, et al., 2019; Jaud et al., 2019; Strobl et al., 2019; Wernette et al., 2022). These projects have had a variety of successes; the use of software to compare different camera types to ensure reliability, analysing both geotagged and non-geotagged photographs, measuring the variation in the two by a margin of error, and development of methods to increase and encourage citizen participation (Jaud et al., 2019; Wernette et al., 2022). Several barriers were also identified, such as the age accessibility gaps in incorporating social media and low continuous citizen participation (Wernette et al., 2022).

3.4 Investigation into Other Types of Coastal Data with Relevance to CoastSnap:

Using pre-existing coastal data alongside CoastSnap proves beneficial in educating communities on coastal processes, such as tides and waves, and how these influence the shoreline. A range of coastal data must be used to reflect the coast's dynamic environment, which has numerous drivers of response.

Wave buoys are a useful tool that collects wave data, including wave height, period, and direction. They show changes in wave climate that are a key driver of coastal change and sediment transport. This was found during the 2016 East Coast Low in Australia, where a change in wave direction from the typical Northward transportation to an easterly direction, consequently resulted in a 40% increase in subaerial erosion compared to a similar event in April 2015 (Louis et al., 2016; Mortlock et al., 2017). Christchurch has a wave buoy off the Banks Peninsula managed by community partners, ECan, which would be advantageous to gain wave data (ECan, n.d.a). Wave height has major seasonal effects and influences on a beach's erosional or accretionary state (Bernabeu et al., 2003). Tide data can also be used to reflect the change in nearshore water level and is favourable in the circumstances of storm surge, where the beach morphology is likely to change significantly if water exceeds a certain level during a high tide (Pye & Blott, 2008).

3.5 Exploration of Other CoastSnap Initiatives and the Implementation of Their Data:

CoastSnap sites were created for Australian beaches, including Manly and North Narrabeen, to engage local communities with coastal monitoring. The project was based on ARGUS cameras, (Hart &

Blenkinsopp, 2020), using the concept of taking pictures from the same position at varying intervals. CoastSnap replaced the stationary camera that needed a power supply and internet connection with a cradle and the public's smartphones (Harley et al., 2019; Harley & Kinsela, 2022; Hart & Blenkinsopp, 2020; Splinter et al., 2018). This engaged the public in coastal science and has contributed to scientific knowledge in the areas implemented.

Image processing was the largest consumer of time and the largest barrier to accessibility within new CoastSnap locations. Retrieving images from various sources and storing them is dependent on the site but takes time and resources to do (Harley et al., 2019; Harley & Kinsela, 2022). Images are processed based on the time and location taken and rectified in MATLAB with code written by Mitchell Harley (Harley et al., 2019; Harley & Kinsela, 2022; Hart, 2021). The rectification, shoreline detection, and tidal correction are all processed by hand using MATLAB which is time and resource intensive.

Outputs from CoastSnap have helped identify trigger thresholds to open/closed lakes, (Harley & Kinsela, 2022; Roger et al., 2020; Splinter et al., 2018). The MATLAB code can also produce quantitative records of shoreline positions over time (Harley et al., 2019; Harley & Kinsela, 2022; Hart, 2021).

4.0 Methods

4.1 CoastSnap Outputs

CoastSnap outputs were created using MATLAB and an established CoastSnap directory. Images sent via email for both locations were all received through the CCC and already loaded into the database. Images uploaded through the CoastSnap Map on the website were downloaded and saved to the database. Initially, downloading images from social media, including Instagram and Twitter, was challenging. The limited images from these sources, as well as time constraints, prompted the executive decision to not include these images in the analysis.

Images were saved to the database with the following information: site (Taylors Mistake, New Brighton North, and New Brighton South); username; photo time; time zone; filename (image name); source (Facebook, website, email); type (snap in CoastSnap cradle or not); and timestamp quality (estimate of the accuracy of the image based on when it was uploaded). If data were inputted or formatted incorrectly, it would result in errors in MATLAB code. YouTube tutorials produced by Mitchell Harley during the 'CoastSnap User Workshop', explained the image analysis process, using the Australian Manly Beach as an example (Harley, 2020a, 2020b, 2020c, 2020d).

Images were analysed in MATLAB using Common Spatial Patterns (CSP) in the code. This allowed images to be uploaded from the database and then rectified using common Ground Control Points

(GCPs). Each site had 5-6 GCPs that were previously surveyed by the CCC. Images were rectified by selecting the GCPs, with a Root Mean Square Error (RMSE) below 4 being deemed accurate by the group.

Shorelines were plotted from the rectified image but often had to be modified to account for the code not recognising the difference between New Zealand Ocean water and the beach sediment. Approved shorelines were saved to the database and could be used to create shoreline change plots on MATLAB using the associated features (‘trend plot last X days’ and ‘Shoreline change plot’).

4.2 Survey

The community’s level of coastal knowledge was gauged through a survey created using the accessible software Qualtrics. The survey consisted of 12 questions, beginning with the demographics of participants (see appendix 1.), and contained questions about participants' prior knowledge of the CoastSnap initiative, and how future engagement could be improved. The participants' knowledge of coastal issues was then tested, to demonstrate why CoastSnap is important for education. It was distributed to several community groups, namely, New Brighton buy, sell & trade, Sumner: New Zealand, New Brighton Residents Association, Ferrymead/Sumner/Redcliffs/Mt Pleasant community page, Taylors Mistake Lifeguard Patrol Swaps Facebook Page, New Brighton Lifeguard Page, Wāhine Swim Squad Messenger Group Chat and the UCSA Noticeboard. These groups had access to the survey through an accessible web link and QR code, with the project’s aims and ethics included. The data collected from the Qualtrics survey was exported into Excel, and summary statistics were created for all quantitative data. These were then used to output multiple pie charts, showcasing the total number of respondents and their relative answers.

5.0 Results

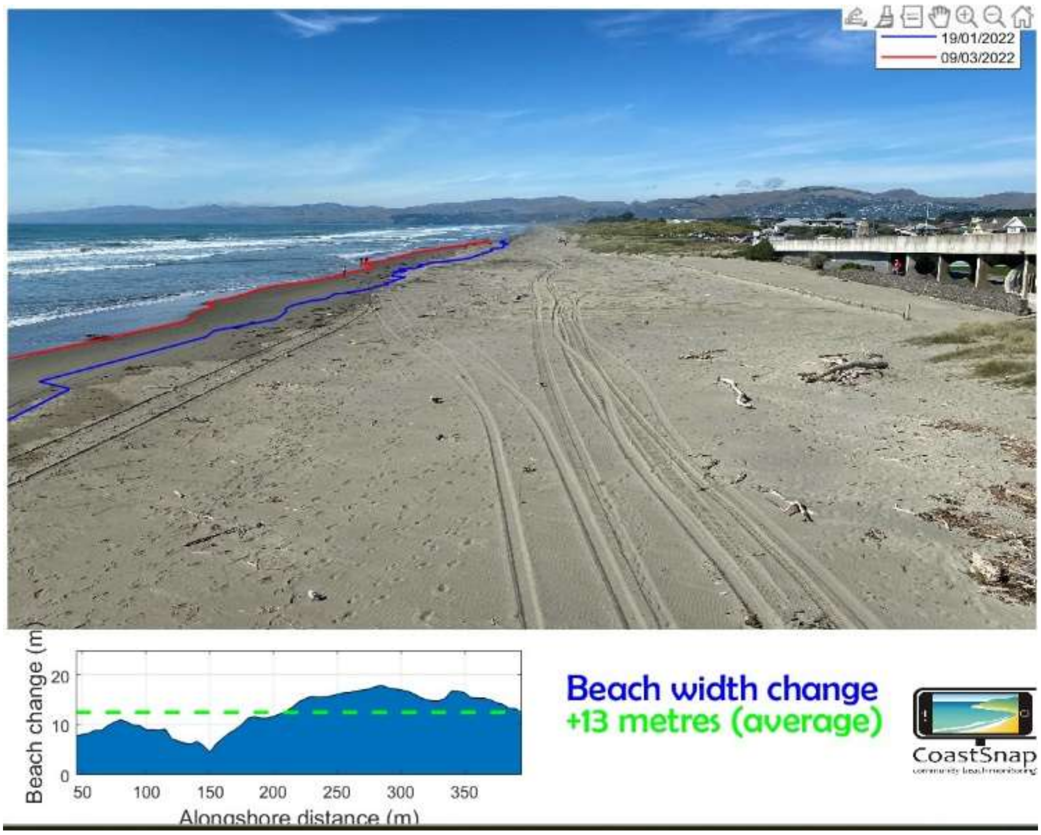

Figure 4: Beach width change from 19/1/2022 to 9/3/2022 at New Brighton Beach, Christchurch New Zealand (facing South.) Plots were created on MATLAB using the CoastSnap code produced by Mitchell Harley and a tidal tolerance of 0.2m.

Figure 4 shows the output for a beach width change from 19/1/2022 to 9/3/2022 at New Brighton Beach (South). Over two months, MATLAB has calculated a 13m positive change in beach width.

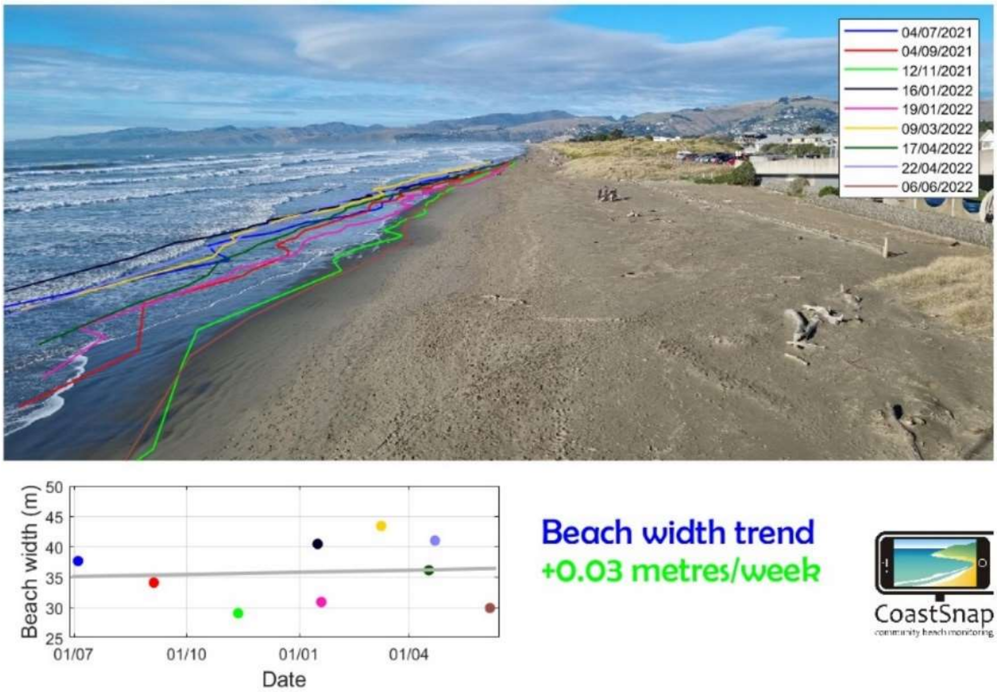

Figure 5: Beach width trend plot from 4/7/2021 to 6/6/2022 at New Brighton Beach Pier, Christchurch, New Zealand (facing South). Plots were created on MATLAB using the CoastSnap code produced by Mitchell Harley and a tidal tolerance of 0.2m.

Figure 5 shows a beach width trend plot from 4/7/22 to 6/6/22 at New Brighton, looking South. Over the year, there have been many stages of shoreline change (both negative and positive), with an overall accretion of 0.03 metres/week.

Figure 6: Shoreline at New Brighton Beach, Christchurch, New Zealand, on Tuesday 2nd of November at 14:33. Shorelines were created on MATLAB using the CoastSnap code produced by Mitchel Harley.

Figure 6 shows a plotted shoreline at New Brighton Beach (South). The shoreline also reflects the time and date, location, and user, allowing for data to be correlated to tide and wave data on the open coast.

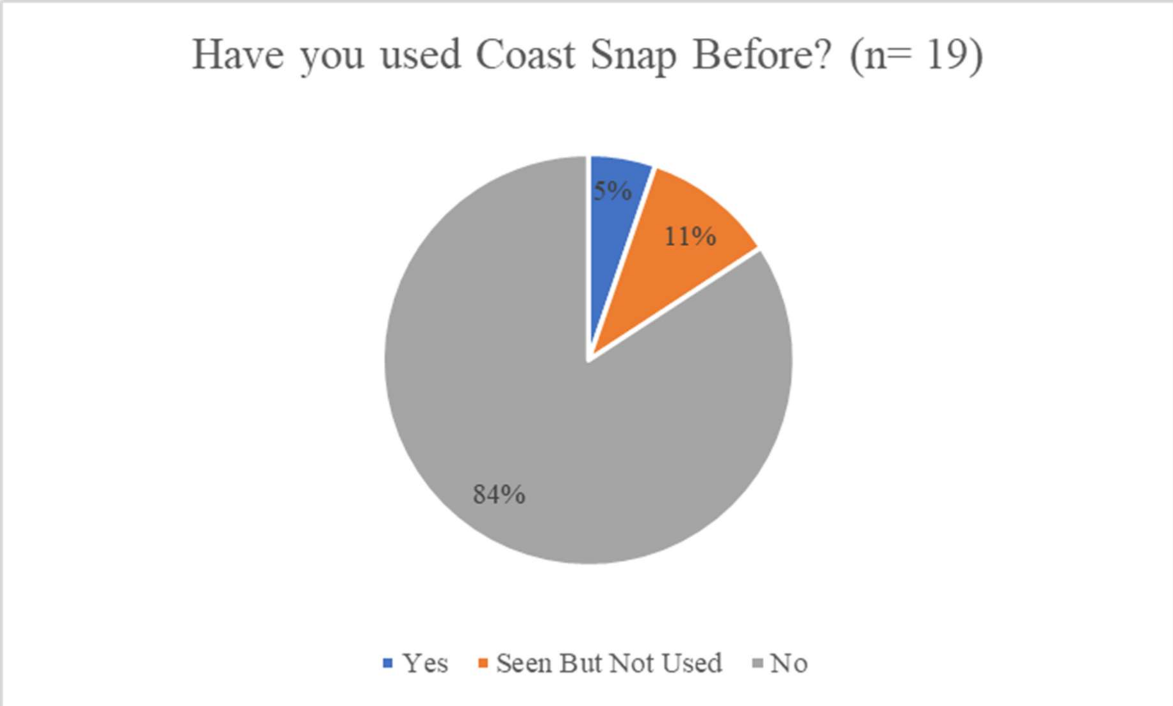

Figure 7a2: Pie Graph showcasing who has used CoastSnap before from Survey (Appendix 9.1). Total of 19 respondents.

Figure 7a shows that the majority of respondents have not interacted with CoastSnap before (84%). Just over a quarter of people (16%) have seen or used CoastSnap at New Brighton or Taylors Mistake.

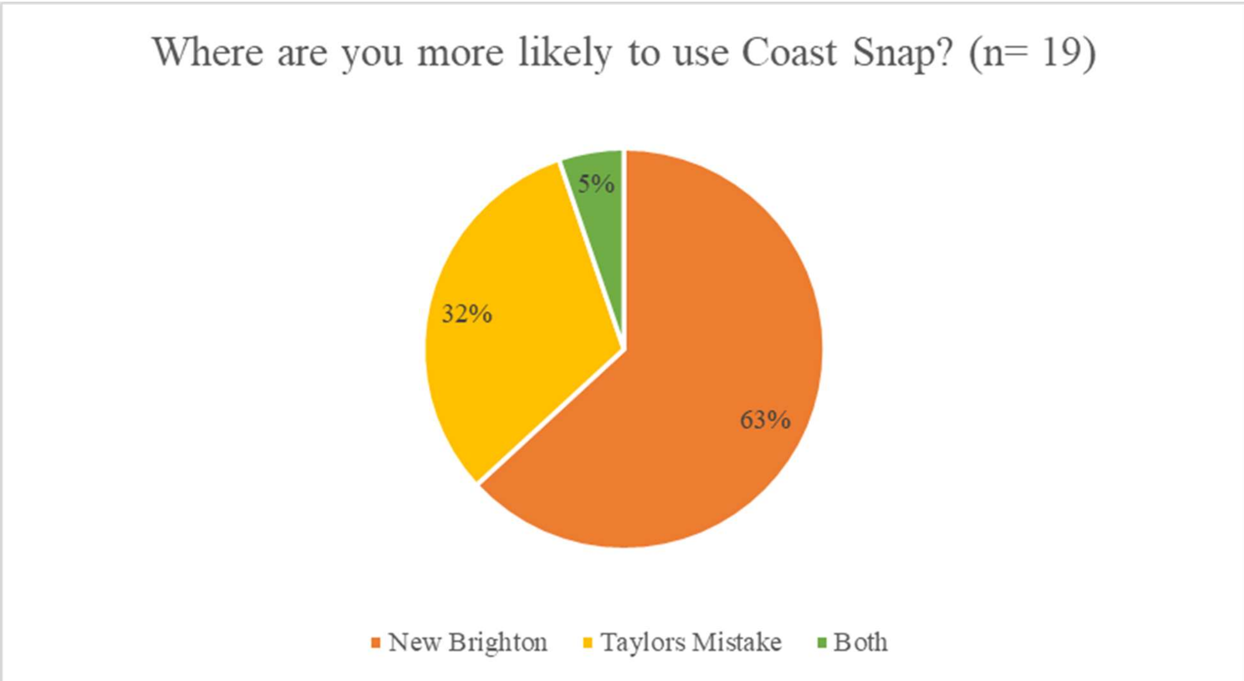

Figure 7b: Pie Graph showcasing the location where respondents are more likely to use CoastSnap from Survey (Appendix 9.1). Total of 19 respondents.

Figure 7b shows the sites where people are most likely to use CoastSnap in Christchurch. New Brighton is the favoured location with 63% of respondents being likely to use the CoastSnap cradles on the pier.

Taylors Mistake had significantly less at 32%, whilst few respondents indicated they would use both sites (5%). Results from other CoastSnap sites can be found in Appendix 1.2.

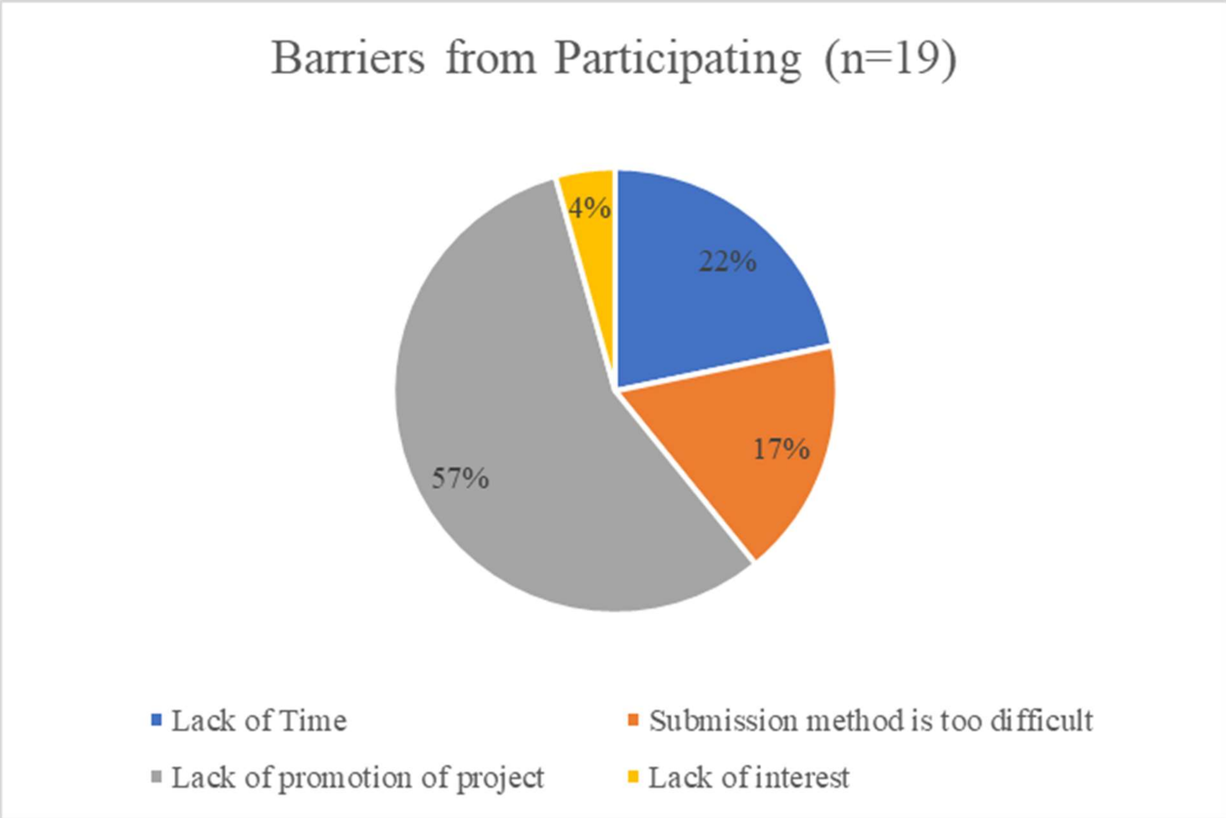

Figure 7c: Pie Graph showcasing the potential barriers to participating with CoastSnap from Survey (Appendix 9.1). Total of 19 respondents.

Figure 7c shows the potential barriers to people participating in the CoastSnap initiative in Christchurch. The main discouragement was the lack of promotion of the project, with 57 % of respondents choosing this as a barrier. Lack of time and submission method being too difficult were similarly measured barriers for the public (22% and 17% respectively), and lack of interest was occasionally chosen as a barrier (4%)

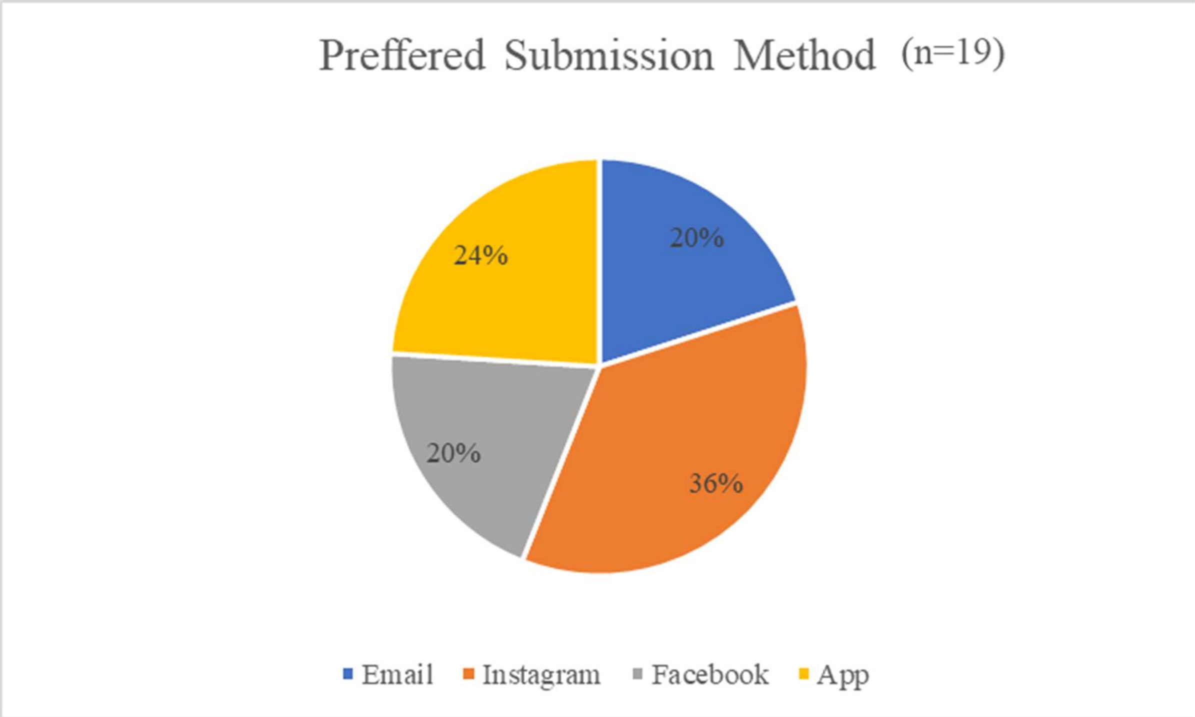

Figure 7d: Pie Graph showcasing the preferred image submission method from Survey (Appendix 9.1). Total of 19 respondents.

Figure 7d looks at the preferred submission method for CoastSnap images, with 36% choosing Instagram, 24% choosing the app, as well as 20% choosing Facebook, and 20% choosing Email.

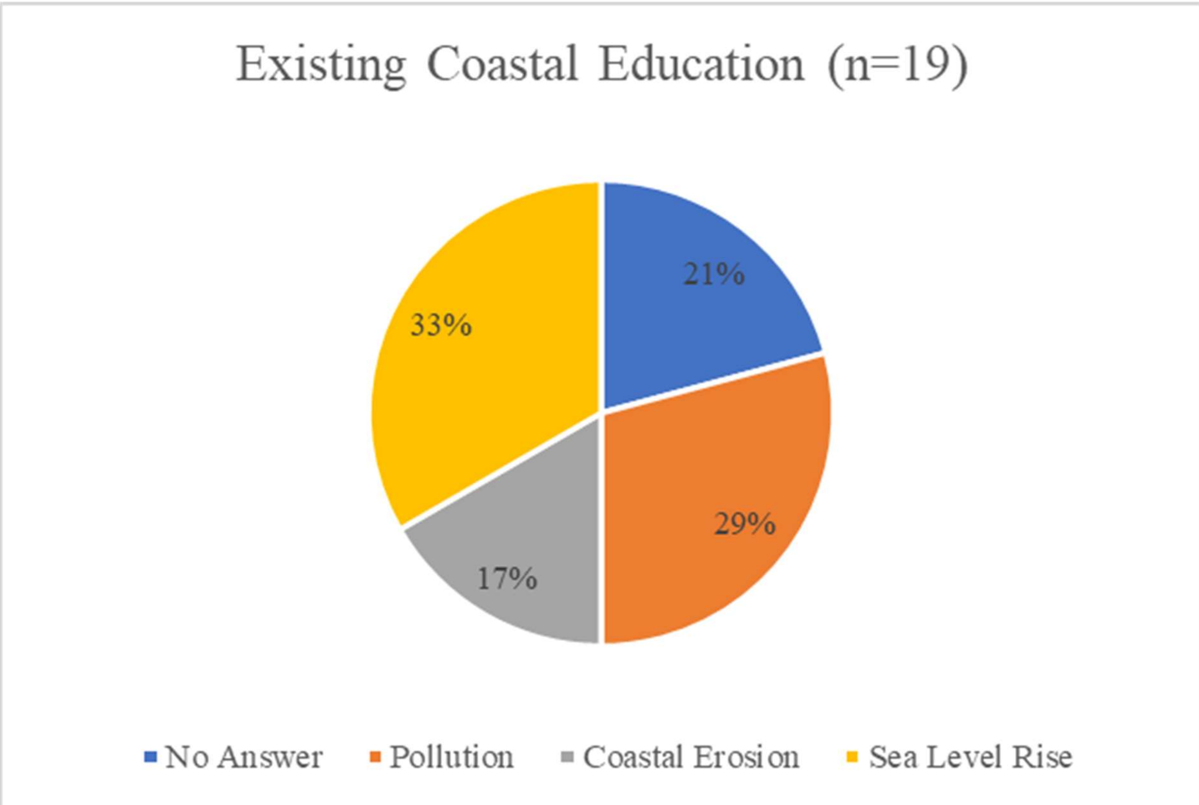

Figure 7e: Pie Graph showcasing categories of existing coastal education within the community; from Survey (Appendix 9.1). Total of 19 respondents.

Figure 7e showcases an even split over four topics, looking at the existing coastal education in the community. The biggest concerns for the respondents were SLR (33%) and pollution (29%), closely followed by coastal erosion (17%). A large percentage of the respondents also responded with no answer (21%).

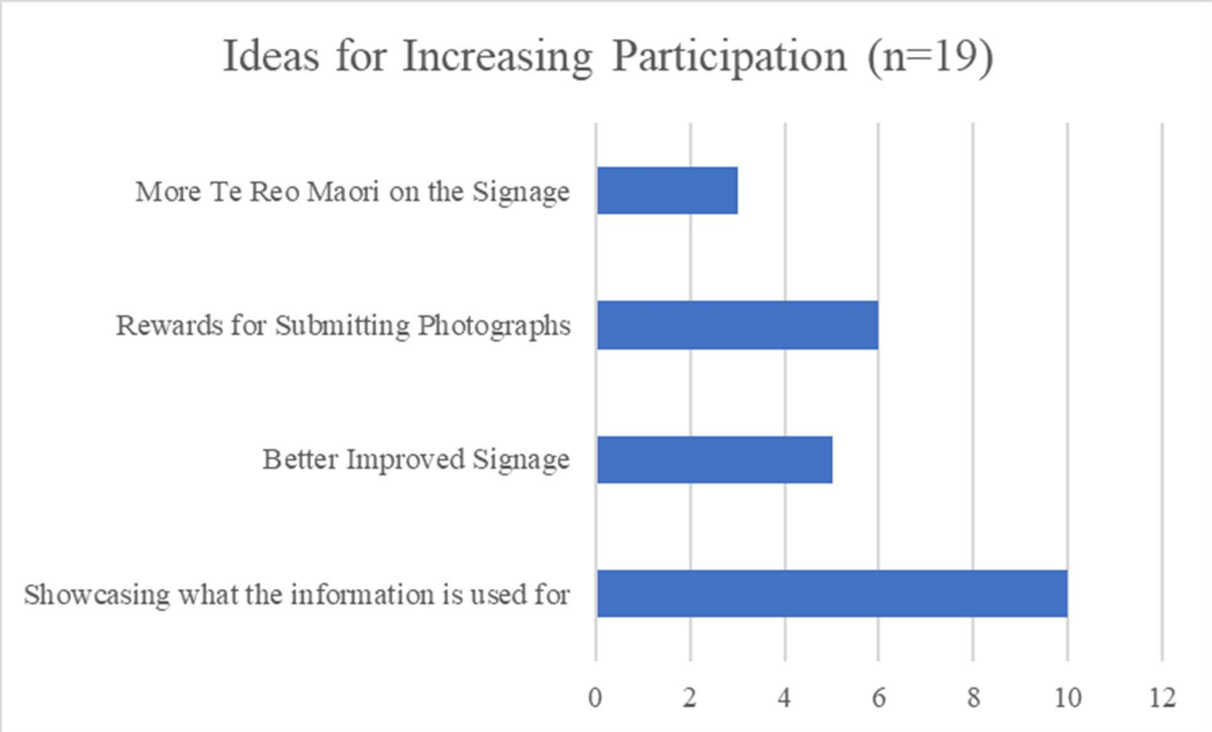

Figure 7f: Pie Graph showcasing potential ideas for increased participation with CoastSnap; from Survey (Appendix 9.1). Total of 19 respondents.

Ideas for increasing engagement are recorded in Figure 7f. This graph showed that 42% of the respondents felt that showcasing what the information is used for would increase their participation in CoastSnap in Christchurch. Additionally, rewards for submitting photographs (25%), improved signage (21%), and more Te Reo Māori in the signage (12%) were also perceived to increase participation.

6.0 Discussion

6.1 Discussion of Results

Figure 7a highlights the need for improvement of current CoastSnap promotional schemes, as well as the need for more community outreach because most of the respondents had not used CoastSnap before. Figure 7b reinforces this, by highlighting that the biggest barrier is limited knowledge about it, closely followed by lack of time, and the submission method being too complicated. However, this figure does show that lack of interest is not a problem. It shows that the community is willing to engage, interact, and learn about local coastal processes. Figure 7c examines which CoastSnap site is being used more, with New Brighton being the most popular, and few people aiming to use both sites. The statistics from this figure corroborate with current CoastSnap engagement at both sites. From this figure, it can be discerned that CoastSnap sites are more likely to be interacted with in areas of higher foot traffic and infrastructure, with New Brighton Pier having more built infrastructure than the Taylors Mistake walking path (Hart, 2021). Figure 7d showcases that the preferred method for submitting an image was Instagram, closely followed by the app. This may highlight that those interacting with Coast Snap may be younger generations who are comfortable using social media. The respondents who chose email as their preferred submission method indicate that there is still a need for this submission method, to ensure CoastSnap is accessible to a range of people.

Existing coastal knowledge in the community was also researched. It was found that people from the New Brighton and Taylors Mistake communities are most educated and concerned about pollution and SLR, closely followed by coastal erosion (Figure 7e). However, nearly half of all respondents left no response. This was concerning due to the respondents being the communities most likely to be affected by coastal changes. It reinforces the idea that there is a need for greater education surrounding coastal processes, which would allow more people to understand how to protect their coastline. Finally, potential ideas for increasing participation were investigated (Figure 7f), showcasing that people are extremely interested in seeing the outputs that come from the images they are taking. People were also interested in having reward schemes for inputting images or improving signage and including more Te Reo Māori within the signage.

The range of results showcases that CoastSnap outputs could be used in conjunction with existing education programs in the coastal sector, such as the Surf Life Saving New Zealand Beach Education program. For the CoastSnap outputs to be used successfully within the education space, several steps would help foster the existing community engagement. These recommendations include improving existing signage, for example creating new signage in the New Brighton and Taylors Mistake area which could include the cultural history of the Whenua in the area. The incorporation of a QR code that scans onto a website showcasing the CoastsSnap outputs, including time-lapses would increase educational opportunities and engagement. These can be used alongside tide and wave data to educate the public on the impacts of SLR and the drivers of change on the coast – an outcome requested by the communities. A common response for the lack of engagement was a lack of understanding of where the pictures were going, and what they were being used for, and these adaptions solve this issue. In conjunction with ECan and the CCC, improving the education of communities and updating the information available from this community-sourced initiative, has the potential to increase community engagement and drive the understanding of coastal issues and processes.

6.2 Limitations of CoastSnap Data Exploration

The main limitation of using CoastSnap was the heavy reliance on image collection from community engagement. This meant that the number of images and the intervals between them were beyond our control. Therefore, any outputs may not reflect extreme events or significant changes in beach morphology if no data was collected near events. Between the New Brighton and the Taylors Mistake locations, there were significantly more images at the former. These images were more frequent and, therefore, gave a much better evaluation of the coastal changes than at Taylors Mistake.

Another limitation of image analysis was the limited knowledge of coding within the team before this project. This lengthened the processing of analysis due to slow debugging and research on how to fix varying database issues. This process also brought to light that some computer systems couldn't run the code which required some group members to use "remote desktops". Due to these setbacks, and the limited time frame for this project only images from 2022 and a few 2021 images were processed.

While rectifying the images and selecting each GCP location, the quality of each image impacted the accuracy. The variation in cameras between smartphones resulted in some of the GCPs being pixelated and unclear. The GCPs further from the cradle were less likely to be accurately located. which affected the RMSE value. The accuracy of the coastlines produced by the MATLAB code also varied between images due to the hard-to-distinguish difference in sand and ocean water colour in New Zealand, compared to Australia (where the code was written). To minimise errors in the outputs, each site's images were rectified by one group member. This meant that each site had the consistency of a single person determining where the GCPs were or where the coastline is.

6.3 Survey Limitations

There were several limitations encountered when using Qualtrics, Excel, and social media for the survey data collection. Distribution of the survey via social media was accessible and appeared efficient. However, with only 19 respondents, the risk of sampling error (Sedgwick, 2015) and inaccurately reflecting the wider population was large. In the 2018 census, New Brighton's population was 3,330, and the wider Sumner area (including Taylors mistake), was 3,519 (StatsNZ, 2018a, 2018b). The low number of respondents compared to the total population restricts confidence in the survey results, and how the results may reflect the general public's perspectives. The spread of respondents' age limited the older and younger brackets. This is a form of sampling bias, and those who participated in the survey may have been within a demographic that more frequently uses social media. Sampling bias occurs when some groups of the population are less likely to be included in a sample than others (Sedgwick, 2015).

Mana whenua engagement was limited within this investigation, with attempts to send the survey directly to local iwi being unsuccessful. This increased sampling bias and must be considered when interpreting survey results. Several potential participants opened the survey and then exited it before recording any results. This could be due to disagreement with the ethics disclaimer before the beginning of the survey.

Question 5 of the survey asked participants "what would entice you to record with CoastSnap on a regular basis?". Four options were available for the participant to indicate their preference, with a fifth open "other" box. In the future, a question of this nature would be more beneficial in the form of an open question box, rather than providing the participant with options and potentially skewing their opinions.

6.4 Mana Whenua Engagement Limitations

This project faced issues concerning the engagement of mana whenua, Ngāi Tahu, and Ngāi Tūāhuriri. Various attempts were made to contact both Ngāi Tahu and Ngāi Tūāhuriri over the phone and through email during the initial and developed stages of the project.

The lack of mana whenua engagement limited our access to traditional knowledge surrounding the whenua and coasts this project focuses on. It also hindered our ability to follow the *'tika'*, or correct, the process of research in alignment with Māori values. As noted in section 6.3, our survey results may have a sampling bias because of the lack of Māori engagement. Resultantly, this project has had to conduct research and provide suggestions on previous knowledge surrounding Te Ao Māori.
It was noted through discussion with other GEOG309 groups that this was a commonly encountered problem, due to the busy time of the year for both rūnanga and iwi. In furthering this project, full engagement of mana whenua is imperative to the success and longevity of CoastSnap.

7.0 Conclusion

Following the investigation of related literature, MATLAB data analysis, and surveying the public it can be concluded that there is a significant opportunity for CoastSnap to be used as a resource to help further educate the public on the coastal processes occurring in their local area. By providing this research we can enable a sustainable future for CoastSnap through key recommendations on how CoastSnap can improve its existing engagement within the communities. A sustainable future for CoastSnap would have a real and influential impact. It would provide new resources that the community has an influence on creating and could be used to help educate and encourage people to become more heavily involved in the dynamic environment of our coasts.

8.0 Acknowledgements

This project was completed in collaboration with the Christchurch City Council and Environment Canterbury. Thank you to Justin Cope, Sarah Pahlen, Dr. Sarah McSweeny, Professor Simon Kingham, and our GEOG309 peers for their guidance and assistance.

We would also like to acknowledge Ngāi Tahu and Ngāi Tūāhuriri as the mana whenua of the land and recognise that collaboration is needed for future generations.

"Mo tatou, a, mo ka uri a muri ake nei"
"For us, and our children after us"
Ngāi Tahu Proverb

9.0 References

Allan, S., Bell, R., Blackett, P., Lawrence, J. & Stephens, S. (2017). *Coastal Hazards and Climate Change: Guidance for Local Government.* Ministry for the Environment, https://environment.govt.nz/assets/Publications/Files/coastal-hazards-guide-final.pdf

Bernabeu, A., Medina, R., & Vidal, C. (2003). A morphological model of the beach profile integrating wave and tidal influences. *Marine Geology*, *197*(1-4), 95-116.

Bopp, L., Resplandy, L., Orr, J. C., Doney, S. C., Dunne, J. P., Gehlen, M., Halloran, P., Heinze, C., Ilyina, T., Séférian, R., Tjiputra, J., and Vichi, M., (2013). Multiple stressors of ocean ecosystems in the 21st century: projections with CMIP5 models. *Biogeosciences*, *10*(10), 6225-6245. https://doi.org/10.5194/bg-10-6225-2013

Bryan, K. R., Kench, P. S., & Hart, D. E. (2008). Multi-decadal coastal change in New Zealand: Evidence, mechanisms, and implications. *New Zealand Geographer*, *64*(2), 117-128.

Cheung, W. W. L., Rogers, A. D. & Sumaila, R. R. (2016). Observed and projected impacts of climate change on marine fisheries, aquaculture, coastal Tourism, and human health: an update. *Frontiers in Marine Science, 3*, 48. https://doi.org/10.3389/fmars.2016.00048

Christchurch City Council. (2019). *Strategic Framework*. Retrieved from Christchurch City Council: https://www.ccc.govt.nz/the-council/how-the-council-works/20182028-vision/strategic-framework/

CoastSnap. (n.d.). *CoastSnap: Community Beach Monitoring.* Retrieved on (10/8/22), from https://www.coastsnap.com/

Crowell, M., Douglas, B. C., & Leatherman, S. P. (1997). On forecasting future US shoreline positions: a test of algorithms. *Journal of Coastal Research*, *13*(4), 1245–1255. http://www.jstor.org/stable/4298734

Dodson, G., & Miru, M. (2021). Ngā Waihotanga Iho: Self-determination through Indigenous environmental education in New Zealand. *Australian Journal of Environmental Education, 37*(3), 254–265. https://doi.org/10.1017/aee.2021.5

Eaves, A., & Doscher, C. (2015). Coastal modelling of sea level rise for the Christchurch coastal environment. *Lincoln Planning Review, 7*(1-2), 3-15. https://researcharchive.lincoln.ac.nz/handle/10182/7907

Environment Canterbury. (n.d.a). *Current wave data.* Retrieved August 24, 2022, from https://www.ecan.govt.nz/data/current-wave-data

Environment Canterbury. (n.d.b). *Our Strategic Direction: Te Aronga Rautaki.* Retrieved August 22, 2022, from https://www.ecan.govt.nz/about/your-council/about-us/our-strategic-direction/

Ghilardi-Lopes, N. P., Kremer, L. P., & Barradas, J. I. (2019). The Importance of "Ocean Literacy" in the Anthropocene and how environmental education can help in its promotion. *Coastal and Marine Environmental Education*, 3–17. https://doi.org/10.1007/978-3-030-05138-9_1

Harley, M. D., & Kinsela, M. A. (2022). CoastSnap: A global citizen science program to monitor changing coastlines. *Continental Shelf Research,* 245, 104796. https://doi.org/10.1016/j.csr.2022.104796

Harley, M. D., Kinsela, M. A., Sánchez-García, E., & Vos, K. (2019). Shoreline change mapping using crowd-sourced smartphone images. *Coastal Engineering, 150*, 175–189. https://doi.org/10.1016/j.coastaleng.2019.04.003

Hart, J. (2021). *Low-Cost Coastal data collection using citizen science.* (Doctoral dissertation, University of Bath). https://purehost.bath.ac.uk/ws/portalfiles/portal/220248236/Hart_PhDthesisFINAL.pdf

Hart, J., & Blenkinsopp, C. (2020). Using citizen science to collect coastal monitoring data. *Journal of Coastal Research*, *95*, 824–828. https://doi.org/10.2112/SI95-160.1

Haughey, R., Jacka, M. & Knook, P. (2021). *Coastal Hazard Assessment for Christchurch District.* Tonkin +Taylor. https://resources.ccc.govt.nz/assets/environment/land/coastalhazards/2021-09-29_CHA_Tech_Report.pdf

Hein, C.J., &Ashton, A. D. (2020). Long-term shoreline morphodynamics: processes and preservation of environmental signals. *Sandy Beach Morphodynamics*, 487-531. https://doi.org/10.1016/B978-0-08-102927-5.00021-7

Jaud, M., Le Dantec, N., Parker, K., Lemon, K., Lendre, S., Delacourt, C., & Gomes, R. C. (2022). How to Include Crowd-Sourced Photogrammetry in a Geohazard Observatory—Case Study of the Giant's Causeway Coastal Cliffs. *Remote Sensing, 14*(14), 3243. http://dx.doi.org/10.3390/rs14143243

Kirk, R. M. (1980). Mixed sand and gravel beaches: morphology, processes, and sediments. *Progress in Physical Geography: Earth and Environment*, *4*(2), 189–210. https://doi.org/10.1177/030913338000400202

Law, C. S., Rickard, G. J., Mikaloff-Fletcher, S. E., Pinkerton, M. H., Behrens, E., Chiswell, S. M., & Currie, K. (2018). Climate change projections for the surface ocean around New Zealand. *New Zealand Journal of Marine and Freshwater Research*, *52*(3), 309-335.

Louis, S., Couriel, E., Lewis, G., Glatz, M., Kulmar, M., Golding, J., & Hanslow, D. (2016, November). NSW East Coast Low Event—3 to 7 June 2016 Weather, Wave, and Water Level Matters. In *Proceedings of the NSW Coastal Conference, Coffs Harbour, Australia* (Vol.911).

Macara, G., Woolley, J. M., Pearce, P., Wadhwa, S., Zammit, C., Sood, A., Stephens, S. (2020). *Climate change projections for the Canterbury region*. (NIWA no. 2019339WN) Wellington. https://niwa.co.nz/sites/niwa.co.nz/files/ClimatechangeprojectionsfortheCanterburyRegionNIWA.PDF

Masselink, G., Hughes, M., & Knight, J. (2014). *Introduction to coastal processes and geomorphology*. Routledge. https://doi.org/10.4324/9780203785461

McMillan, S. G., & Binns, T. (2011). Environmental education and learning communities: The case of Kaikorai Stream, Dunedin, New Zealand. *New Zealand Geographer, 67*(3), 199–212. https://doi.org/10.1111/j.1745-7939.2011.01212.x

Ministry for Business, Innovation, and Employment. (n.d.). *Vision Mātauranga*. Retrieved August 19, 2022, from https://www.mbie.govt.nz/science-and-technology/science-and-innovation/agencies-policies-and-budget-initiatives/vision-matauranga-policy/

Ministry of Education. (2020). *Education for sustainability / Curriculum resources / Kia ora - NZ Curriculum Online*. Tki.org.nz. Retrieved 10/8/22 from https://nzcurriculum.tki.org.nz/Curriculumresources/Education-for-sustainability mitchellharley. (2020a). *CoastSnap User Workshop Day 1: Introduction to CoastSnap* [Video]. YouTube. https://www.youtube.com/watch?v=NXQbUzvahHI&t=6s

mitchellharley. (2020b). *CoastSnap User Workshop Day 1: CoastSnap Site Selection and Image Registration* [Video]. YouTube. https://www.youtube.com/watch?v=NXQbUzvahHI&t=6s

mitchellharley. (2020c). *CoastSnap User Workshop Day 2: Tutorial 1 (CoastSnap Manly Example)* [Video]. YouTube. https://www.youtube.com/watch?v=NXQbUzvahHI&t=6s

mitchellharley. (2020d). *CoastSnap User Workshop Day 2: Tutorial 2 (CoastSnap Broulee Example)* [Video]. YouTube. https://www.youtube.com/watch?v=NXQbUzvahHI&t=6s

Mortlock, T. R., Goodwin, I. D., McAneney, J. K., & Roche, K. (2017). The June 2016 Australian East Coast Low: Importance of wave direction for coastal erosion assessment. *Water*, *9*(2), 121.

Mukhopadhyay, A., Mukherjee, S., Mukherjee, S., Ghosh, S., Hazra, S., & Mitra, D. (2012). Automatic shoreline detection and future prediction: A case study on Puri Coast, Bay of Bengal, India. *European Journal of Remote Sensing, 45(1)*, 201-213. https://doi.org/10.5721/EuJRS20124519

Ngāi Tahu. (n.d.). *Te Ngāi Tūāhuriri Rūnanga*. Retrieved August 19, 2022, from https://ngaitahu.iwi.nz/te-runanga-o-ngai-tahu/papatipu-runanga/ngai-tuahuriri/

Nicholls, R. J., & Cazenave, A. (2010). Sea-Level rise and its impact on coastal zones. *Science, 382*(5985)*,* 1517-1520. DOI: 10.1126/science.1185782

Pecl, G.T., Stuart-Smith, J., Walsh, P., Bray, D.J., Kusetic, M., Burgess, M., Frusher, S.D., Gledhill, D.C., George, O., Jackson, G., Keane, J., Martin, V.Y., Nursey-Bray, M., Pender, A., Robinson, L.M., Rowling, K., Sheaves, M. and Moltschaniwskyj, N. (2019). Redmap Australia: Challenges and Successes with a Large-Scale Citizen Science-Based Approach to Ecological Monitoring and Community Engagement on Climate Change. *Frontiers in Marine Science, 6.* https://doi.org/10.3389/fmars.2019.00349

Pye, K., & Blott, S. (2008). Decadal-scale variation in dune erosion and accretion rates: an investigation of the significance of changing storm tide frequency and magnitude on the Sefton coast, UK. *Geomorphology*, *102*(3-4), 652-666.

Rajasree, B. R., Deo, M. C., & Nair, L. S. (2016). Effect of climate change on shoreline shifts at a straight and continuous coast. *Estuarine, Coastal and Shelf Science*, *183*, 221-234.https://doi.org/10.1016/j.ecss.2016.10.034

Roger, E., Tegart, P., Dowsett, R., Kinsela, M. A., Harley, M. D., & Ortac, G. (2020). Maximising the potential for citizen science in New South Wales. *Australian Zoologist, 40*(3), 449–461. https://doi.org/10.7882/AZ.2019.023

Santos, C. R., Grilli, N. M., Ghilardi-Lopes, N. P., & Turra, A. (2018). A collaborative work process for the development of coastal environmental education activities in a public school in São Sebastião (São Paulo State, Brazil). *Ocean & Coastal Management, 164*, 147–155. https://doi.org/10.1016/j.ocecoaman.2017.08.011

Scavia, D., Field, J. C., Boesch, D. F., Buddemeier, R. W., Burkett, V., Cayan, D. R., Fogarty, M., Harwell, M. A., Howarth, R. W., Mason, C., Reed, D. J., Royer, T. C., Sallenger, A. H., &

Titus, J. G. (2002). Climate change impacts on U.S. Coastal and Marine Ecosystems. *Estuaries*, 25(2), 149-164. https://doi.org/10.1007/BF02691304

Sedgwick, P. (2015). Uncertainty in sample estimates: sampling error. *BMJ: British Medical Journal, 350.* https://www.jstor.org/stable/26520631

Splinter, K. D., Harley, M. D., & Turner, I. L. (2018). Remote sensing is changing our view of the coast: Insights from 40 years of monitoring at Narrabeen-Collaroy, Australia. *Remote Sensing, 10*(11). https://doi.org/10.3390/rs10111744

StatsNZ. (2018a). New Brighton. https://www.stats.govt.nz/tools/2018-census-place-summaries/new-brighton

StatsNZ. (2018b). Sumner. https://www.stats.govt.nz/tools/2018-census-place-summaries/sumner

Stive, M. J., Ranasinghe, R., & Cowell, P. J. (2010). Sea level rise and coastal erosion. In *Handbook of coastal and ocean engineering* (pp. 1023-1037). https://doi.org/10.1142/9789812819307_0037

Strobl, B., Etter S., van Meerveld I., Seibert J. (2019). The CrowdWater game: A playful way to improve the accuracy of crowdsourced water level class data. *PLOS ONE 14*(9). https://doi.org/10.1371/journal.pone.0222579

Sweetman, A. K., Thurber, A. R., Smith, C. R., Levin, L. A., Mora, C., Wei, C. L., ... & Roberts, J. M. (2017). Major impacts of climate change on deep-sea benthic ecosystems. *Elementa: Science of the Anthropocene*, *5*(4). https://doi.org/10.1525/elementa.203

Wernette, P., Miller, I. M., Ritchie, A. W., & Warrick, J. A. (2022). Crowd-sourced SfM: Best practices for high resolution monitoring of coastal cliffs and bluffs. *Continental Shelf Research*, *245*, 104799. https://doi.org/10.1016/j.csr.2022.104799.

Appendix:

1.1 Survey Questions and Ethics

Coast Snap is a worldwide community science initiative that was established in 2017. This initiative is aimed at documenting coastline changes over time through the use of pictures that are taken by the community at the same location over an extended period of time. There are 3 existing locations in Christchurch: New Brighton Pier (Looking North and South) and Taylors mistake. The sites require users to place their phones on a holder, take a picture, and send it through to the city council (through social media or email). These images can then be integrated to create outputs which can measure coastline changes over an extended time period.

As a group from the University of Canterbury we are researching how Coast Snap could be further adapted in order to increase the current engagement. We are also interested in how Coast Snap can be used to help educate the local community on coastal climate change, and the best mechanism to undertake this.

The following links provide more background information to the Coast Snap project.
https://www.coastsnap.com
https://ccc.govt.nz/environment/coast/adapting-to-coastal-hazards/community-science-and-youth-involvement/coastsnap

Department: Geography, School of Earth and Environment, University of Canterbury

Dear participant,

In preparation for a GEOG309 – Research for resilient environments and communities, research project this semester (2022), we would like to consider the thoughts and perspectives from local residents of Taylors Mistake and New Brighton. This survey will take about 10 minutes to complete, and your responses will go towards our research, enabling us to investigate how we can use community science data collection to educate the public on their local coastal processes. This survey will be analysed in collaboration with Christchurch City Council and Environment Canterbury.

Participation in the survey is voluntary, and you have the right to withdraw at any stage. You may ask for your raw data to be returned to you or destroyed at any point. Any information you give us will be removed from this research if you wish to withdraw. If you are wanting to withdraw, please let us know before the 30th of September as we will then start the data analysis, making it difficult to remove individual responses. The research findings will be presented at a formal conference on the 8th of October to the rest of our Geography class, community partners, and to other guests from Christchurch and the University of Canterbury. After our conference we will be using this data to write up a group report that will be shared with the coordinators of this course, Christchurch City Council and Environment Canterbury. This research will be carried out by Ella Gorton, Eliza McCracken, Katie Rosie, Lucy Coulston and Mia Horton under the supervision of Dr. Sarah McSweeney.

By clicking on the arrow to advance to the survey questions, you agree to the following:
□ I have been given a full explanation of this project.

□ I understand that participation is voluntary, and I may withdraw at any time without penalty. Withdrawal of participation will also include the withdrawal of any information I have provided should this remain practically achievable.

□ I understand that any information or opinions I provide will be kept confidential to the research team and that any published or reported results or direct quotes will not identify the participants unless prior consent have been given.

□ I understand that data collected from this survey will be used in a research report as well as be presented at a conference in front of our Geography class, members of the community partners, and to other guests from the city and UC. Lead by Ella Gorton, Eliza McCracken, Katie Rosie, Lucy Coulston and Mia Horton.

Have you used CoastSnap before?

- Yes
- No
- I have seen it but not used it

What CoastSnap location are you most likely to engage with?

- New Brighton (north facing & south facing)
- Taylors Mistake
- Neither

Which picture submission method is most appealing to you?

- Twitter
- Email
- Instagram
- Facebook
- App
- Other (please specify)

What barriers may prevent you from participating in a project such as CoastSnap?

- Lack of time
- Lack of interest
- Submission method is too difficult
- Lack of promotion of project
- Other (please specify)

What would entice you to record with CoastSnap on a regular basis?

- Better/improved signage
- Rewards for submitting photographs
- More te reo Māori on the sign
- Feedback on what the information is used for
- Other (please explain)

What coastal issues are you currently aware of and value the most?

Please indicate how big of an impact you believe climate change will have on coastal Christchurch (1 being minor, 10 being huge)

0 10 20 30 40 50 60 70 80 90 100

Any other thoughts or opinions you may have on the topic?

How did you find this survey? (if social media please specify which facebook community group)

→

1.2 CoastSnap Outputs Continued

Figure 8: Shoreline Plot at Taylors Mistake, Christchurch, New Zealand on Sunday 26th of February at 11:29am. Shorelines were created on MATLAB using the CoastSnap code produced by Mitchel Harley.

Note: shorelines change plots were unable to plotted at the time of this report due to coding difficulties in MATLAB.

Figure 9: Shoreline Plot at New Brighton, Christchurch, New Zealand (North) on Friday 24th of June at 14:58. Shorelines were created on MATLAB using the CoastSnap code produced by Mitchell Harley.

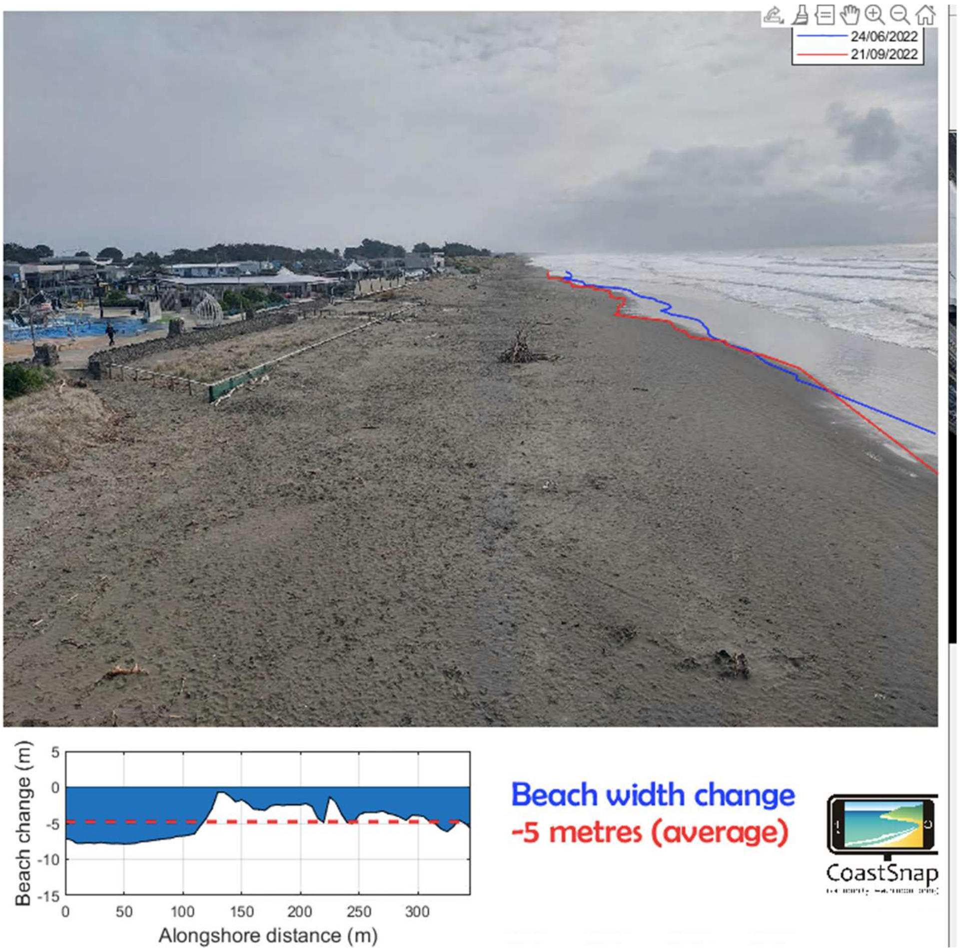

Figure 10: Beach width change from 24/062022 to 21/092022 at New Brighton Beach, Christchurch New Zealand (North). Plots were created on MATLAB using the CoastSnap code produced by Mitchell Harley and a tidal tolerance of 0.2m.

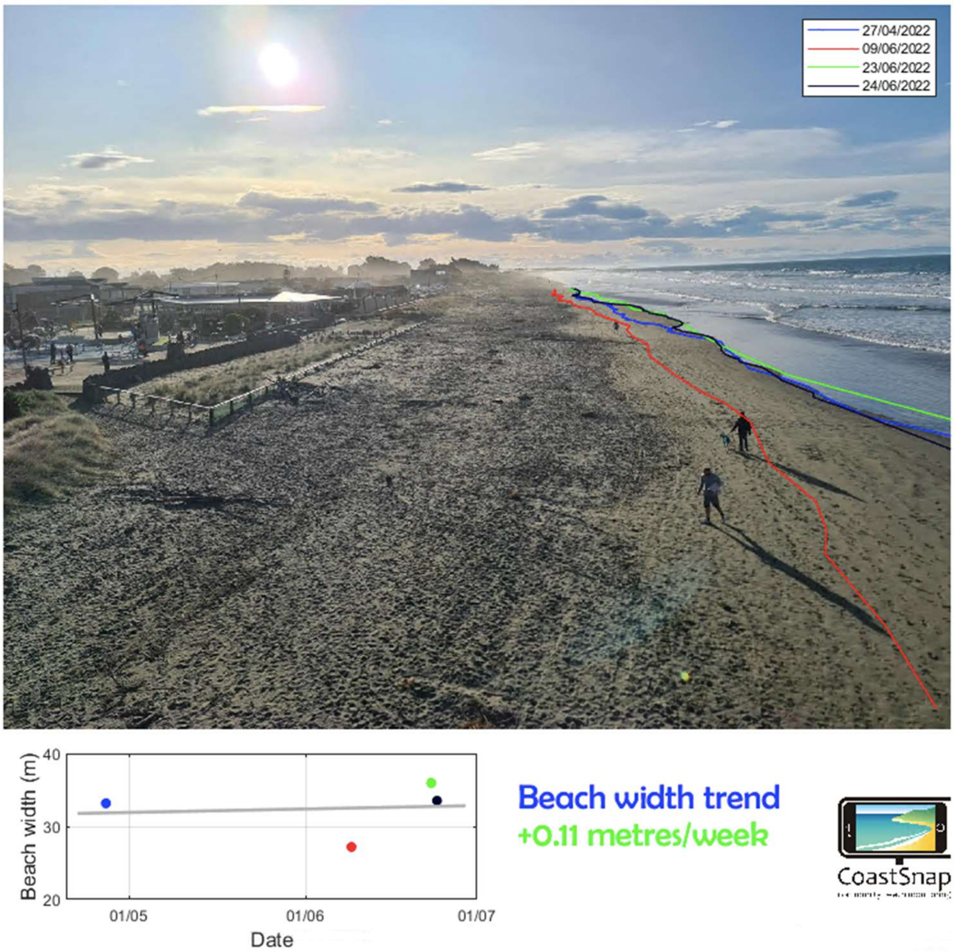

Figure 11: Beach width trend plot from 27/04/2022 to 24/06/2022 at New Brighton Beach Pier, Christchurch, New Zealand (facing North). Plots were created on MATLAB using the CoastSnap code produced by Mitchell Harley and a tidal tolerance of 0.2m.