Developing a GIS Web Map for the wider Te Awa Kura/Barnett Park Area

Anna Cory-Wright, James Buckeridge, James Gleeson, Luke Spencer, Tyler Fauchelle

Table of Contents

Executive Summary

The Redcliffs Residence Association and the Te Awa Kura/Barnett Park Regreening Group have requested us to partner with them to develop a GIS platform to hold historic and ecological data for the wider Barnett Park area. To assist in future planting site identification, potential trail construction areas, and sites for memorialisation. The project aims to enable future community projects by answering the following research questions; *What criteria need to be considered when developing a web GIS platform that effectively stores and visualises data related to Te Awa Kura/Barnett Park? And what allows for the continuous uploading of citizen science data to ensure ongoing relevance and utility for the community?*

The project data was split into categories based on its spatial components and non-spatial data was geolocated. The GIS methods used include using multiple software in the ArcGIS ecosystem and working together to provide GIS functionality, which includes ArcGIS online on the server side and Map Viewer on the client side. The project concludes that when creating GIS platforms for community usage, a platform that is simple, accessible and can maintain its relevance is critical. This included the legends and symbology when displaying the data, the categorisation for navigating the web map, the inclusion of non-spatial data to contextualise the information, shared and openly accessible through the ArcGIS online portal, and an editable platform host to maintain relevance. The main project limitations included the lack of existing spatial data, which led to rough estimates in some of the point locations. This could cause issues when planning future projects as incorrect data can cause complications between planning and execution. Possible future research could look at using the web map coupled with LIDAR, sunshine and rainfall data to determine locations for future planting. Other possible research could place the map in a more intuitive and user-friendly interface like dashboards.

1. Introduction

The Redcliffs Residence Associations' Regreening group has asked our group to create an interactive web map to hold scientific data on the local Te Awa Kura/Barnett Park. From the brief

outline of their desired outcomes for the project, we identified some key criteria needing to be considered to ensure the project's relevance. The project needs to have the capacity to store information and data on current and future projects desired by the community, like their regreening data or historical and cultural information of the park. The project also needs to be able to be editable and deliverable to the wider community through an interactive and engaging medium.

The focus of the project is Te Awa Kura/Barnett Park, an area of mixed usage and vegetation coverage land that borders Monck's Bay, the Te Ihutai/Avon-Heathcote Estuary and Redcliff's. The area has been settled for around 700 years, dating back to the mid-14th century when the Waitaha people and Ngāti Māmoe tribes settled (Redcliffs Residents Association, 2023). In the 17th century, Ngāi Tahu displaced Ngāti Māmoe and lived in the area until the first Europeans began to arrive. In the 1840's rapid European colonisation in the area led to the deforestation of the podocarp-hardwood forests for grazing land across Horomaka/Banks Peninsula (Harding, 2003). In the early 1960's the park was one of the first parks established in the wider Christchurch region, and today consists of a sports ground, and an informal dog park, enabling visitors and members of the community to experience the outdoors.

As the idea of interactive web maps being used as a means of community engagement gradually gained more traction due to a variety of benefits over traditional means (Kolbe et al, 2003), the focus of the project is to create an interactive platform to showcase these significant aspects that contribute to the park's identity. Interactive web maps empower individuals and communities to feel a sense of connection to their place as they provide them with information on their local area helping residents to make informed decisions. Compared to traditional community information-sharing methods, interactive web maps can help facilitate two-way communication as users can provide feedback, report issues, or ask questions, fostering engagement and collaboration. An existing study by Lee et al., (2006) on engaging citizens to collect wildlife information using a web-based GIS platform found the platform fostered a learning environment that facilitated behavioural change and direct action in participating members of the community. This is relevant to our project as it enables the Redcliffs Residence Association and Redcliffs community to increase engagement with ongoing projects in their area. The study by Lee et al., (2006) included a local project coordinator who guided the development and utilisation for the project and communicated with the local community to determine the best practice for the collection and upload of the data, indicating that citizen

science or community collected data is eligible for projects similar to ours if basic guidelines surrounding the type/quality of data is communicated to the community. This is one of the reasons we will have a member of the Redcliffs Residence Association act as a moderator, so they can continue to use the platform and to ensure the validity and relevance of data uploaded to the platform. Keeping the criteria and the community partners preferences discussed above in consideration, our group formed the following research questions:

1. *What criteria need to be considered when developing a web GIS platform that effectively stores and visualises data related to Te Awa Kura/Barnett Park?*
2. *What allows for the continuous uploading of citizen science data to ensure ongoing relevance and utility for the community?*

2. Literature Review

To further understand how best to approach this research project, a review of relevant literature was undertaken. From this review came three important topics; the use of GIS mapping using citizen science data, the importance of regreening initiatives, and mapping historical and cultural data.

2.1. GIS maps using citizen science data

Our partner requested that field data collected has the ability to be uploaded by citizen scientists. To achieve this we can make use of a method that has become increasingly popular with the rise of internet access called Public Participation GIS (PPGIS) (Brown & Weber, 2013). One of the main benefits of PPGIS is the inclusivity of the software (Kahila et al., 2019), the visual aspect reduces the impact of language barriers and increases engagement compared to traditional alternatives.

When involving the community in a GIS project, elements such as cost, accessibility, personal value, potential training, equipment required, and spatial and temporal scales must be considered (Fraisl et al., 2022; Johnston et al., 2021; Brown et al., 2020). Using PPGIS increases the dimensions of the project, where community members would need access to be able to upload and process their collected data to the platform. There may be issues of privacy or safety that restrict how results are shown, particularly when personal values or opinions are part of that data (Fraisl et al., 2022; Fagerholm et al., 2021).

2.2. GIS platform framework

A GIS platform has two main functions: the backend manages data, permissions, and data delivery, while the frontend presents maps for public interaction. Both the frontend and backend facilitate user data uploads and processing, and typically require various software components for full functionality. We have two software options: Open-source software (OSS) which is free and customizable but may lack integration with other software. (Brovelli et al., 2014) On the other hand, closed-source software like Esri's ArcGIS ecosystem, while costing money, offers extensive features and strong integration. Considering the requirements, two frameworks were considered: an open-source one and another using the ArcGIS ecosystem. The decision-making process and implications are explained in section 5.1.

2.3. Importance of Regreening Initiatives

Regreening initiatives commonly focus on the restoration of degraded ecosystems through anthropogenic causes such as urbanisation, deforestation, and industrial and agricultural demands. Regreening initiatives positively influence various environmental, social and health aspects for communities through ecosystem and biodiversity restoration, improved mental and physical health, and community engagement. This is relevant to the project as one of the intended uses of the GIS platform is to assist the community in planning future regreening projects.

Regreening initiatives such as planting native vegetation throughout Te Awa Kura/Barnett Park are likely to support and increase native biodiversity in the valley. This is because endemic animals have been found to significantly prefer native habitats over exotic habitats (Crisp et al., 1998; Bowie & Sirvid, 2004). This would be especially true for native invertebrates (Bowie & Sirvid, 2004), so by planting more natives you would be supporting invertebrate growth in the valley. An article by McKergow et al. (2016) on the use of riparian planting as a restoration tool for New Zealand streams found riparian buffers intercepted and removed contaminants entering streams from pollutants such as livestock, which is relevant to Te Awa Kura as sheep graze on the western face above the park and their excretions wash into the water below.

This regreening process aims to restore degraded or deforested areas to a healthy ecological state through the planting of vegetation and improving soil fertility, water retention and preventing erosion. This is relevant to the project asked of us by the Redcliffs Residence

Associate and the Te Awa Kura/Barnett Park Regreening group as there are concerns about the stability of the bluffs on the western face of the park and the main flow of the Rifle Range stream is to be replanted due to growing concerns of bank erosion and its effect on the subsequent increased flow and flood rate of downstream sections nearest to local housing. Reports on the erosion-preventative benefits of riparian planting (Northland Regional Council, 2005; Collier et al., 1995) found that smaller grasses and flaxes, such as harakeke, will bend with the flow of water when riparian planting is undertaken on the edge of waterways close to the water, and that larger trees and other root stabilising vegetation situated further back in flood-prone areas best stabilise waterways while allowing water to easily flow past.

2.4. Mapping historical and cultural data

Barnett Park has a rich history dating back to early Māori settlements. The Moncks Bay Cave, discovered in 1889, is a key focus, offering insights into the lives, customs, and connections of the people who once lived there. The cave contains many Taonga such as carvings, wooden and stone tools, fishing nets and canoe paddles. These artefacts are vital components of cultural knowledge, representing the practices and skills of the Māori people who once inhabited Barnett Park.

Using geographical information systems (GIS) to help map these cultural sites will result in the preservation of information, cultural knowledge and indigenous identity for future generations. Barnett Park has a few of these culturally important sites such as Moncks Bay Cave, and historic rifle ranges, and mapping these is paramount.

In summary, during this research into Barnett Park's history, a wealth of historical knowledge about early Māori settlement, and cultural practices has been revealed. This can especially be seen at Moa Bone Point cave. This knowledge not only enhances our understanding of New Zealand's history but also emphasises the critical importance of preserving cultural and indigenous heritage for the benefit of current and future generations.

3. Methods

3.1 Framework deployment

The implemented architecture is depicted in Figure 1. The backend/server-side is handled by the ArcGIS Online web application hosted by the Esri corporation. ArcGIS Online includes both

a Database and Web mapping service to process our data. The project files are stored in our ArcGIS online group called "Barnett Park Research Group (GEOG309)" which allows efficient collaboration and easy sharing with other group members. The group manages individual member permissions for editing and viewing map content. The ArcGIS online group also manages public access for group content.
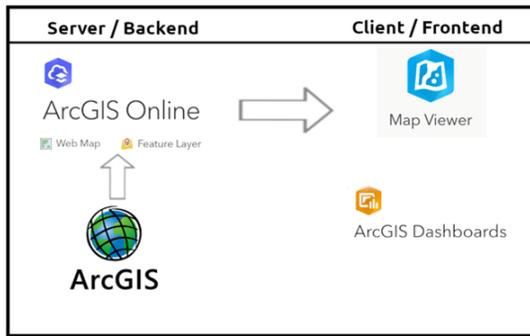
Figure 1. *Deployed framework diagram, left side representing Backend software and right side representing Frontend software. Arrows depicting communication/integration with other software*

Development and processing of the data for our GIS platform was conducted in ArcGIS Pro. ArcGIS Pro has direct integration with ArcGIS online groups allowing for the research team to conduct joint development. Future development can also be achieved by accessing the data in the group and submitting their own changes.

The maps stored in ArcGIS online can be viewed in Esri's free online software called "Map Viewer" which can be accessed by anyone with a web browser (Allowing for both PC and mobile devices to view) via a sharable link. Map Viewer allows the user to toggle layers and view specific data points with pop-ups. The map interface can be customised in depth by an additional Esri web application called "ArcGIS Dashboards", This however was not needed for our application as the default features in Map Viewer were sufficient.

3.2 Data sources & processing

Data used in the creation of the online web map was acquired from two places. The first being from the Redcliffs Residents Association (RRA). The RRA gave our research group access to a drive with a wealth of data, documents and historical information about Te Awa Kura/Barnett Park. The second place being Land Information New Zealand's (LINZ) data service (Land

Information New Zealand, 2023). Which is a government database that allows users to freely download spatial data regarding New Zealand.

Processing the data in order for it to be opened in GIS software was a major part of this project. The data we received was sorted into three categories for further processing. These were spatial data, non-spatial data, and non-usable data. Any data that was placed in the non-usable category was taken out of the project. Data placed in the non-usable category included emails, irrelevant photos, and data that could not be spatialised.

3.2.1 Spatial data

This refers to any data that was received that already had a spatial component. That being latitude and longitudinal values. This type of data required less processing time in order to be displayed in ArcGIS Pro. The processing that was done to this type of data, often involved rearranging, formatting and joining tables together. An example of this processing was during the creation of the soil depth and moisture layer. Where a join was used to combine tables together. This connected the spatial component with the soil data using GPS points as a unique identifier.

3.2.2 Non-spatial data

Non-spatial data was the majority of the data given to us by our community partners and required the most processing using types of geolocation techniques for use in ArcPro. Often when adding spatial components, members would use their own discretion to discern the location. Meaning one member of the research group would look at all available information, and make a decision on where best to place the point. An example of this discretion was during the creation of the bird counts layer. Screenshots of the location where each survey had taken place were received. From here a member of the team created new points in arcPro in what they believed to be the same location.

3.3 Cartographic process

Once data was spatialised and accessible in ArcPro. It was transferred to the web map where it went through a cartographic process. This was done to make layers easily understandable for the community when using the map. This process often involved changing the symbolism, colour, size of the points and their layer hierarchy when interacting with other layers. Another

important thing that was done to each layer was the level of zoom at which the layer appeared/disappeared. This was done to make the map less busy when layers are turned on. We also grouped like layers together into four main categories, ecological, archaeological and historical, recreation, and park attributes. This was done to make the interface as tidy and easy to understand as possible.

4. Results

Throughout the process of creating this platform, we have found key elements that must be considered when creating a GIS platform for a community. By considering these elements, we have created a platform that is effective in displaying the available data in Barnett Park. The map is accessible through this link as of 20/10/2023: https://arcg.is/fiXWj

4.1 Displaying data

How data is displayed is important for understanding the map. Relevant symbols were used to represent data points in a way that makes sense for all users. Useful symbology allows users to understand the map without having to figure out what each symbol means. Colour, size and shape have to be taken into consideration to create intuitive symbols, as seen in Figure 2, where features that represent trees are coloured green. Some symbols are pre-loaded into GIS software, which can be used to easily recognise data points.
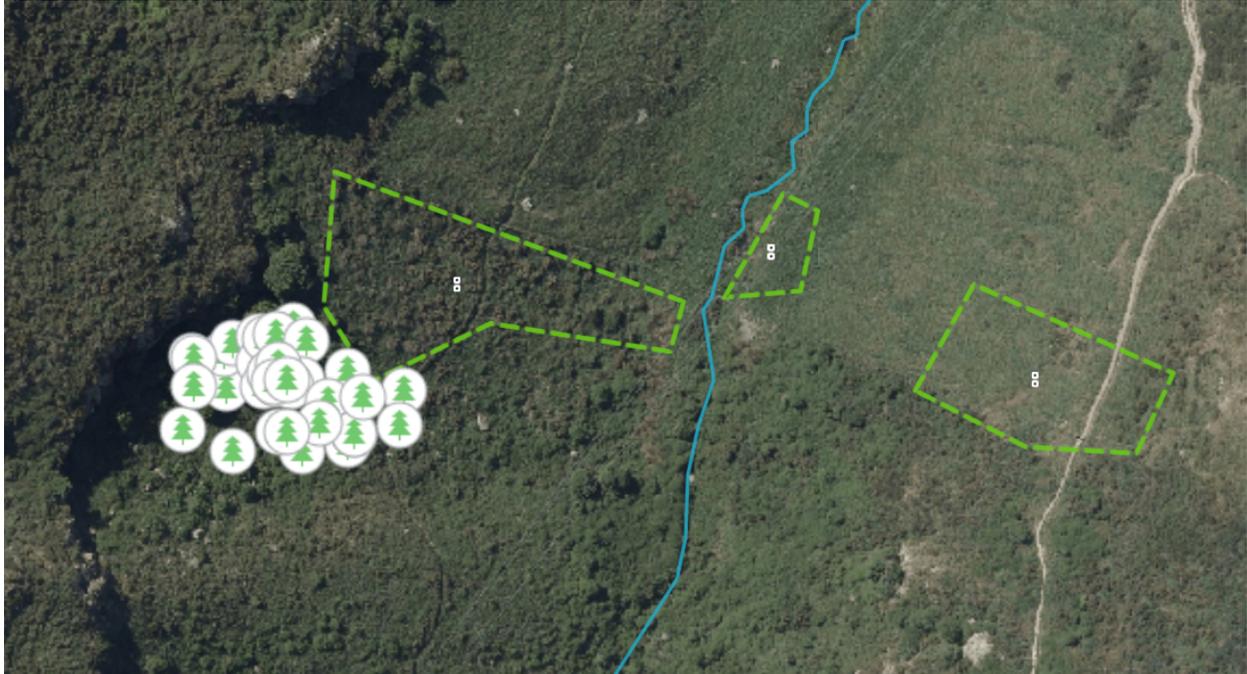
Figure 2. *Excerpt from the platform map. Shows planting areas with dotted green polygons, and Totara planting locations with points marked by tree symbols.*

Additionally, there is a legend to inform users what each symbol represents. It is necessary to include a legend for users to check, however by assigning useful symbology to each layer, we reduce the need for users to look at the legend.

4.2 Navigation of the platform

There are many features of the GIS platform that make it easy for the community to engage with the data that is available. The data has been put into categories to allow easy navigation. The categories are recreation, ecological, archaeological, and park features. Within each of these categories, there are individual layers that show different datasets and spatial features.

When using the platform, one can choose what data is shown on the map by clicking on a hide button next to each layer as shown in Figure 3. This means that the experience of using the platform can be customised to a specific purpose. Hiding layers is useful to not crowd the map, and makes it easy to see the necessary data. Users can hide entire categories of data or individual layers.
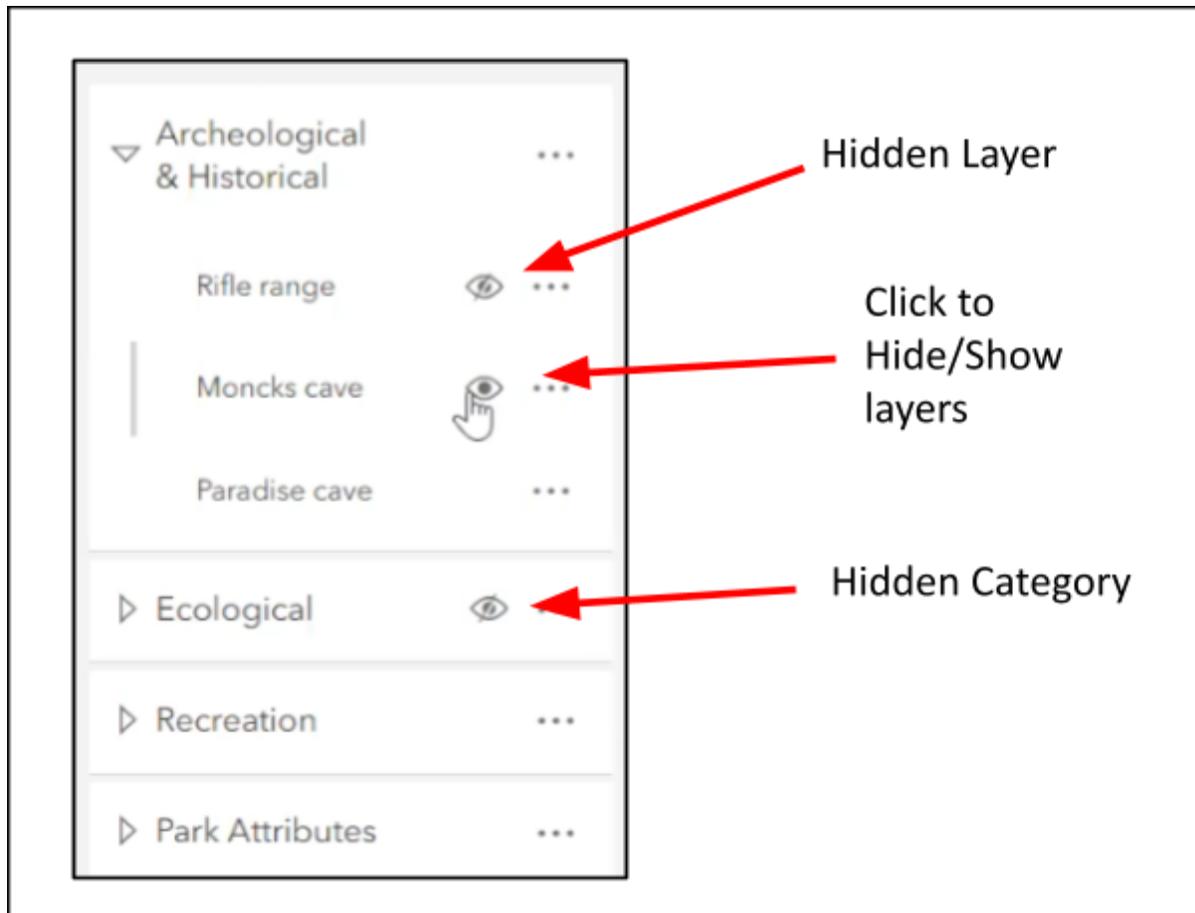
Figure 3. Screenshot of ArcGIS map viewer layer panel. Arrows show features that will enable easy navigation of the data

4.3 Including non spatial data

To provide context to the spatial data that is shown on a platform, it is useful to include non spatial data. This data can be accessed by users when they click on the features of these layers. Having the non-spatial data accessible on a spatial platform allows users to contextualise and visualise the information that they read. Adding these descriptions also enables users to understand why it is useful to have specific spatial features on the map. The non-spatial data includes historical information, descriptions of park features, and survey information collected at points within the park.

4.4 Sharing the platform

It is important to consider how a community will be able to access a GIS platform. If an account or payment is needed to view the platform, then it will be less accessible. Additionally, if there is public access to the product, then there are potential data security issues. We used an ArcGIS web map to display our data. Our platform is accessible in the ArcGIS online portal, and an account is not needed to view it. As it is online, the platform can be shared through a link or a QR code, see appendix A. This means we can share the platform through both online and paper methods. Even if we cannot send the link to a person, anyone with a smartphone and access to the internet can scan the QR code to gain access to our map.

4.5 Future Editing

A final consideration is how the platform can maintain relevance over time. It is ideal if a system is created where data can be added in the future. As our platform was created within the ArcGIS ecosystem, anyone who has an ArcGIS account will be able to take the data in our platform and use it. To edit the platform itself, we have appointed an administrator within the community group who has access from their ArcGIS account. This means that as more data is gathered on our park, it can be added and shared by this administrator.

5. Discussion

5.1 Map Success

It was the purpose of this research to attempt to answer the following research questions:
1. What criteria need to be considered when developing a web GIS platform that effectively stores and visualises data related to Te Awa Kura/Barnett Park? 2. What allows for the continuous uploading of citizen science data to ensure ongoing relevance and utility for the community? In regards to the first question, the research group has given the community partner an ArcGIS online web map, which currently stores and visualises the data that they have collected over the years. This map does this very well due to the Arc-online system where the map is hosted. The arc online system also helps to answer the second question. Now that the web map has been handed over to a moderator from the residents' association, it enables them to continuously upload data. Also as the map can be freely viewed via a link or QR code it

allows for the wider community to utilise the map. The web map has a multitude of uses. These range from enabling the regreening group to providing users with highly important information on culturally significant sites, and information on flora and fauna.

5.2 Framework Considerations

Each framework carries significant strengths and weaknesses. Our initial framework, consisting of only OSS software utilises a PostgreSQL database to store data for Web map visualisation via OpenLayers and GeoExt. ODK facilitates public data uploads for database processing, with GeoServer managing administrative and citizen scientist permissions.
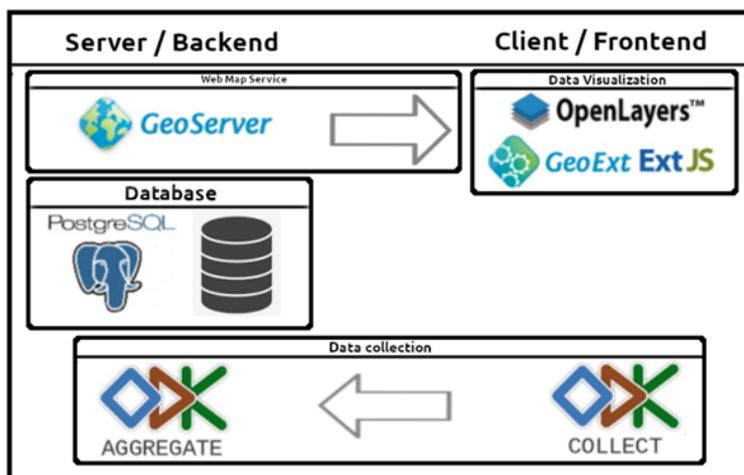
Figure 4. *The planned OSS framework, the left side represents Backend software and the right side represents Frontend software. Arrows depicting communication/integration with other software.*

The ArcGIS framework offers streamlined development and improved collaboration within users who have an ArcGIS account. However, we are limited to the software available by Esri. In contrast, the OSS framework provides extensive control but is complex and time-consuming. We chose ArcGIS due to time constraints and the team's familiarity with the software. We were also able to host the map for free as it was under University of Canterbury's ArcGIS organisation.

5.3 Key takeaways

This report details things that need to be considered when creating web maps using citizen science data. Newman et al. (2011), state that citizen science is ever-growing and that these

communities want to be able to visualise this data. Our research project has resulted in our community partner being able to achieve this desire of visualising their data. When creating a platform for use by the wider community it is important that it is as intuitive and simple to use as possible. The decisions on symbology and layer grouping were all made with these ideas in mind. Engaging with communities using citizen science data empowers and gives them more control over the data and usage of it (Sieber, 2006).

5.3.1. Future Research

Potential future research could look at reformatting the map in another arc online system making it more accessible and intuitive for users. This could involve systems such as story maps and ArcGIS online dashboard. Now that the map and background data sets have been set up, future research and community initiatives could look to identify areas suitable for regreening. This could be achieved by using LIDAR data, coupled with sunshine and rain data. This would be the base for identifying suitable areas for regreening. Some more potential research could look at adding more data layers to allow for more comparisons between other layers.

5.4. Limitations

A potential limitation faced in the creation of the web map was using data that lacked spatial data. This led to group members using their own discretion to determine point locations. Imprecise geolocations were unavoidable in the creation of this web map. Another potential limitation of this research is the prior knowledge of GIS needed to operate the map. For the average user, they must either know what they are looking at or spend time learning how to use the web map. This may make the map less accessible to the wider community as some prior knowledge may be required to operate. An additional constraint is the proprietary control exerted over the data representations by Esri. This constraint primarily manifests in the hosting of the pertinent data resources. Reliance on a singular entity for data management and spatial representation may affect future accessibility.

6. Conclusion

In conclusion the web map built for our community partner meets all of their identified needs to provide a spatial representation of Barnett Park and additional collected data. The key considerations for making web maps for communities are, displaying the data with good cartographic skills, making the platform easy to use by grouping like layers together, adding non-spatial data provides context, and choosing the right GIS software that allows sharing and editing. The ArcGIS ecosystem allows for the continuous uploading of data and as it is constantly updated will remain relevant for many years. This system makes it possible to easily share the project with the wider community.

7. Acknowledgements

8. References

Bowie, M. H., & Sirvid, P. (2004). Invertebrate diversity and abundance in ten Port Hills reserves, Canterbury. *Lincoln University Wildlife Management Report, 34.* https://core.ac.uk/download/pdf/35459705.pdf

Brovelli, M. A., Minghini, M., & Zamboni, G. (2014). Public participation GIS: A foss architecture enabling field-data collection. *International Journal of Digital Earth, 8(5),* 345–363. https://doi.org/10.1080/17538947.2014.887150

Brown, G., Reed, P., Raymond, C. M., & Sveriges lantbruksuniversitet. (2020). Mapping place values: 10 lessons from two decades of public participation GIS empirical research. *Applied Geography, 116,* 102156. https://doi.org/10.1016/j.apgeog.2020.102156

Brown, G., & Weber, D. (2013). A place-based approach to conservation management using public participation GIS (PPGIS). *Journal of Environmental Planning and Management, 56(4),* 455–473. https://doi.org/10.1080/09640568.2012.685628

Collier, K. J., Cooper, A. B., Davies-Colley, R. J., Rutherford, J. C., Smith, C. M., & Williamson, R. B. (1995). Managing riparian zones. *A contribution to protecting New Zealand's rivers and streams*, 1. https://www.doc.govt.nz/documents/science-and-technical/riparianzones2.pdf

Crisp, P. N., Dickinson, K. J. M., & Gibbs, G. W. (1998). Does native invertebrate diversity reflect native plant diversity? A case study from New Zealand and implications for conservation. *Biological Conservation, 83(2),* 209-220. https://doi.org/10.1016/S0006-3207(97)00053-0

Fagerholm, N., Raymond, C. M., Olafsson, A. S., Brown, G., Rinne, T., Hasanzadeh, K., Broberg, A., & Kyttä, M. (2021). A methodological framework for analysis of participatory mapping data in research, planning, and management. *International Journal of Geographical Information Science, 35(9),* 1848-1875. https://doi.org/10.1080/13658816.2020.1869747

Fraisl, D., Hager, G., Bedessem, B. et al. (2022). Citizen science in environmental and ecological sciences. *Nat Rev Methods Primers 2,* 64 https://doi.org/10.1038/s43586-022-00144-4

Harding, J. (2003). Historic deforestation and the fate of endemic invertebrate species in streams. *New Zealand Journal of Marine and Freshwater Research, 37(2),* 333-345. https://doi.org/10.1080/00288330.2003.9517171

Johnston, A., Hochachka, W. M., Strimas-Mackey, M. E., Gutierrez, V. R., Robinson, O. J., Miller, E. T., Auer, T., Kelling, S. T., & Fink, D. (2021). Analytical guidelines to increase the value of community science data: An example using eBird data to estimate species distributions. *Diversity & Distributions, 27(7),* 1265-1277. https://doi.org/10.1111/ddi.13271

Kahila-Tani, M., Kytta, M., & Geertman, S. (2019). Does mapping improve public participation? exploring the pros and cons of using public participation GIS in urban planning practices. *Landscape and Urban Planning, 186,* 45-55. https://doi.org/10.1016/j.landurbplan.2019.02.019

Kolbe, T. H., Steinrücken, J., & Plümer, L. (2003). Cooperative public web maps. *Proceedings of the International Cartographic Congress (ICC),* 1062-1071. https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=fce63b1259d0534eb40a76dae48af9b010f5c20b

Land Information New Zealand (2023). *LINZ data service.* https://data.linz.govt.nz/

Lee, T., Quinn, M. S., & Duke, D. (2006). Citizen, science, highways, and wildlife: using a web-based GIS to engage citizens in collecting wildlife information. *Ecology and Society, 11(1).* https://www.jstor.org/stable/26267782

McKergow, L. A., Matheson, F. E., & Quinn, J. M. (2016). Riparian management: a restoration tool for New Zealand streams. *Ecological Management & Restoration, 17(3),* 218-227. https://doi.org/10.1111/emr.12232

Newman, G., Graham, J., Crall, A., & Laituri, M. (2011). The art and science of multi-scale citizen science support. *Ecological Informatics, 6(4),* 217-227. https://doi.org/10.1016/j.ecoinf.2011.03.002

Northland Regional Council. (2005). Clean streams: a guide to riparian management in Northland. *Northland Regional Council, Whangarei, New Zealand.* https://docs.niwa.co.nz/library/public/0909006377.pdf

Redcliffs Residents Association. (2023, October 15). Welcome to Redcliffs. *Redcliffs Residents Association Information for Redcliffs residents.* https://redcliffs.org.nz/

Sieber, R. (2006). Public participation geographic information systems: A literature review and framework. *Annals of the association of American Geographers, 96(3),* 491-507. https://doi.org/10.1111/j.1467-8306.2006.00702.x

9. Appendix

Appendix A

Scannable QR Code to access the web map