The experimental tree planting project would provide opportunities to research the ways in which long-lived vegetation shapes ecosystems (I. Dickie

The use of fire during Polynesian and Māori occupancy changed the ecosystems in the area as beech forest was replaced by low tussock grassland (Molloy, 1977). Since the Cass area has special cultural values to Māori, tree-planting experiments need to consider how the experiments will affect the land, water and mahinga kai in the area.

Since European arrival, farming activities started after indigenous vegetation removal in the Canterbury Plains (McLeod & Burrows, 1977). UC owns the lease of the Cass Mountain Research Area. They gave permission for cow grazing in the area. However, there were incidents of illegal ploughing which further changed the ecosystem and soil of the site (I. Dickie, personal communication, 26th July 2021).

## 3.4

An initial idea for the Lake Sarah Flats design included a walking track. A walking track would help sustain community engagement by creating access for volunteers from tree planting days to return and observe the growth of the trees. Recreational activities such as walking, biking, and fishing could occur on the site.

Utilising walking tracks can provide benefits to mental, physical, and social wellbeing. They are proven to increase mood and self-esteem while decreasing stress and depression (Barton et al., 2009). Physical activity improves cardiovascular and pulmonary health, resulting in less risk of experiencing strokes or other related diseases. Furthermore, walking is a management strategy for joint pain, hypertension, cholesterol, and diabetes (Witten et al., 2008; Olafsdottir et al., 2020). Research shows incorporating different values into the site (e.g., aesthetic, cultural, spiritual, and social values) can help sustain community engagement (O'Brien et al., 2019). Some of the notable challenges of a walking track include the potential impacts on the controlled tree planting experiment, cost, the need for additional facilities, and public access to the site.

Sustained community engagement can be achieved from the community's involvement in tree planting and from collaboration with UC community. Tree planting provides community engagement for 6 to 9 years while tree planting is occurring (I. Dickie, personal communication, July 26, 2021). Sustained community engagement could be enhanced through community days where the public can learn about the experiment and observe its progress. Furthermore, UC students can be involved with the development of the project through a course such as GEOG309.

## 3.5

Literature on Geographic Information Systems (GIS) was explored to determine the most effective method for surveying the Lake Sarah Site. The methods explored include unmanned aerial vehicles used for structure from motion (UAV-SfM) and the use of a total station (TS).

UAV-SfM consists of an unmanned aerial vehicle flying over the desired site taking aerial photographs. The TS processes involve a person collecting data by walking around with a pole (Arango & Morales, 2015). Both types of technology are available at UC and were used in this research. The UAV-SfM is an accurate and time-efficient method for mapping the Lake Sarah Flats site, 0 g0 GcG[(Bobthe )-35(TS)]TJETQq0.00000912 0 612 792

The GIS methods were used to construct an orthomosaic image and a DEM. These maps identify features in the area, inform where tree planting can occur, and areas for restoration and preservation. Overall indicating how and where the community can engage with the site and informing potential arrangements for the tree planting.

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The research questions for our topic were created during a weekend workshop to Living Springs with the GEOG309 cohort and staff.

After developing research focuses, we met up with our tutor Matiu Prebble and community partner Ian Dickie to fine tune the questions and come up with a draft plan on research methodology. The following methodology which will be expanded on in the following section:

1. Make a mana whenua engagement plan (Assignment 1).
2. Carry out initial research through individual literature reviews (Assignment 2).
3. Gather spatial data of the site using GIS 0.00000912 0 612 792 re3L/8 0 TJETvingethite c4(s)16(truct )ETelwillure

boundary (Figure 3). GCPs were white or yellow 1 m squares. The locations of GCPs can be seen in Figure 5, which is also an output of the DEM of the site. GCPs are the blue flags with white squares/rectangles adjacent to them.

Figure 5. The locations of the GCPs placed around the Lake Sarah Flats site.

After thoughtful placement of GCPs around the perimeter of the site, Giles walked to their locations and collected their GPS location and elevation using a Trimble R8 GNSS Survey Grade Rover Receiver

An orthomosaic image was created using the UAV-SfM processes. To begin, a flight path was digitally created which flew the drone to known coordinates of GCP locations. It is important the GCPs are evenly spatially distributed over the entire target area. This decreases any error which may be carried throughout the model as the GCP locations are used for georectification in post processing.

The drone then flew along the flight path and took hundreds of photographs of different angels and locations. These photographs are then used in post processing and are stitched together to recreate the scene of the Lake Sarah Flats site, producing an orthomosaic image. Aquera et al. (2017) discuss potential parameters which influence the creation of an orthomosaic and provide clear methodology which may prove useful for deeper understanding of GIS.

It is important to note GIS methods mentioned here purely reflect the processes which occurred in the field. For understanding of post processing contact Giles Ostermeijer, Drone Technician at UC.

## 4.3

In the final stages of data collection, qualitative data responses were gathered through a Maptionnaire survey. This survey tool is a map-based questionnaire, designed to gather data about community engagement within projects. We created a short survey on the Maptionnaire web page asking whether people currently use the land, are associated with any groups who use the surrounding area, and any ideas for community engagement. The survey was sent to staff within different departments at UC (mainly Science departments) as well as Forest and Bird, and owners of the Kiwi Rail bach near the site.

## 5.1

We had nine respondents to our Maptionnaire survey which was sent to all potentially interested parties. The raw results will be sent to the Cass Research Advisory Board. The anonymous results of the Maptionnaire survey are outlined below:

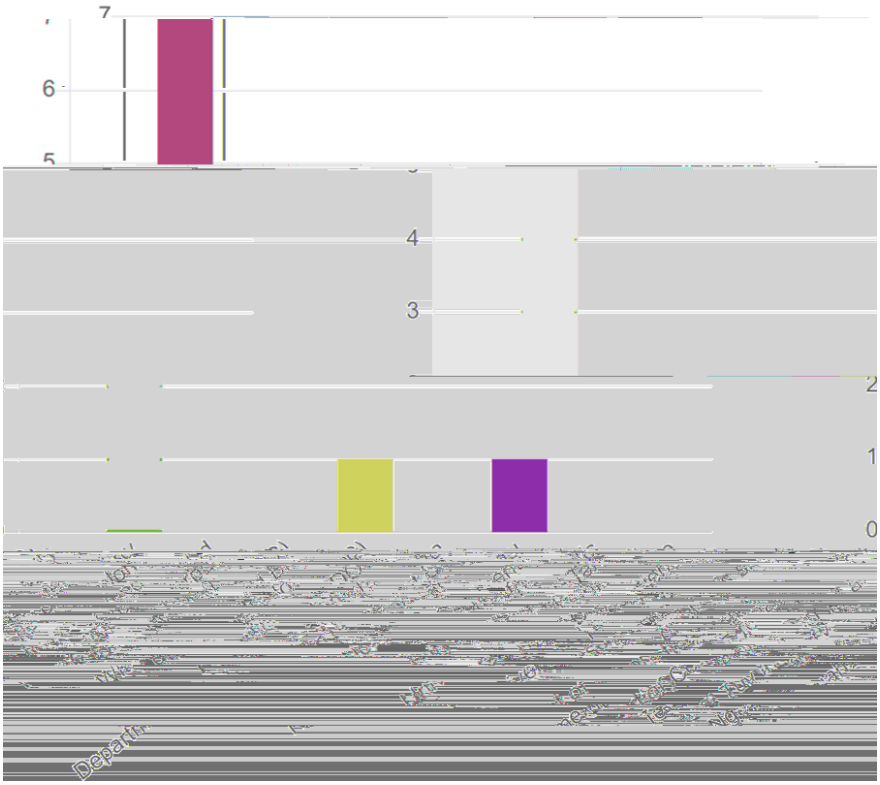


Figure 6. Showing which group/organisation survey respondents identify with.

From Figure 6 we see that the majority of the Maptionnaire respondents are from UC (seven responses), one from a different Tertiary Institution, and a response from Ngāi Tahu.

Figure 7. Shows how the survey respondents use Lake Sarah Flats site.

Figure 7 shows majority of the M

We posed the question “What can the site be used for?”. The range of responses align with the values the experimental planting project may offer. Scientific research, ecological restoration, landscape tourism,

A further valuable comment is how “Limited and controlled human access and disturbance are quite important for long-term research projects, which unfortunately can run counter to the desires of other users”.

## 5.2

It is important to note the Maptionnaire results may not reflect the wide realm of Lake Sarah Flats users. This is because several respondents were predominantly from the UC Science departments. Therefore, may not represent the diverse range of perspectives over the site and surrounding area.

## 5.3

Before the drone survey, the best data available to us on the Lake Sarah Flats site was from Google Earth. The level of detail on Google Earth was insufficient for the purposes of this project. The data obtained from the GIS drone survey were generated into a DEM and an orthomosaic image. These were used to

Figure 8 shows the elevation is largely flat for the site. There is a dip in the top north west corner of the map which is shown by a darker blue and indicates a decrease in elevation. This area is not recommended to be included in the experimental tree planting plots. Furthermore, there is a lowering in elevation on the eastern side of the site which is due to a boggy area that was observed on the field trip to the site. We suggest this location is also not included in the planting design.

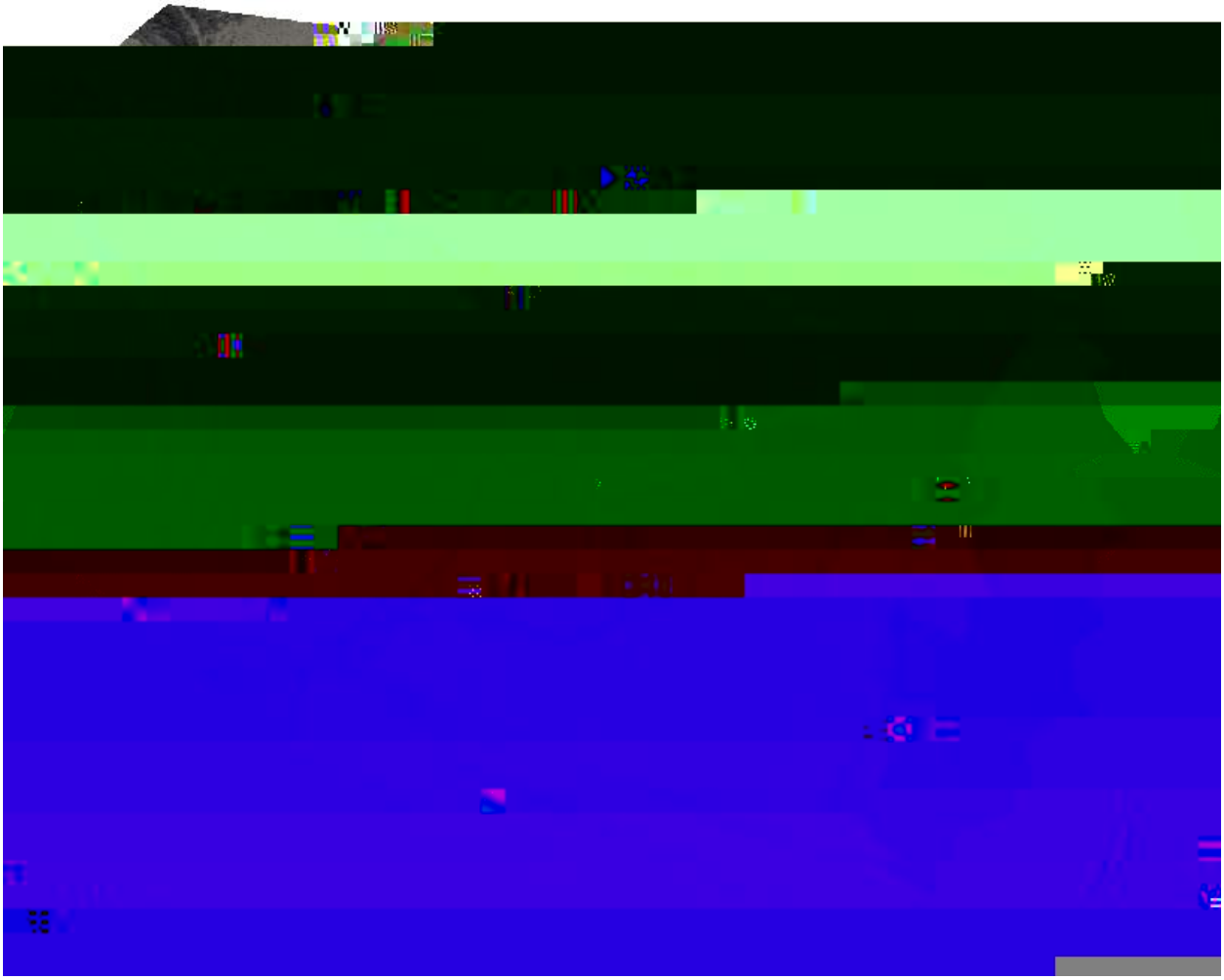

Figure 9. Orthomosaic image of the Lake Sarah Flats site (WGS1984).

The orthomosaic image (Figure 9) is useful to help provie tree planting suggestions and to identify existing features within the site. Figure 9 shows there are non-native grasses present, indicating the land has been stripped of its original vegetation. The stream running through the centre of the site can also be seen in the shape of the love heart extending towards Lake Sarah. This provides a valuable resource for the Cass Research Advisory Board because it documents the base line appearence of the site before the experiment starts

Figure 11. Distortion caused by different projection systems. Note the roof of the buildings, the buildings in the left image (WGS 1984) are not at right angles (distorted) while the building in the right image (NZGD2000 / UTM zone 59S) are (normal).

A second method for drawing polygons was to use a grid layer on top of the map, which generated accurately sized polygons of ten plots (figure 10). However, this method was difficult because once each polygon was created, it was stuck in place and could not be relocated. This made arranging all nine polygons challenging. To a person experienced with GIS software, these issues would not present a significant challenge, and a layout for the polygons could be designed relatively quickly.

Our GEOG309 group has fo

## 6.1

In future, a consideration of potential risks should be thoroughly undertaken. Risks that we have identified through the course of our research include:

- Wild pigs are one of the major pests in the area. It will be important to consider how they may affect tree planting and human safety when planting trees.
- Fire risk caused by sparks from the railway. We researched fire breaks, yet this would need to be explored further.
- Variations in soil type or quality across the site.
- Potential requirements and methods for irrigation.
- Public trespassers, we got feedback from the bach owners when doing a site visit there are commonly people camping out on/near the site. This could also cause issues for the controlled experimental tree planting.**t the** p tresnsid.00000912 0 612 792 reW*nBT/F3 11.04 Tf1 0 0 1 318.65 514.51 Tm00
- Trees may be affected differently by the wind. At the north end of the site the wind would likely be greater than closer to the shore of the lake, as this would be sheltered by the other trees. This environmental parameter may affect the arrangement of trees within each polygon.
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Agüera-Vega, F., Carvajal-Ramírez, F., & Martínez-Carricondo, P. (2017). Accuracy of digital surface models and orthophotos derived from unmanned aerial vehicle photogrammetry. (2), 4016025. https://doi.org/10.1061/(ASCE)SU.1943-5428.0000206

Arango, C., & Morales, C. A. (2015). Comparison between multicopter UAV and total station for estimating stockpile volumes. (1), 131-135. https://doi.org/10.5194/isprsarchives-XL-1-W4

O'Brien, W. J., Shultz, S. P., Firestone, R. T., George, L., & Kruger, R. (2019). Ethnic-specific suggestions for physical activity based on existing recreational physical activity preferences of New Zealand women. (5), 443-450. https://doi.org/10.1111/1753-6405.12902

Olafsdottir, G., Cloke, P., Schulz, A., van Dyck, Z., Eysteinsson, T., Thorleifsdottir, B., & Vögele, C. (2020). Health benefits of walking in nature: a randomized controlled study under conditions of real-life stress. (3), 248-274. https://doi.org/10.1177/0013916518800798

Reznichenko, N. (2012). A field guide to the geology of the Castle Hill Basin. University of Canterbury. https://www.canterbury.ac.nz/science/outreach/learning-resources/castle