TREES FOR CANTERBURY

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1. Executive Summary

What is an optimal native-plant regeneration strategy which fits the drainage flow for Marley Hill and ‘Flying Nun’ mountain bike track?

Trees for Canterbury are a well-established community organisation who expressed a need to optimise native plant regeneration efforts within the Port Hills, specifically on Marley Hill and the ‘Flying Nun’ mountain bike track. The research objective focusses on drainage as an important variable when addressing optimal regeneration.

Physical soil samples were collected and analysed in the field and in the laboratory, as well as using a Geographic Information System (GIS) to model the hydrological processes of Marley Hill. Combined, these analysis techniques gave an understanding of the soil composition and drainage to deliver an optimal planting guide.

Soil moisture and drainage play the most important roles in site suitability for the native plants, as well as being the most varied elements. Soil testing showed consistent results for most soil characteristics except for drainage capability. Soils are composed of silt loam. The result of GIS hydrology modelling produced two specific maps. One displays a stream order or drainage network. The second identifies the location waypoints that validate the models integrity. The final figure displays the site specific planting guide.

There is a limitation in the validity of infiltration results. There was also significant manipulation of the Digital Elevation Model for features such as depressions. Another limitation identified is the representation of all possible soil characteristics which influence native plant survival.

The addition of a non-regeneration zone, and a larger more accurate scientific sample as well as analysis of soils is recommended for a further defined classification of appropriate plants for regeneration.

2. Introduction

The community partner, Trees for Canterbury, a welldetermine the direction that ecological restoration processes take. This can be witnessed by regeneration efforts on Marley Hill as Trees for Canterbury and CCC operate to restore land use activities from economic driven agriculture back to a regenerated natural ecosystem. Thurston and Reader (2001) concluded that in relatively short-term time scales (years) effects on soil and forest habitat would be impacted greatest by mountain biking and other recreational activity. Because of this recreational impact it is of great importance that any regeneration efforts made are planned effectively for optimal survival of plants. This not only benefits the natural ecosystem, but maximises Trees for Canterbury's investment and involvement in native regeneration. Trees for Canterbury and the CCC have been investing time in the Marley Hill recreational area prior to approaching the University with an opportunity. It had been noticed that the same species of native plants were experiencing different growth rates and survival potential within close proximity to each other, as seen in Figure A.1, Appendix A.

The current vegetation of Marley Hill is predominately introduced species, with a large amount of gorse and broom. Meurk & Swaffield (2000) identified Gorse and Broom as species able to act as nurseries for native plant regeneration, meaning Marley Hill is a good candidate for regeneration efforts. Areas of regeneration in close proximity to the track are often trampled by riders as they avoid areas of slower saturated track. It is important that resilient species of plant are planted in these areas. This concept is strengthened in Hartley's study (1979; cited in Price, 1985), as he expresses that carbohydrate reserves in roots and underground storage organs of plants were significantly lower in plants nearer to the trail. This reduces the reproductive potential of the plant, while also being smaller in size. This is an important consideration to take into account when the planting plan is being applied to Marley Hill.

Soil type is the most important facture influencing erodibility. Fine silts and sands are most easily eroded, while clays reduce erosion (Goeft & Alder, 2001). Loess and basalt are the main erodible material for soil production in the Port Hills, the rate of which is affected by local microclimates (Pattle Delamore Partners LTD, 2007). Soil of this type is typically susceptible to further erosion as it is has a minimal cohesion between soil particles. Nonetheless, the presence of vegetation increases the stability of the soil (Environment Canterbury, 2011). It has also been identified that increased saturation of soils alongside downhill recreation tracks are the most susceptible to erosion (Chiu & Kriwoken, 2003; Goeft & Adler, 2001). Sediment loss is further increased in these areas of saturation when poor braking techniques, resulting in skidding occur, loosening the soil (Goeft & Adler, 2001). This breaking technique can lead to channel creation, draining water off the track unnaturally, impacting the growth of plants as they have specific requirements (Goeft & Adler, 2001). It is important regeneration within a recreation area focus on affective drainage to limit saturation of track soil.

4. Method

In order to answer the research question, exchange of hydrogen ions occurs (Baver & Rehling, 1930). Two drops of water were mixed with the soil and barium sulphate. Then two drops of universal indicator were added, the colour change was observed and measured against a pH chart. The second test was the Emerson Crumb Dispersion T direction. Finally, a stream order tool was used to infer a drainage network (these steps a visually shown in Figure D.1, Appendix D and described in a flow chart Figure D.2, Appendix D). Stream ordering is a method of assigning numeric order to a network by identifying and classifying types of streams based on a numeric threshold. For example, first order stream are dominated by overland or surface water flow and do not have any contributory flow from above streams.

Once the drainage network of the site had been identified a validation exercise was

The soil tests were carried out in six different locations, with 1 at the top of the track and 5 at the bottom, 2a is located in the middle of the track (Table 2). Results from soil testing show consistent results over the samples for most of the soil characteristics except for drainage capability. Most of the soil on and around the track is composed out of silt loam, with soil penetration strengths that varied from 1 to 3.5. Infiltration time fluctuated from

	Strength	Infiltration	Infiltration		Emerson	Soil	Soil	
[illegible]	silt [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	silt [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	gravel [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	silt [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1	silt loam	4	43 36.654 S	172 38.211 E	1.5	60+		5.5
[illegible]	silt [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

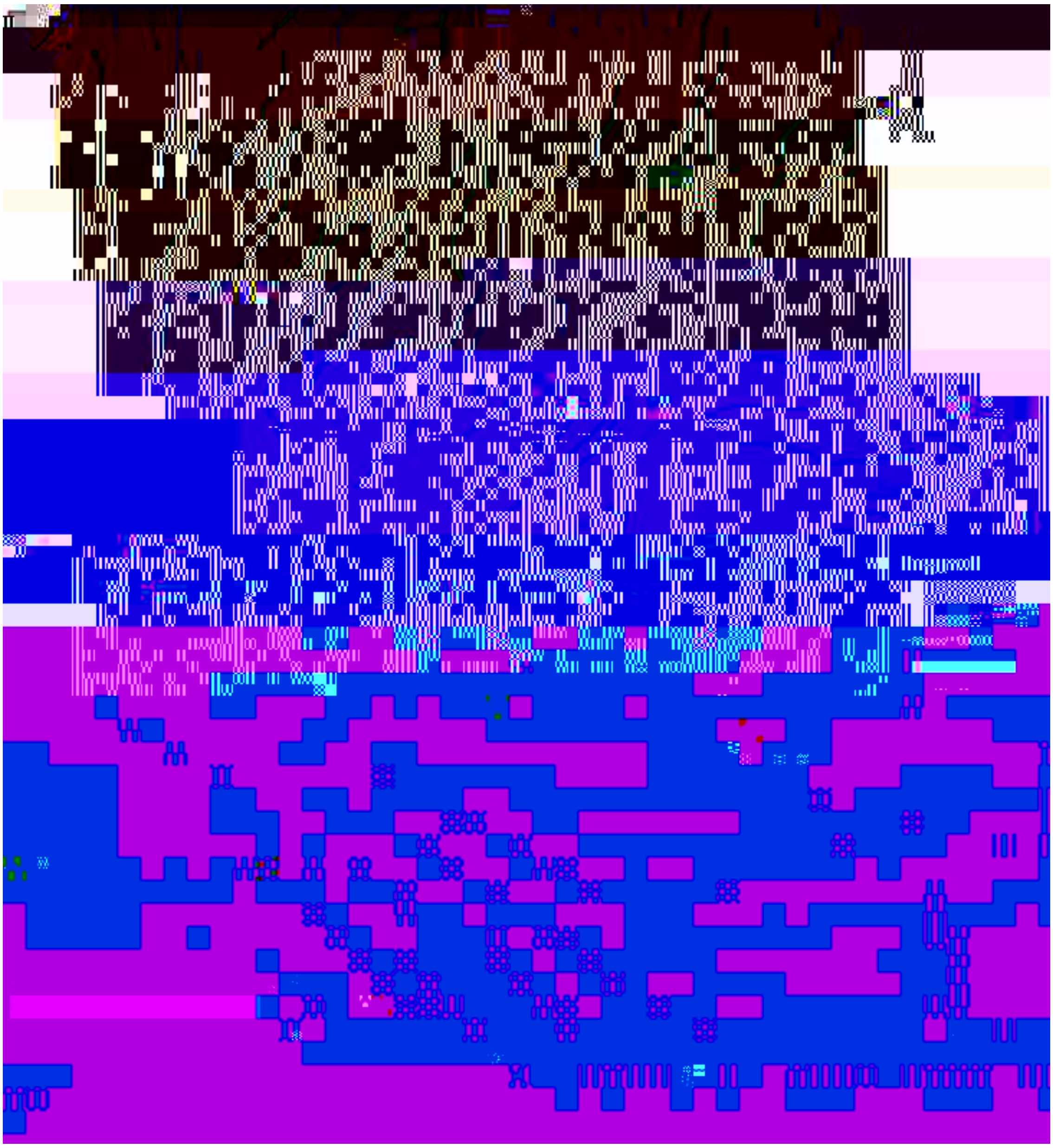


Figure 1: Stream Order Drainage

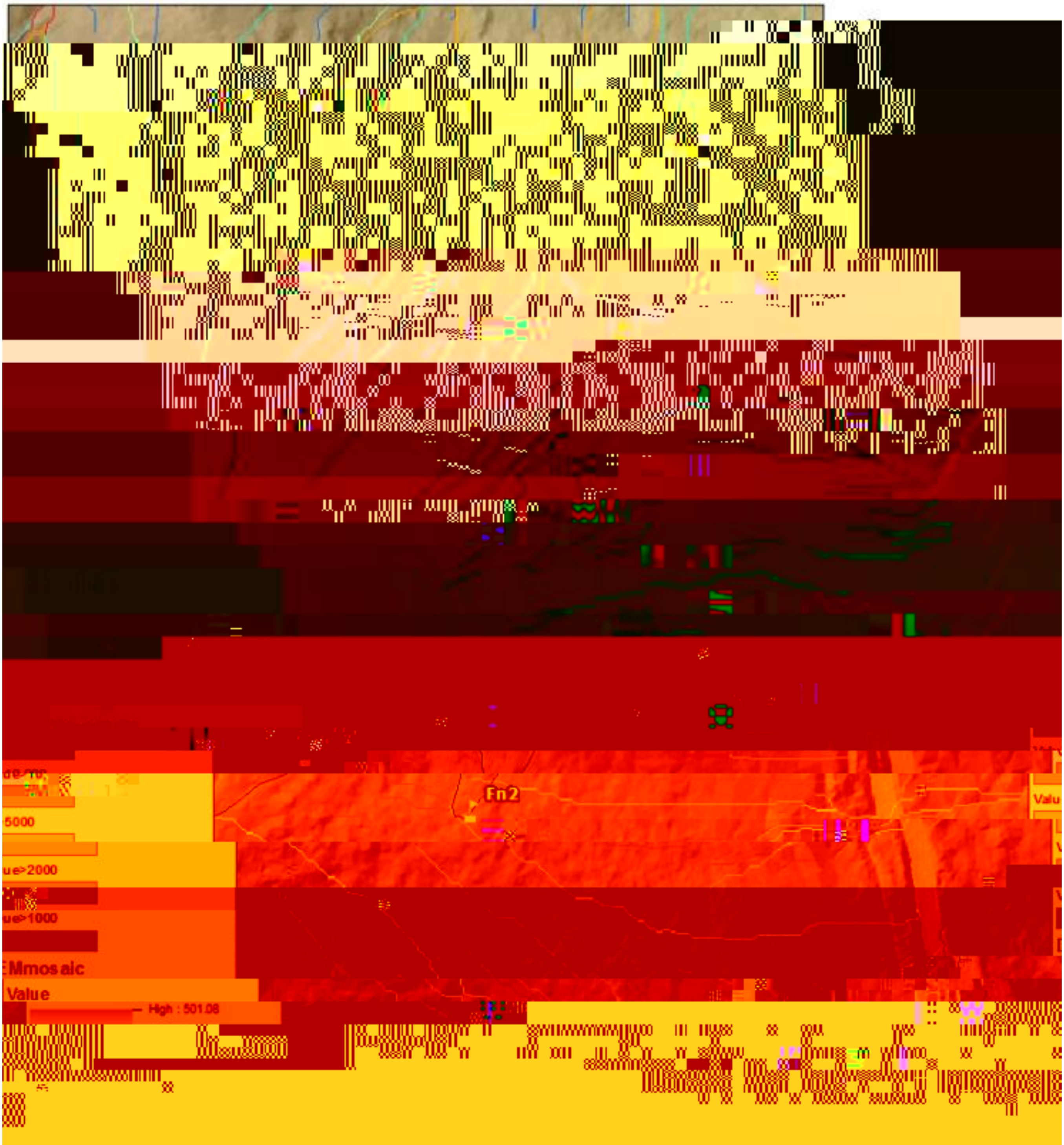
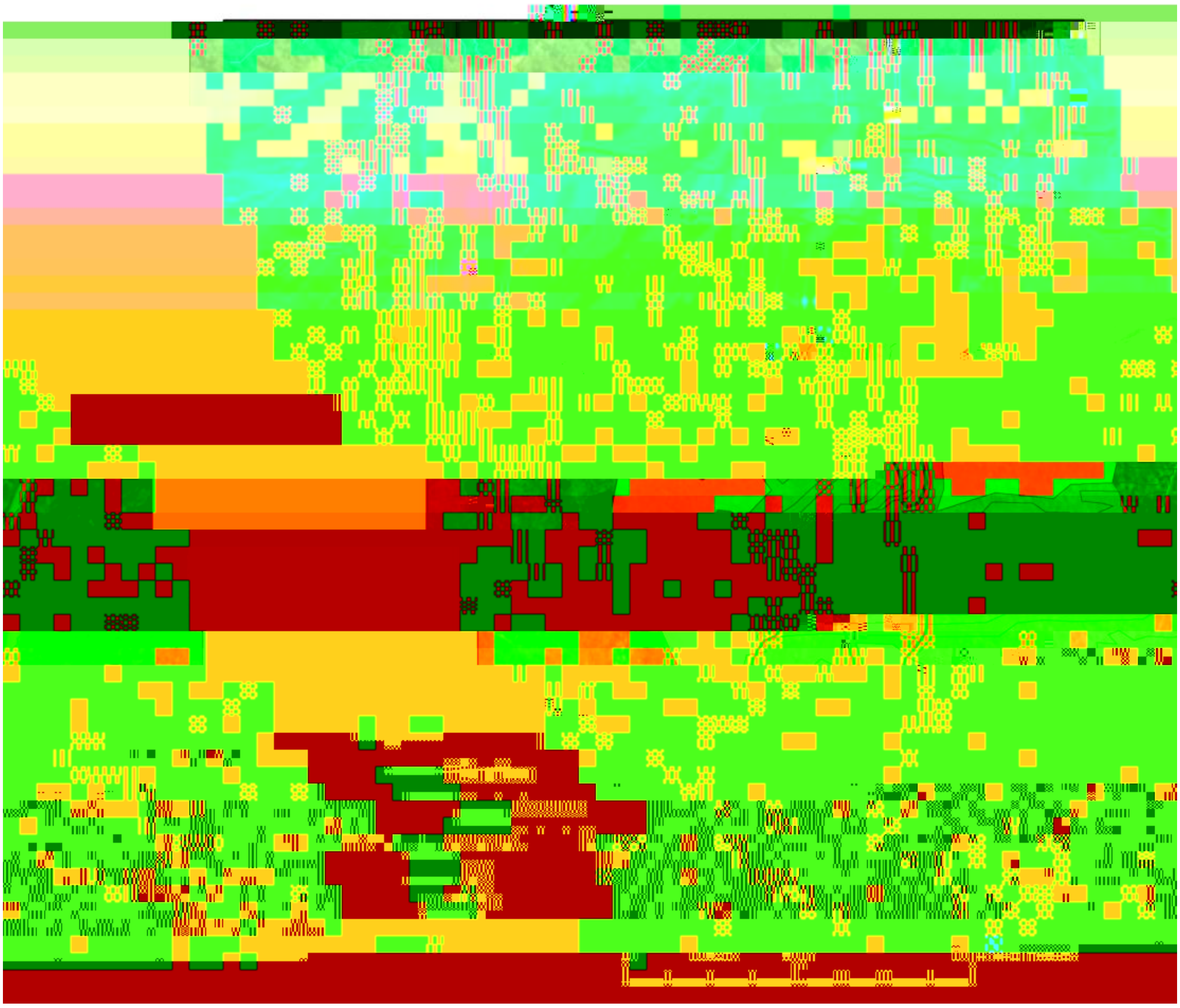


Figure 2: Validity

The photographs, as seen in Figure 3, are illustrated with arrows and boxes indicating areas of track saturation. The photos were taken on a fine day so no surface runoff is visible.

The proposed distribution of native plants regeneration on the research site was generated based on the drainage map (Figure 4). It is advised that the plants are planted according to the drainage and soil moisture, which is a consequence of drainage, determines suitability of plants on different areas on the site.

Plants more suited to saturated conditions (Refer to Table 1), are planted on the drainage flows, which are shaded in blue. Plants suited for drier areas are to be planted on the drier



6. Discussion

A guideline for optimal native plant regeneration

The use of ArcGIS to model hydrology became the foundation of the final planting guide. The maps that were produced accurately identified the location of drainage channels. This is displayed by Figure 2, which plots the position of validation waypoints measured in the field close to modelled channels. The hydrology is accurately modelled because the DEM

7. Conclusion

Trees for Canterbury introduced a need to best optimise their regeneration efforts. The goal of this research project was to offer an educational tool set so that Trees for Canterbury could optimise their regeneration efforts on Marley Hill. What was produced was a number of maps and tables that can act as a guideline for optimal native plant regeneration. The drainage flow of the research area was found to be the defining characteristic which impacted plant survival. Modelling of drainage was verified to be an accurate representation of the areas hydrology, because the DEM manipulated was from high resolution LiDAR data that produced a clean digital surface layer. Future work to improve these models would be to measure the length of time these drainage channels and the adjacent soils retained water, so that native plants could further be classified into the amount of time saturated environment can be tolerated. The addition of a planting margin or zone of non-regeneration would be of a further benefit to native plant survival as this limits the disruption of trampling. Furthermore, a larger and more accurate scientific sampling and analysis of soil samples is required for a reliable classification of the Marley Hill research area. Currently, the soil results are a limited representation of all possible soil characteristics influencing the survival of native plant regeneration in Marley Hill and the ‘Flying Nun’ mountain bike track.

8. Acknowledgements

We thank Steve Bush from Trees for Canterbury for being our community partner during this research project. To Nick Singleton and Di Carter, the Christchurch City Council rangers, who explained management techniques of the ‘Flying Nun’ mountain bike track and conservation. We thank Dr. Heather Purdie,m

9. References

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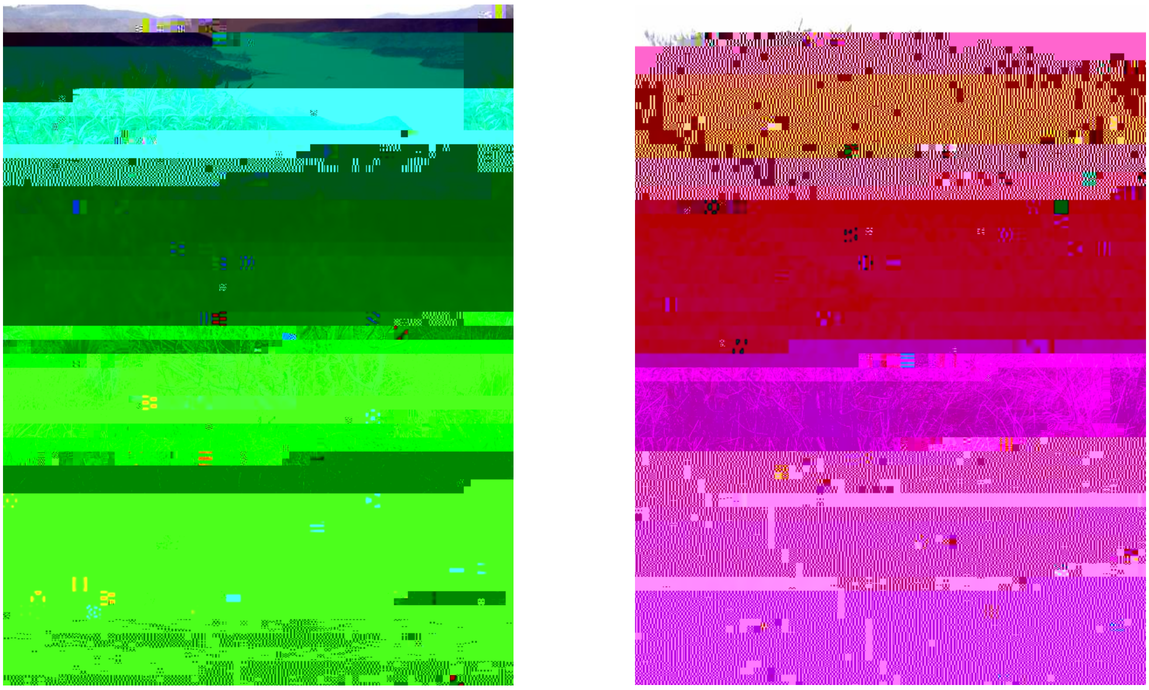
10. Appendices



(a)

Figure A.1: An example of native regeneration which is struggling because of drainage flowing at its base. (a) is an example of a healthy native plant species, this photo was taken

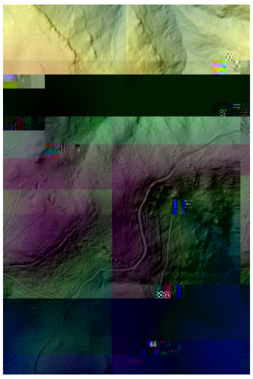


Figure C.1: Initial site representation by four individual DEMs

Figure C.2: Single DEM used as an input for Flow Direction

Figure D.1: Visual representation of creation of GIS drainage modelling

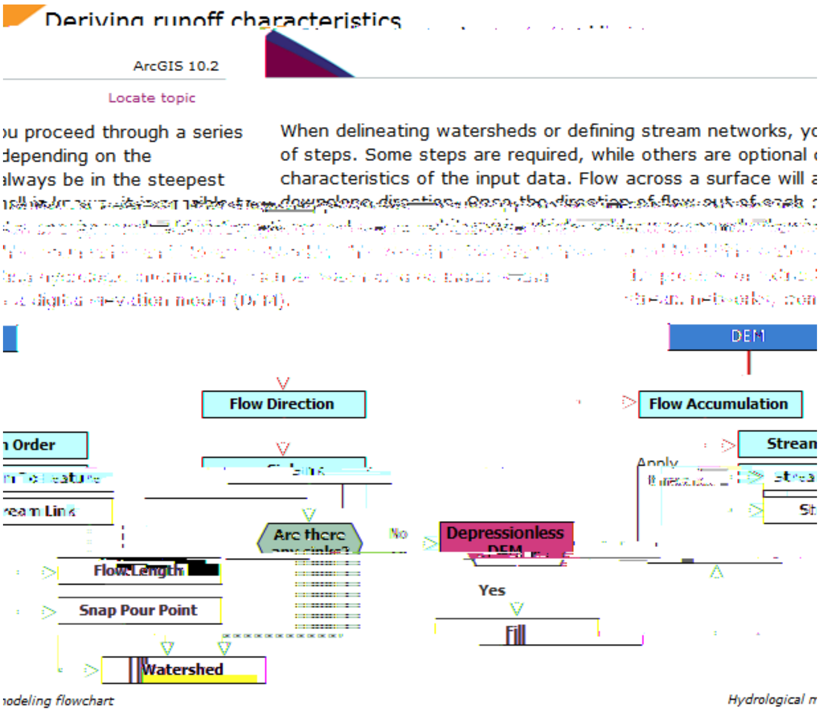


Figure D.2: Flowchart of steps taken in GIS drainage modelling

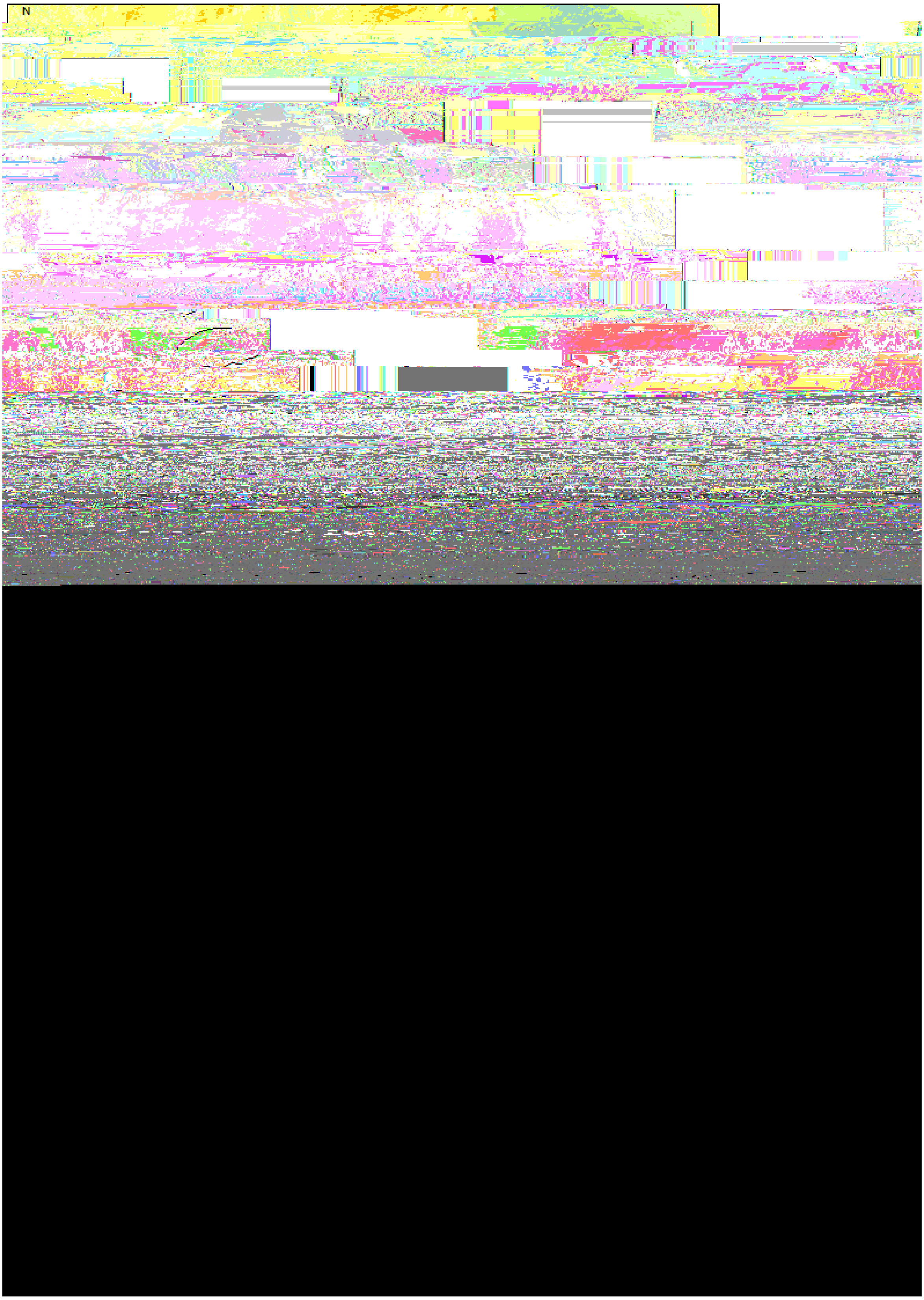


Figure E.1: Map showing the aspect of Marley Hill