Understanding Rural Productive Land Use Change in Canterbury and its Driving Factors

Samuel Cook, Dempsey Rose-Day, Thomas Sunderland, Jack Thorp, Sam Wong

GEOG309: Research for Resilient Environments and Communities

1. Executive Summary

The research aim was to map rural productive land use change in Canterbury over recent decades and identify key driving factors.

Data was collected from government departments, peer-reviewed journals, satellite images, weather stations, and industry professionals.Datn

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3. Literature Review

The following section delves into the four sub-themes that we have hypothesised to be drivers of rural productive land use change in Canterbury, in addition to mapping

3.5 Mapping Methodology

Mapping rural land is a substantial and time-intensive task. To meet our project's

To your knowledge, what is the one key factor that drives land use change in the Canterbury region?

To what extent do you think these factors play in land use changes within Canterbury: socio-economic, extreme weather events, precipitation trends, urban sprawl, and migration?

4.3 GIS Mapping

The process of creating the map involved multiple

4.3.3 Image Classification

Utilising the Image Classification tool within ArcGIS, every pixel across all three of the satellite images was then classified based off of their resulting NDVI values, as described in Table 1. Creating several distinct classes allowed us to gain a better understanding of the underlying land cover.

Table 1:

5.2.2 Farm Count and Size

Figure 3: Different types of livestock producing land in the Canterbury region by hectare (2002-2019; Stats NZ, 2021c).

5.2.3 Livestock and Horticulture Land Use

Figure 3 shows livestock land use change in the Canterbury region from 2002 to 2019 - over this

Figure 4: Changes in Canterbury land use for forestry (2002-2019; Stats NZ, 2021d).

Figure 5 shows horticulture land use in the Canterbury region over the period from 2002-2019. The available data suggests that horticulture land use in Canterbury has stayed relatively similar with slight increases over the data period. Horticulture is] l r

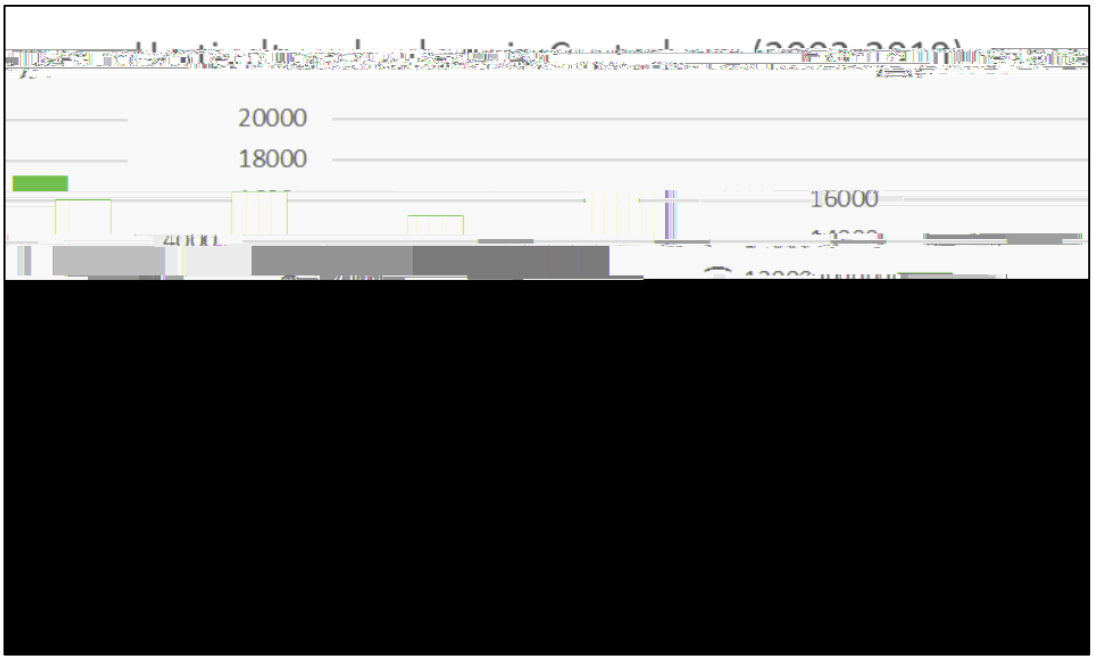

Figure 5: Horticulture land use in Canterbury in increments (2002-2019; Stats NZ, 2021d).

5.3 GIS Results

Prior to the discussion of GIS results, it is noteworthy that the 2010 results are heavily influenced by a major drought that hit the region during that summer, with an abundance of dry fields. An additional issue found was a form of sensor error in the same image, which saw some values erroneously measured. Both notes can be observed in Figure 7.

Smaller changes are often noticeable in the distribution of dry or stressed fields, constituting a significant portion of the visual alterations across the images (Figures 6, 7 and 8). However, these changes in distribution may not offer substantial insights into underlying land use patterns. Such alterations in the number or prevalence of dry fields are frequently attributed to individual farmer practices. These are not indicative of any consistent land use trends unless, for example, they result from an extreme weather event, as exemplified by the 2010 drought. While identifying significant changes in land use can be challenging through satellite images and NDVI classifications, subtle transformations are still observable. Over time, numerous small farming communities in the mid-Canterbury plains have expanded. Commercial forestry activities have emerged in the foothills, with fields extending further up the hills. These observations suggest that economic activity in the mid-Canterbury region is thriving, expanding, or adapting to meet evolving demands.

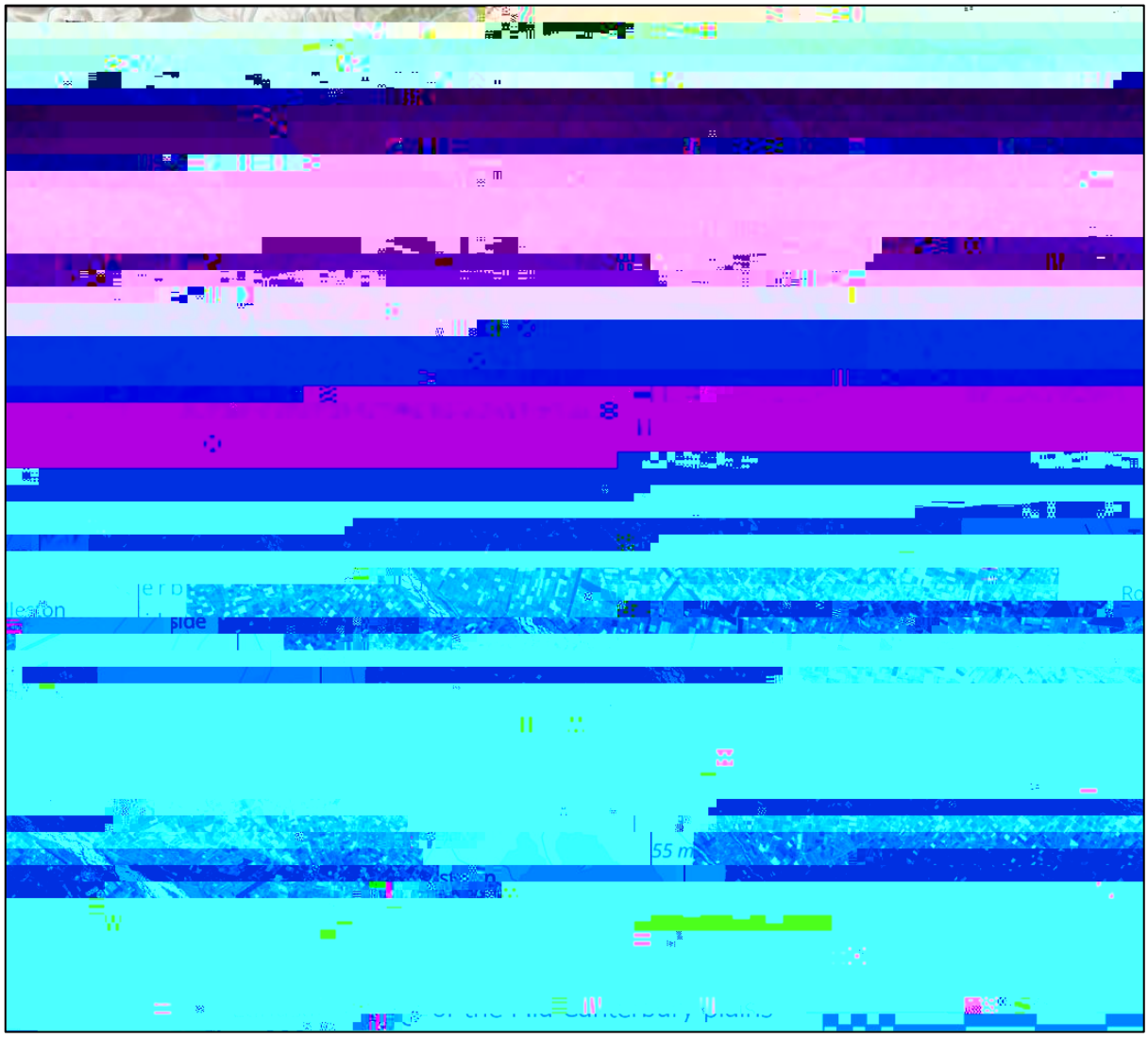

Figure 6: Landsat-7 satellite image of mid-Canterbury Plains, December 1999, for visual comparison purposes.

Figure 8: Landsat-8 image of the mid-Canterbury Plains, November 2021.

Comparing classification results across all three timeframes (Figures 9, 10, 11, 12, 13 and 14), with each pixel representing roughly 400 meters squared and considering the class guide (Table 2), we can observe minimal change between 1999 and 2021. As expected, a large jump in classes 3 and 4, which represent water and dry fields, can be observed in 2010. Yet, as many dry field pixels have been misclassified as water, the significant jump in the number of dry fields is not entirely represented in the graph. If we observe only class 4, it can be seen

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Figure 9: NDVI land cover classification map of mid-Canterbury Plains, December 1999.

Figure 10: Bar graph depicting the distribution of pixels in set classes, from NDVI classification of 1999 mid-

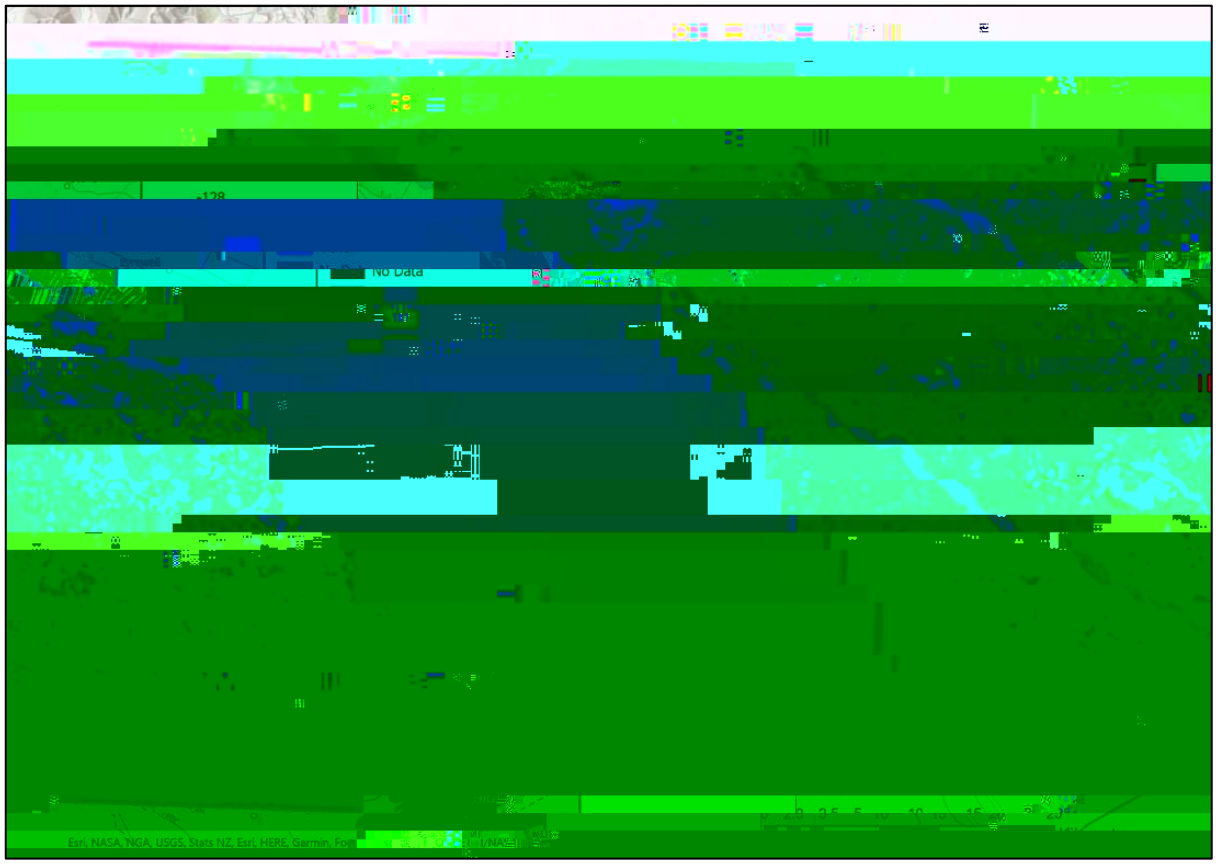

Figure 11: NDVI land cover classification map of mid-Canterbury Plains, December 2010.

Figure 12: Bar graph depicting the distribution of pixels in set classes, from NDVI classification of 2010 mid-Canterbury Plains. Refer to Figure 11 for the conversion of classes into real-world land cover.

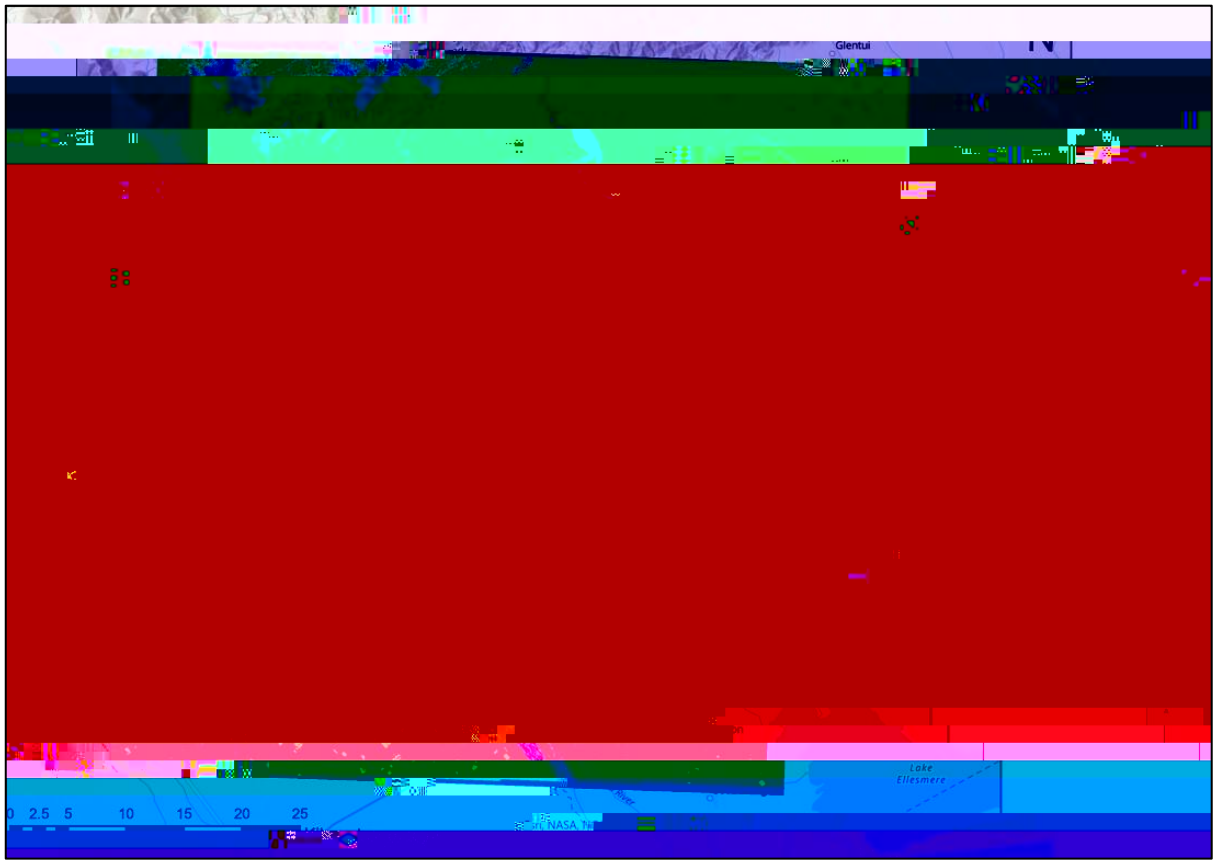

Figure 13: NDVI land cover classification map of mid-Canterbury Plains, November 2021.

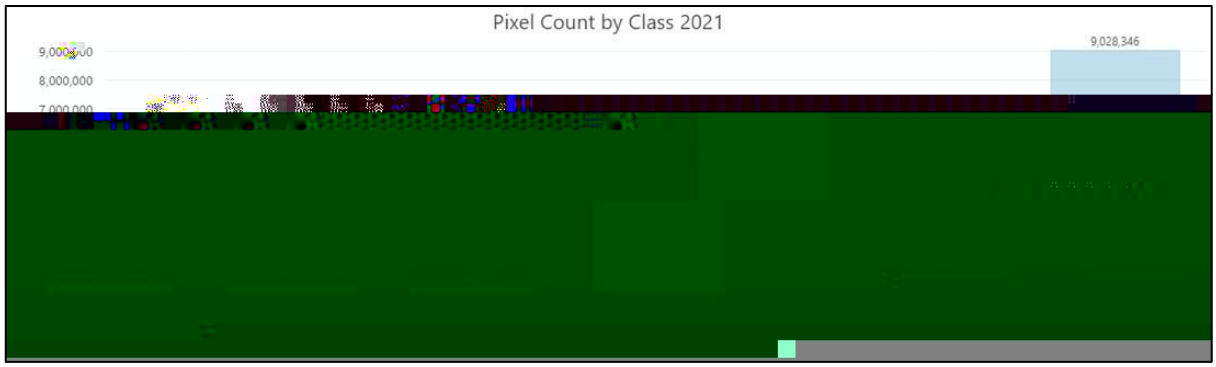

Figure 14: Bar graph depicting the distribution of pixels in set classes, from NDVI classification of 2021 mid-Canterbury Plains. Refer to Figure 13 for the conversion of classes into real-world land cover.

Table 2: Classification table for the translated pixel classification into real-world land cover.

5.4 Weather Analysis Findings

Firstly, a plot of average annual rainfall values across our study area over the last five decades shows an overall decreasing trend consistent with studied literature (Figure 15). It is noteworthy, however, that significant fluctuations of relatively high and low precipitation can be observed between the years, an unsurprising feature given the numerous interrelated climate variables affecting New Zealand (such as El Ni¶o-Southern Oscillation). Concentrating on the evolution of seasonal average rainfall distributions between the late 20th and early 21st centuries, whilst little change was observed in autumn and spring months, Figure 16 reveals an interesting shift in the summer and winter months. Those seasons post-2000 exhibit a shrinking of their lower quartiles and expansion of their upper quartiles, in addition to decreases in their median values, in comparison with their pre-2000 counterparts. This is indicative of intensification of rainfall events, but drier conditions overall, potentially making for a key consideration in rural land use decisions.

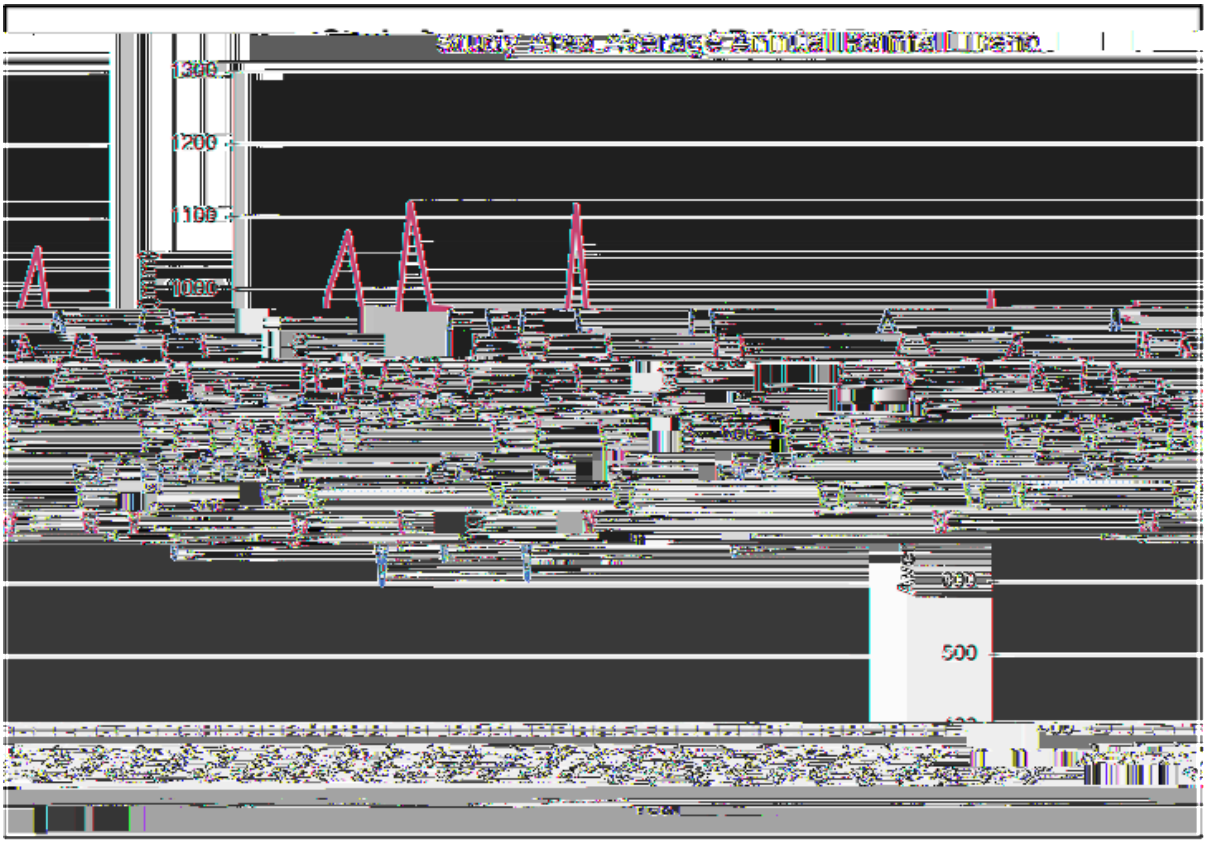

Figure 15: Overall decreasing average annual rainfall trend identified in study area between 1970-2020.

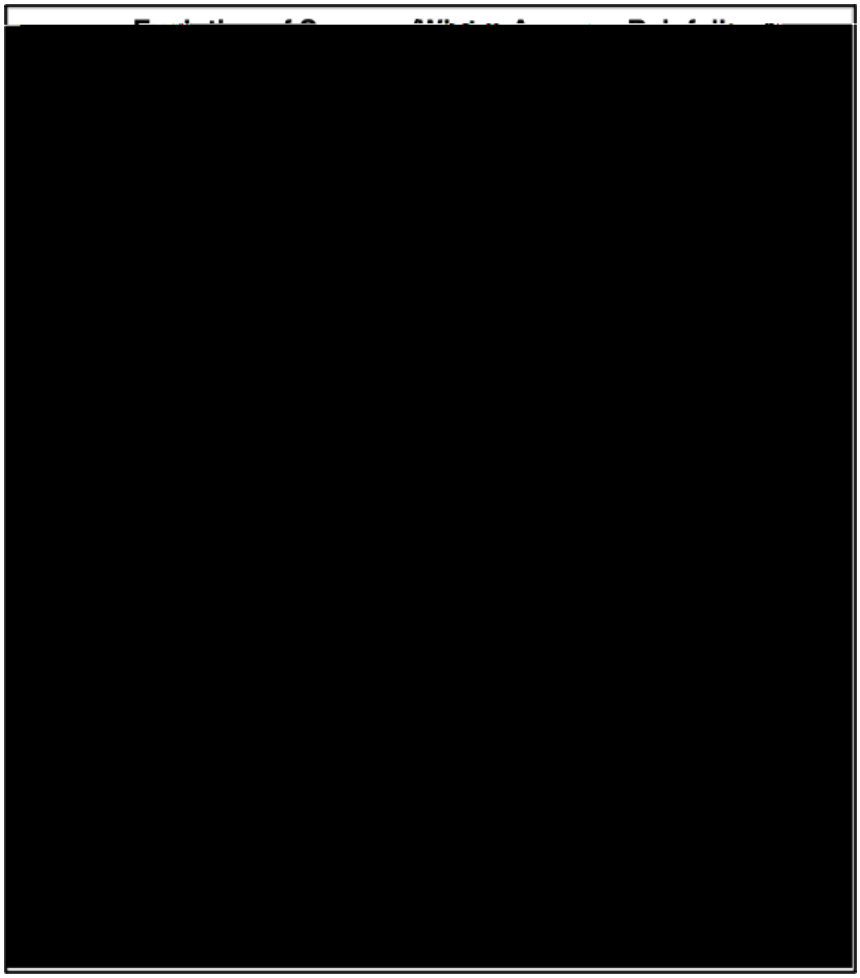

Figure 16: Comparison between late 20th century and early 21st century summer and winter months, exhibiting intensification of rainfall events but overall drier conditions.

As for mean air temperature, slightly increasing trends of a very similar gradient were identified across all four seasons over the previous four decades (Figure 17). There was little temperature separation between the autumn and spring data series (approximately one degree Celsius), whilst the summer and winter series exhibited an approximately ten-degree Celsius difference. Observing the distributions of mean seasonal air temperatures pre and post-2000 (Figure 18), all four seasons experienced a compaction ï in other words, a lesser degree of variation in mean air temperatures over the past two decades. This change was found to be most pronounced in the winter and spring months, and less so in autumn months. This may be a welcomed finding for Canterbury farmers, indicating more predictable temperatures at a seasonal scale. However, it is important to reiterate that scarce data availability resulted in limited coverage of mean air temperature data, thus these findings should be interpreted with caution.

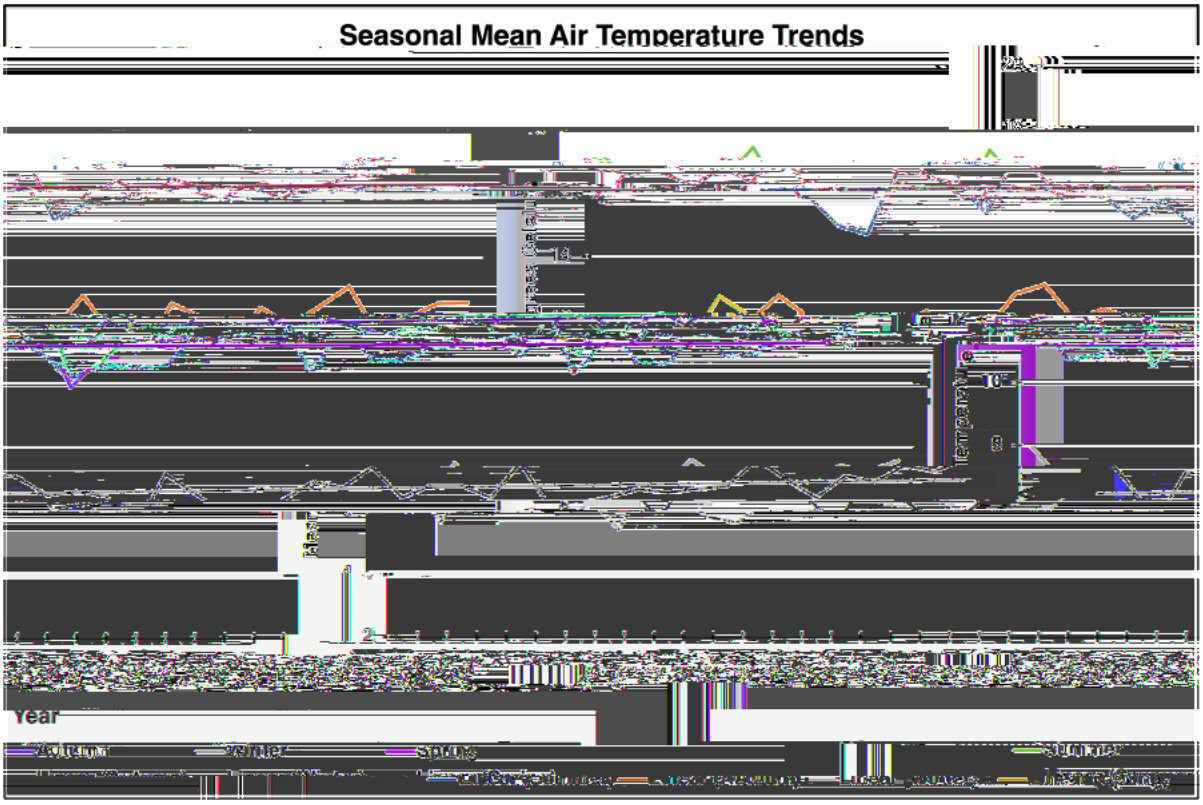

Figure 17: Small increasing trends in mean air temperature of a similar gradient identified across all four seasons in study area between 1980-2020.

Figure 18: Comparison between late 20th century and early 21st century seasonal mean air

A major limitation of the project was the lack of necessary data. We were able to source statistics from Stats NZ regarding overall agricultural productivity in the Canterbury region, in the absence of the individual farm scale data required for the original project proposal. Another data collection method that we deemed unfeasible was door knocking for surveying. With the number of farms and size of our study area, this method would have taken too long to obtain representative responses and an accurate sample size. The questionnaire we sent to industry professionals, although providing us with useful information, also had limitations. Namely: response time (or lack thereof) and field of the professional.

7. Conclusion

The rural, productive areas of the Canterbury region are constantly changing. Our research shows that the quantity and extent of traditional rural land uses is continuing to decrease every year, while urban land coverage continues to rise. This was most apparent in areas such as West Melton, Darfield, and Rolleston. Initially, we hypothesised several factors that we believed were key drivers in rural land use change, being socio-economic, urban expansion, precipitation trends and extreme weather events. Of these, it is evident from our research that socio-economic is the main driver of rural land use change in Canterbury. Analysis of weather data, namely precipitation and temperature, revealed considerable changes over recent decades that point towards environmental factors also playing a fair role in influencing rural productive land use decisions. GIS methodology allowed us to visualize land cover change across multiple time periods. Although we identified limited changes in land cover, further research could expand upon our findings using higher resolution satellite images among other methods to potentially produce data at an individual farm scale

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