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This report aims to investigate where hedgerows are in relation to infrastructure, and the associated fire risks. The research was based in New Zealand's South Island, with a focus on the rural Canterbury region. The central research question explored was: *How do the distribution and characteristics of hedgerows and shelterbelts influence fire risk to infrastructure in rural Canterbury?* This location is relevant to this research due to the large number and variety of hedgerows and shelterbelts. A case study site (Figure 1) located within this area will be used to demonstrate methods and results at a small scale, which can later be reproduced at a wider scale.

This is an important area of research as rural Canterbury has large numbers of both hedgerows and infrastructure, including houses and sheds. Wildfires create widespread damage and carry significant costs on the New Zealand economy. Costs include direct, indirect as well as social and environmental. The occurrence and severity of wildfires are increasing faster than predicted around the world, as a result, increasing fire risk and costs are predicted to increase by 400% by 2050 (Scion, 2022). The increasing number of wildfires is occurring due to climate change, and anthropogenic factors, such as land use changes. Experts predict that by 2050, the changing climate will cause the costs of wildfires to rise to $547M per annum in New Zealand (Scion, 2022) (Bowman et al., 2020).

Figure 1: Aerial image of the Case Study site using 0.3m resolution data taken from LINZ.

Hedgerows play an important role when understanding the fire risk to infrastructure, as varying characteristics can influence the risk. Little research has gone into directly understanding how they influence risk. However, hedgerows and shelterbelts are believed to have a large influence. This is due to factors such as vegetation compositions, which can alter flammability and would, therefore, create a higher or lower risk to infrastructure within a certain proximity.

To best understand the risk that hedgerows pose in infrastructure three main aims where produced. First, to identify and map the locations and densities of hedgerows and shelterbelts in rural Canterbury. This will help to understand their spatial relationship and is an important risk influence. Secondly, understanding how factors, such as fuel load, vegetation type and proximity, affect fire risk at a smaller case study location (Figure 1). This can be used to compared to large scale spatial analysis. Finally, provide mitigation methods to reduce fire risk using FENZ buffer zones of 10, 30 and 50 metres. By exploring these objectives, a clearer understanding will emerge of how hedgerows and shelterbelts impact risk in rural Canterbury.

This report begins by outlining the literature reviews which provided essential information for the research. The literature reviews were organized into four key themes: overall fire risk, methodology and geospatial analysis, vegetation flammability, and mitigation approaches. Next spatial analysis and gr

although most natives have low flammability

Next, point data was obtained using the classification map. This was done using the raster-to-point tool, which converted the classified raster into individual pointss int data

Figure 2: Canterbury wide classification created using multispectral imagery. The base image was obtained from Plant Lab containing 2,3 and 4 wavelength bands. The classification was run using training data that was manually created. Infrastructure is shown in red, and hedgerows/shelterbelts are shown in Green. All other features (e.g. grass) are shown in black.

Figure 2 depicts a widescale classification of the Canterbury region using infrared aerial imagery. Red represents infrastructure including, houses, sheds and roads whereas green objects highlight hedgerows, shelterbelts and other large trees. The remaining black areas are other land features, such as grass paddocks or undeveloped land.

Figure 3: A segment of the wider Canterbury infrared image. This image was obtained from Planet Labs which contains the 2, 3 and 4 wavelength bands. Bright red areas show healthy vegetation, and bright green areas show unhealthy vegetation. Grey or white area represent non-vegetated surfaces including roads, or buildings. This near-

to housing posing a great risk to the infrastructure in this area. This classification is a simple way to identify the location of hedgerows, shelterbelts and infrastructure and the proximity between them.

Figure 6: Infrastructure point density map of the case study site. This map illustrates the concentrations of houses, sheds or roads. Areas with higher density are showing in bright red. Areas with lower density are shown in lighter red.

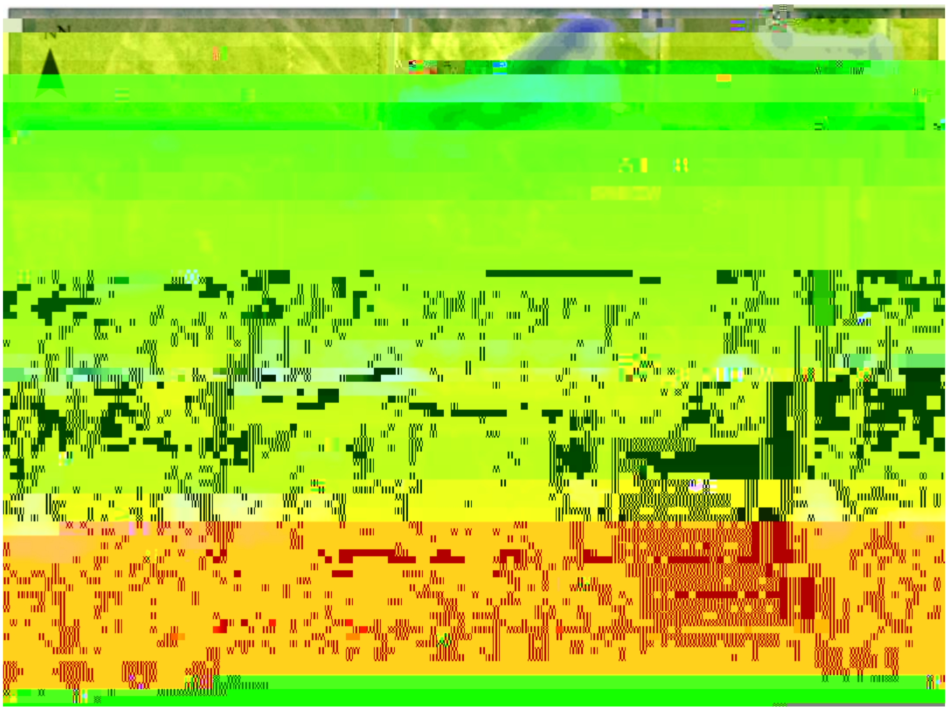

Figure 7: Hedgerow and shelterbelt point density map at the case study site. This map illustrates concentrations of hedgerows and shelterbelts across the study area. Areas highlighted in dark blue show higher density and areas of lighter blue represent areas of lower density.

Figures 6 and 7 reveal hotspots of hedgerows, shelterbelts and infrastructure. Areas on the hedgerow map that are a darker shade of blue represent more points or a higher density. Likewise, on the infrastructure map, areas that are dark pink, showing that there are more sheds or houses. These outputs help to show isolated areas that are either hedgerows or infrastructure without combining the features. Figure 6 reveals distinct clusters of infrastructure, suggesting that these areas are of higher development or activity. Conversely, the areas with lower infrastructure density, indicate more rural or undeveloped regions. Figure 7 shows linear patterns of clustering around paddocks or houses. The density of hedgerows or shelterbelts varies across the map, with some areas having higher concentrations than others.

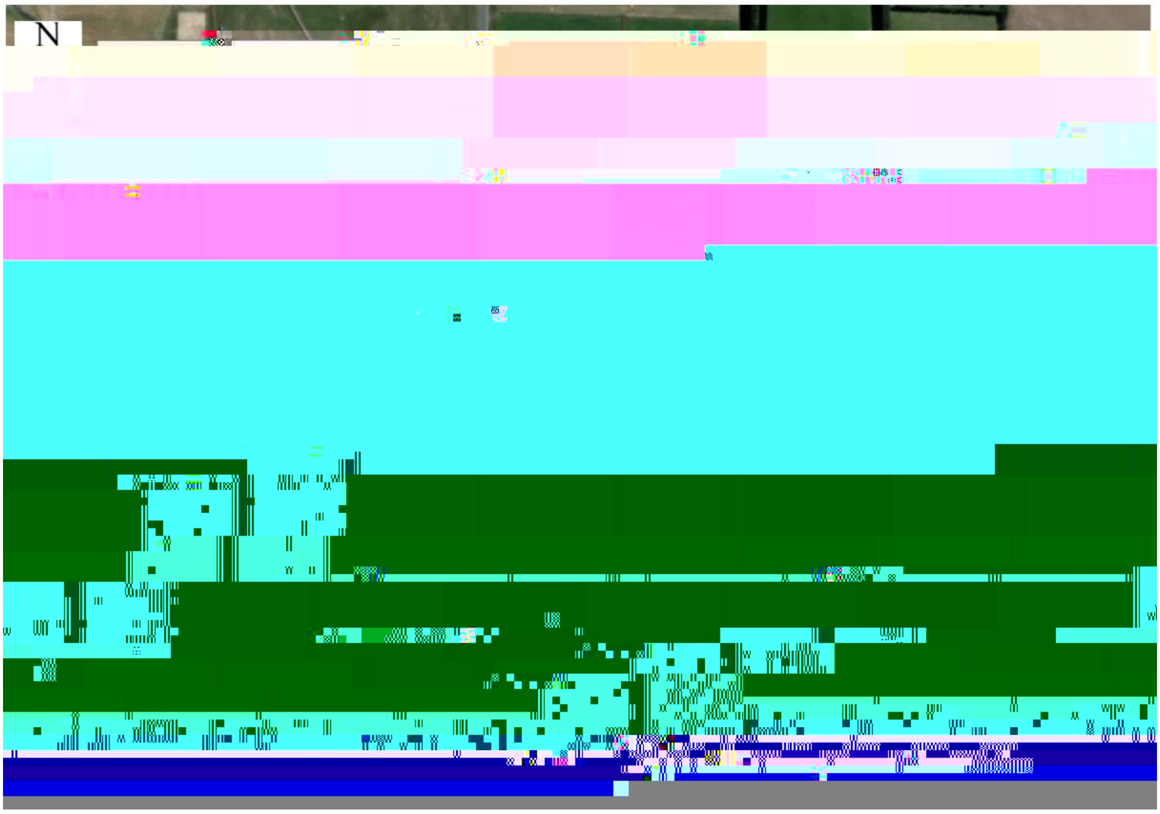

Figure 8: Grid heat map of the case study site that visually represents the concentration of infrastructure and hedgerows. Darker red grids indicate a higher density of both, suggesting a greater risk of fire. In contrast, lighter or white grids represent areas with lower concentrations, indicating a lower risk of fire. This map is valuable for emergency responders as it helps prioritise areas for resource allocation and mitigation efforts during wildfires.

Figure 8 is a grid heat map showing the areas with a high or low amount of infrastructure and hedgerows. Areas with a darker red shade represent grid sections with large amounts of hedgerow and infrastructure points. Therefore, using background knowledge, darker grids areas are at higher risk during a wildfire due to the possibility of fire spread from hedgerows and increased infrastructure vulnerability. In contrast, lighter or white areas have fewer hedgerows and infrastructure. These areas are less at risk and less likely to experience rapid fire spread or significant damage to infrastructure. This grid heat map serves as a crucial tool for firefighters and disaster management teams. By identifying high-risk zones, where both hedgerows and infrastructure are concentrated, emergency responders can allocate resources more efficiently and prioritize areas that require immediate attention during a wildfire. It could also be used to identify areas for mitigation methods before fires occur.

Table 1

Table 2: Risk data for various planting sites at the study site in West Melton. This shows the species type, distance from property, fuel load, and individual risk of each planting site. Each planting site was given an individual risk which was then used to calculate the total property risk. The total property risk score is 71 which is medium risk.

Figure 9

Figure 10: Buffer zones around key infrastructure at the case study site in West Melton. This was completed using FENZ recommended 10,30 and 50 metre distances. The number in each text box corresponds with the planting site allocated in the field study which provides context of how risk changes with proximity. High fuel load hedgerows are located within proximity to the houses and sheds on the property.

Figure 10 shows 10, 30, and 50-meter buffer zones surrounding the four main infrastructure sites. These buffer zones are crucial as they visually represent the different levels of risk based on vegetation proximity to the infrastructure. The closer the vegetation is, the higher the potential fire risk. The combination of spatial and quantitative data offers a comprehensive tool for assessing and managing fire risk on rural properties.

The results produced are significant and can serve to reduce wildfire impacts. The presence of non-native species and high fuel loads validates the case study's impacts.

their capacity to confront fire risks effectively. Together, these outputs are significant, as they will

The research has demonstrated a spatial relationship between hedgerows, shelterbelts, and nearby infrastructure, directly impacting fire risk levels on infrastructure in rural Canterbury. The proximity of vegetation to buildings, combined with the vegetation type and fuel load, plays a crucial role in determining the potential for fire spread. Through the use of a grid heat map, high-risk areas were identified, which could be expanded into a region wide output.

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