Hedgerow and Shelterbelt Impact on Fire Risk to Rural Canterbury Infrastructure

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Executive Summary

This report investigates the influence of hedgerows and shelterbelts on fire risk to rural infrastructure in Canterbury, New Zealand, in collaboration with Fire and Emergency New Zealand (FENZ). With wildfires becoming more frequent, this research addresses a critical need to assess how hedgerows and shelterbelts impact wildfire hazards. The central research question explored was: *How do the distribution and characteristics of hedgerows and shelterbelts influence fire risk to infrastructure in rural Canterbury?* The methodology involved a combination of qualitative and quantitative methods. Ground truthing was conducted at a rural property where the height, width, distance, and species composition of hedgerows and shelterbelts were measured. Aerial imagery and ArcGIS Pro were used to analyse spatial data, create heat maps, and develop buffer zones around critical infrastructure. Findings reveal a spatial correlation between the distribution of hedgerows and infrastructure at a regional level. Ground truthing and spatial analysis of the case study property confirmed that it is an at-risk property. Various imitations were encountered throughout the process, including data availability, fire risk assumptions and research scale. Future research would help to expand the scale of the results, increase output quality and make computation more efficient.

Introduction

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.

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

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).

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 ground truthing methods are explained along with the results produced. The significance and limitations of the research were analysed in the discussion, followed by future research recommendations in the conclusion.

Literature Review

Overall Fire Risk

Hedgerows and shelterbelts are prominent and important features globally. They serve various purposes, including land boundaries, agriculture, wildlife habitats, and cultural heritage. These features offer numerous benefits, such as, increased productivity, reduced weather impacts, and aesthetic value (Hedgelink, 2024) (Gregory, 1995). However, wildfires pose significant risks to infrastructure, particularly houses and sheds located near vegetation in the wildland-urban interface (Calviño-Cancela et al., 2016). Little research has gone into defining direct risks posed by hedgerows. Wildfires can cause substantial financial loss, property damage, and environmental harm. In 2020, there was $142 million worth of losses in New Zealand (Scion, 2022). The risk of wildfires is increasing due to climate change, aging infrastructure, and expanding rural settlements (Bowman et al., 2020) (Scion., 2022). Climate change is leading to more frequent and severe droughts, heatwaves, and longer fire seasons (Clarke et al., 2016) (Bowman et al., 2020). Human factors, such as increased fuel loads and ignition sources, are also contributing to the rising risk (Calviño-Cancela et al., 2016) (Clarke et al., 2016) (Radeloff et al., 2023).

Methodology and Geospatial Analysis

Integrating remote sensing into fire risk assessment offers deeper insights and expands the scope of the study. Technologies like LiDAR and aerial imagery allow for efficient data collection on fuel load, proximity to infrastructure, and vegetation types (Whig et al., 2024). Traditionally, this data was gathered manually, but remote sensing offers a faster and more economical approach (Andersen et al., 2006). While remote sensing is beneficial for large-scale mapping, limitations such as image resolution mean it may not be suitable for species identification (Xie et al., 2008). Geospatial technologies, such as fire hotspot maps, will also be used to identify high-risk areas (Said et al., 2017). A fire risk index will be useful to quantify variables that influence fire hazards, such as vegetation moisture and proximity to infrastructure (Mhawej et al., 2017). This index provides a standard method to assess fire risk and tailor mitigation strategies for rural Canterbury (Mhawej et al., 2017). Ground truthing is necessary to validate remote sensing data by verifying vegetation types and hotspot locations on-site (Satyanarayana et al., 2011). This combination of advanced technologies and field validation enhances the accuracy and effectiveness of fire risk assessments, especially in rural Canterbury.

Vegetation Flammability

Different hedgerow and shelterbelt species have varying flammability characteristics which can contribute to fire risk. Specific species characteristics, such as leaf morphology, oil content, fuel load, and moisture content, can all influence fire behaviour through ignition or spread. Native New Zealand species Mānuka and Kānuka are highly flammable due to their dense foliage and high oil content although most natives have low flammability (Fire and Emergency New Zealand, n.d.). Non-native species are also flammable, with Gorse having the highest flammability due to its low moisture content and invasive nature (Wyse et al., 2016). Leaf morphology and its decomposition rate affects fire intensity as species such as *Pinus contorta* with slow decomposing dense leaves can store fuel which raises fire risk (Kauf et al., 2018; Simberloff et al., 2010). Species with thinner, and curled leaves have faster fire spread rates in comparison to thicker leaves (Kauf et al., 2018). In mixed species vegetation, the presence of highly flammable species such as gorse elevates overall species flammability (Wyse et al., 2017). Furthermore, moisture content which varies between plant species, significantly influences the flammability of species mixtures as dry conditions increase the risk of ignition (Blauw et al., 2015).

Mitigation Approaches

Hedgerows and shelterbelts can influence fire risk based on their vegetation type, moisture content and management. Vegetation with higher moisture levels, such as native forest, is less prone to ignite while dry and dead plant material is more flammable (Popović et al., 2021; Muffly & Birchall, 2023). Native forests provide deep shade, keeping temperatures lower and moisture content higher, which reduces fire risk (Calviño-Cancela et al., 2016). Replacing flammable species with moisture-rich vegetation or introducing fire breaks with low-flammability plants can slow fire spread (Curran et al., 2017). Fuel reduction methods, like pruning and thinning, play a crucial role in risk fire mitigation. These techniques reduce the continuity of fuels, preventing surface fires from reaching the canopy (Hevia et al., 2018). Proper spacing of trees and removal of low branches also lower the likelihood of fire spreading near infrastructure (Fire Emergency New Zealand, n.d.). Education is essential for encouraging property owners to adopt these mitigation strategies. Research shows that easy, affordable measures are more likely to adopted by residents (Faulkner et al., 2009). By combining fuel management with education and species selection, fire risk in rural areas can be significantly reduced, offering better protection for infrastructure and communities.

Methods

Geographic Information System

Both qualitative and quantitative geospatial analysis were used to address various aspects of the research question and objectives. These included identifying spatial relationships between hedgerows and infrastructure and quantifying any patterns. Firstly, data was sourced and downloaded from LINZ and Planet Labs. Planet Labs' infrared data was used to create a classification that could differentiate vegetation types and, more specifically, define boundaries between hedgerows and other vegetation types. Near-infrared, red and blue bands were used, which can penetrate through plants to identify cell structures, making vegetation species more definable. Training areas were created to help the computation of the supervised classification; this involved assigning classes to hedgerows, infrastructure and other vegetation within the downloaded aerial images. After the training areas had been completed, the classification was run, and the classification map was produced.

The case study classification varied from the large classification as higher quality LINZ aerial imagery, which had a resolution of 0.3m was used. The same method was followed; however, due to the lack of near-infrared bands the classification was more difficult and relied on manual re-classifications to distinguish between similar features.

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 points. Any points that were not classed as infrastructure or hedgerows were deleted, allowing for analysis of patterns between those two variables. Density maps were created within the case study site to highlight areas that have large amounts of hedgerows and infrastructure.

To create a map that could quantitatively define areas with significant risk, a grid heat map was developed. The previously created density maps were reclassified to show a value of 0 (not infrastructure or hedgerow) or 1 (is infrastructure or hedgerow). The raster classified tool was used to overlap and show the points with a value of 1. A grid was produced using a fishnet, with cell sizes of 100x100 metres, and overlapped on the aerial image to separate zones into risk areas. The grid and point data were then spatially joined and separated into 32 classes to define risk areas as areas that have high counts of both infrastructure and hedgerow points within a grid cell.

To better assess the risk at the case study site, buffers were created to define risk zones. Buffers of 10, 30 and 50 metres were created and plotted on the house. Ground truthing was completed to obtain vegetation location, species, distance to infrastructure, and fuel load. These variables were then plotted into the buffer map to help visualize risk areas around a property.

Fire Risk Assessment (Risk Index)

To collect data for the fire risk assessment, ground-truthing was conducted through direct field measurements at a case study site in West Melton, Canterbury. This site was selected due to its rural location and the presence of diverse hedgerow and shelterbelt species, making it an ideal environment to assess vegetation-related fire risk factors. The shelterbelts were measured, focusing on critical parameters such as width, length, and distance from nearby infrastructure. A measuring tape was used to ensure accuracy. Plant species within the shelterbelts and hedgerows were identified using the iNaturalist app. This tool provided visual species recognition and enabled community verification, ensuring reliable identification of the vegetation types at the site.

The height of the hedgerows was calculated using the measured distance from the observer, the angle of elevation obtained for an Abney level, and the observer's eye-level height. This method provided accurate tree height measurements, which are essential for assessing fire risk. The fuel load of the hedgerows and shelterbelts was calculated by determining the overall volume of vegetation. This was done by multiplying the measured width, height, and length of each shelterbelt. The calculated volumes provided an estimate of the available flammable material, which is crucial for assessing the potential fire risk on the property.

The risk index is composed of the key factors that influence fire risk, taken from the literature (Table 1). This includes proximity to infrastructure, fuel load, and vegetation type. The three categories are given a score from 1 to 3 based on the severity of the risk they pose, with 1 representing a low risk and 3 indicating a high risk. These are added together to find the individual risk of each hedge. If a hedgerow scores 9 overall, a multiplier is applied based on the number of such hedgerows on the property. A lower-scoring hedgerows are evaluated separately without a multiplier, ensuring accurate risk assessment. This risk matrix was then applied to a rural property located in West Melton to show how it could be used (Table 2). Every planting site was assigned a number and assessed based on vegetation type, proximity to infrastructure, and fuel load (Figure 9). Each planting was then given a score ranging from 3 to 9. The score was then calculated to get an overall risk score of the property.

Results

Geographic Information System

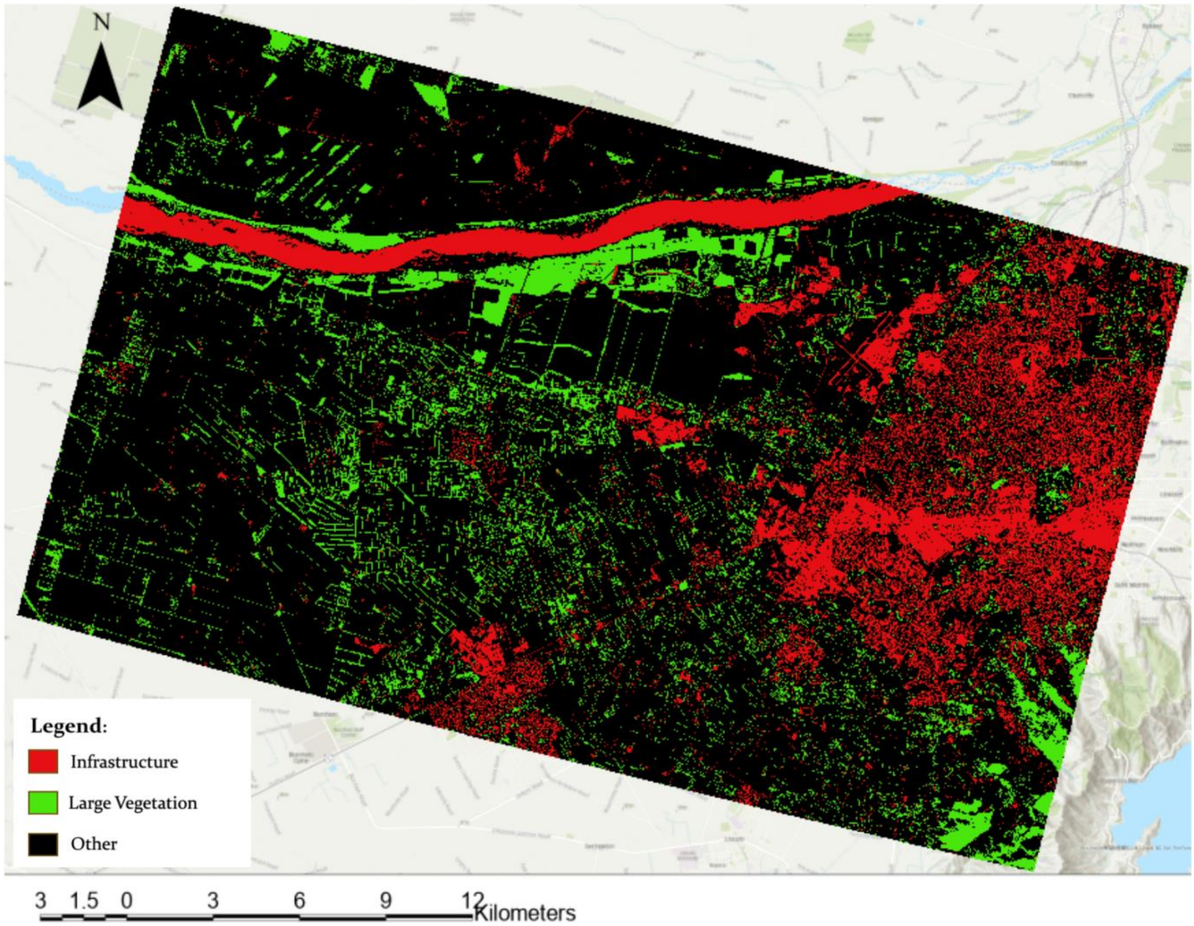

Figure 2) Canterbury wide classification created using multispectral imagery. The base image was obtained from Plant Lab containing 2,3 and 4 wavelength bands. The classification was run using training data that was manually created. Infrastructure is shown in red, and hedgerows/shelterbelts are shown 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. The close proximity of hedgerows to infrastructure is evident, as most red pixels are clustered near green pixels. This highlights a clear spatial relationship between the locations of infrastructure and hedgerows and the large distribution of hedgerows across rural Canterbury.

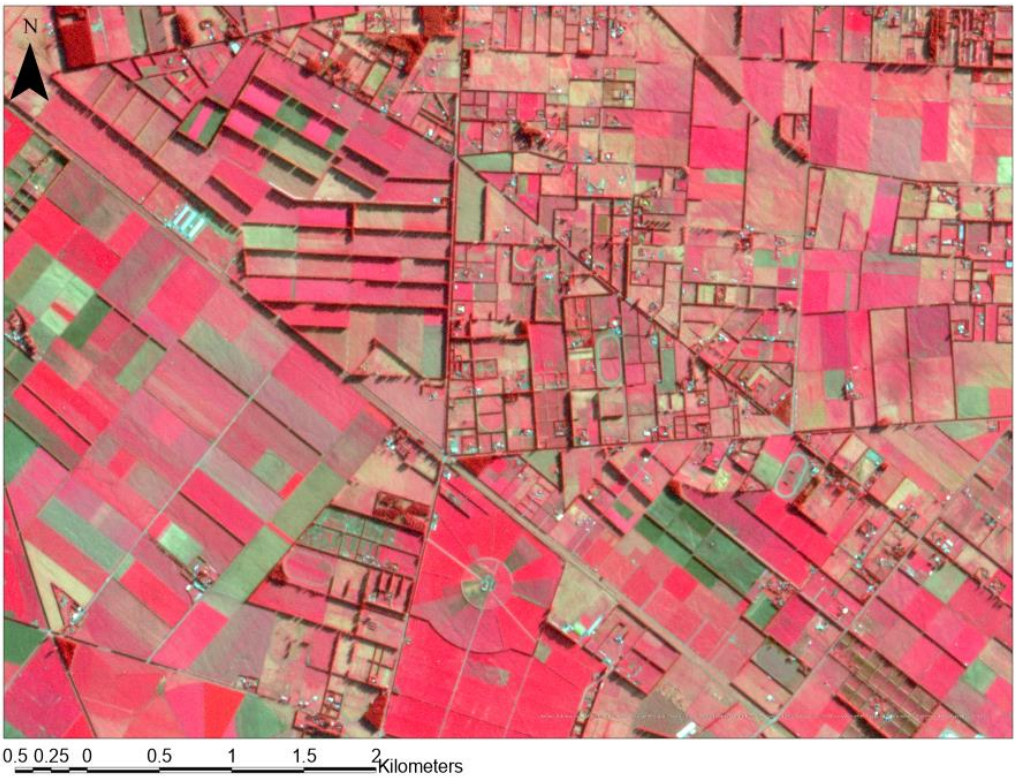

Figure 3) A segment of the wider Canterbury infrared image. This image was obtained from Planet Labs which contains the 2, 3 and 4 wavelength bands. Bright red areas show healthy vegetation, and bright green areas show unhealthy vegetation. Grey or white area represent non-vegetated surfaces including roads, or buildings. This near-infrared image is highly useful for detecting vegetation health and land use patterns when completing classification.

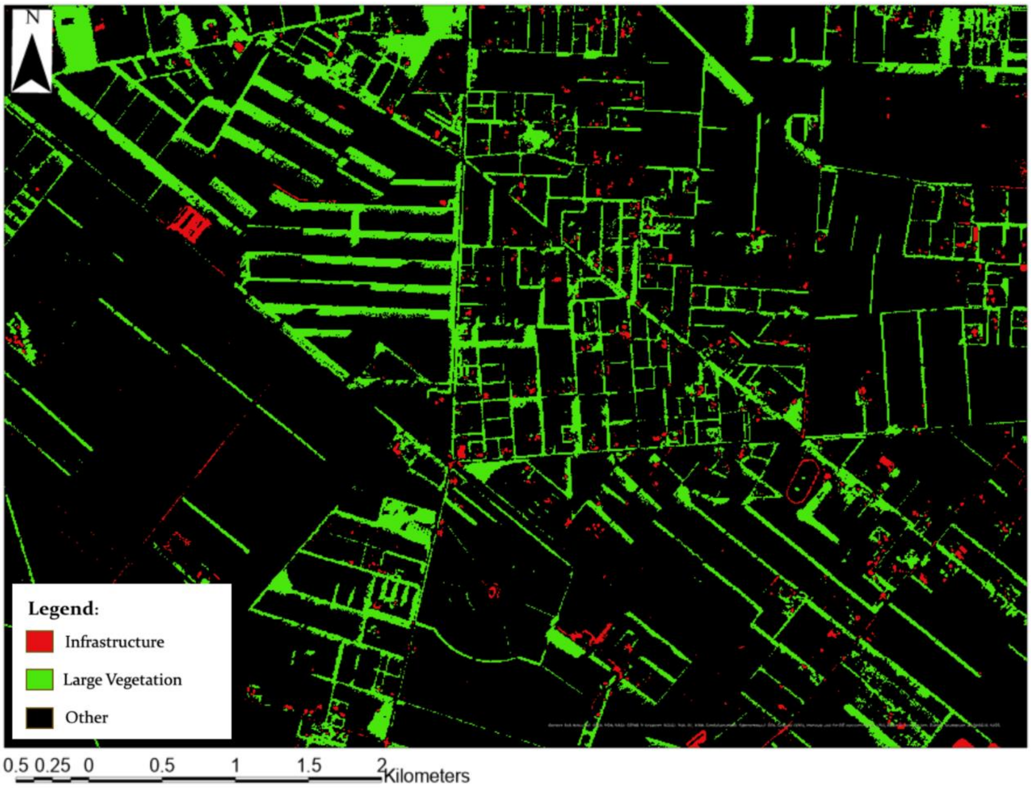

Figure 4) A segment of the wider Canterbury classification, created using infrared imagery. Infrastructure is shown in red, and hedgerows/shelterbelts are shown in Green. All other features (e.g. grass) are shown in black. This segment was used to verify accuracy of classification outputs.

Figure 3 is a snippet of a Planet Lab multispectral infrared aerial image, with 3m resolution. The distinct red colouring is produced when using infrared, red and blue bands. Infrared colouring helps to define varying vegetation types, as hedgerows appear as darker colours, due to the reflection of healthy cell structure within the vegetation. Surfaces that are not vegetation including infrastructure appear as more neutral or white coloured. This image is important to help define categories of land use types, which will be used during classification to produce more accurate results. Figure 4 shows a segment of the wider Canterbury classification. The clustering of green and red pixels suggests that hedgerows are concentrated around developed areas, which shows that these areas may be a greater fire risk.

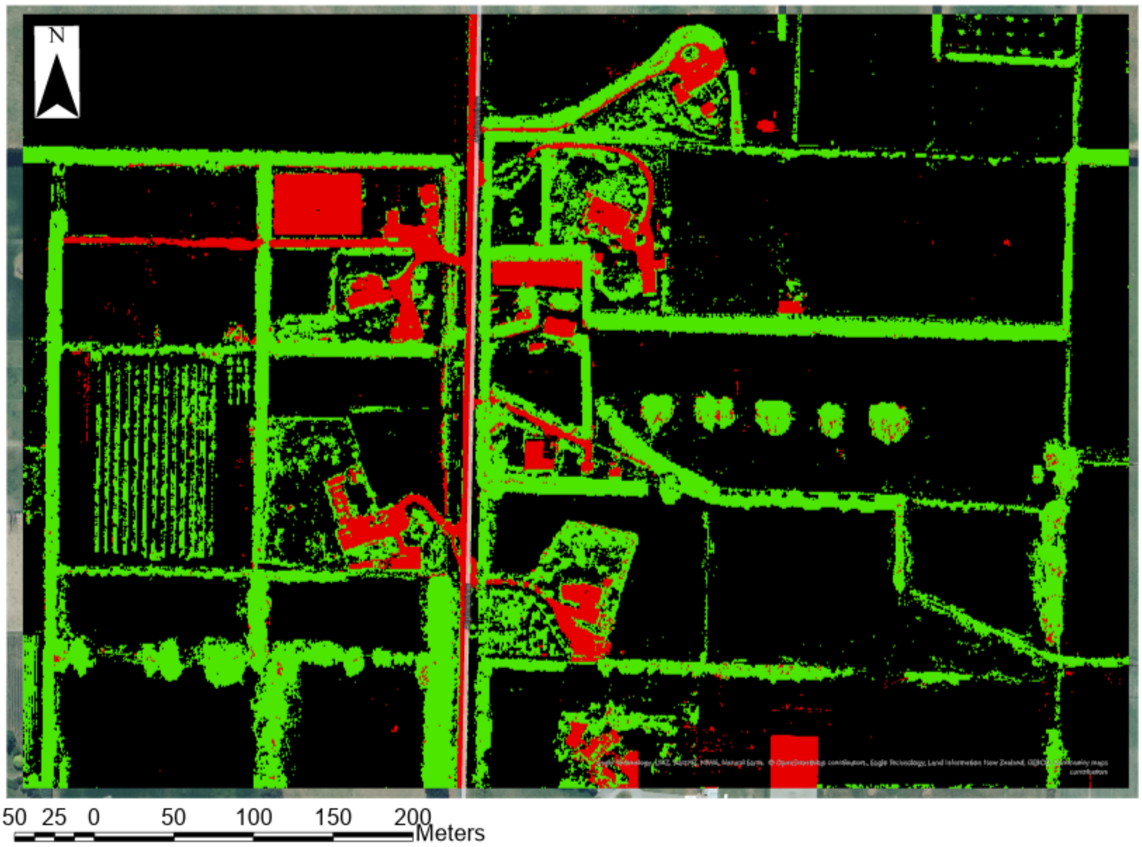

Figure 5) Case study site classification, showing infrastructure in red and hedgerows/ shelterbelts in Green. This classification was completed using LINZ aerial imagery. The classification was run using training data that was manually created. Reclassification was completed to increase the accuracy of the results.

Figure 5 shows the study site classification. There is a strong relationship between the location of hedgerows, shelterbelts and infrastructure in this area. Hedgerows tend to be located extremely close 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.

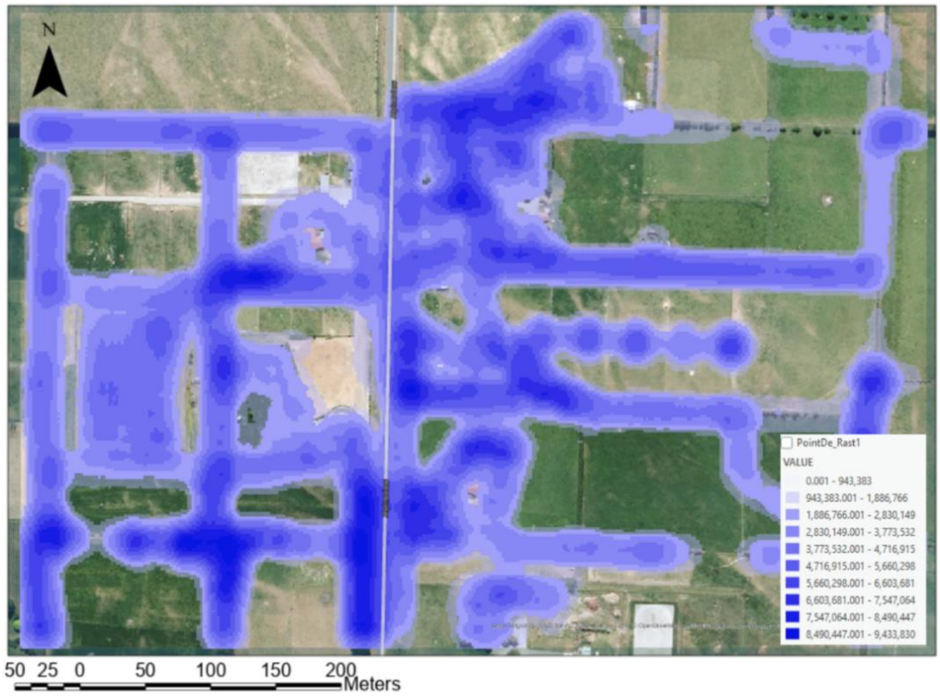

Figure 7) Hedgerow and shelterbelt point density map at the case study site. This map illustrates concentrations of hedgerows and shelterbelts across the study area. Areas highlighted in dark blue show higher density and areas of lighter blue represent areas of lower density.

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.

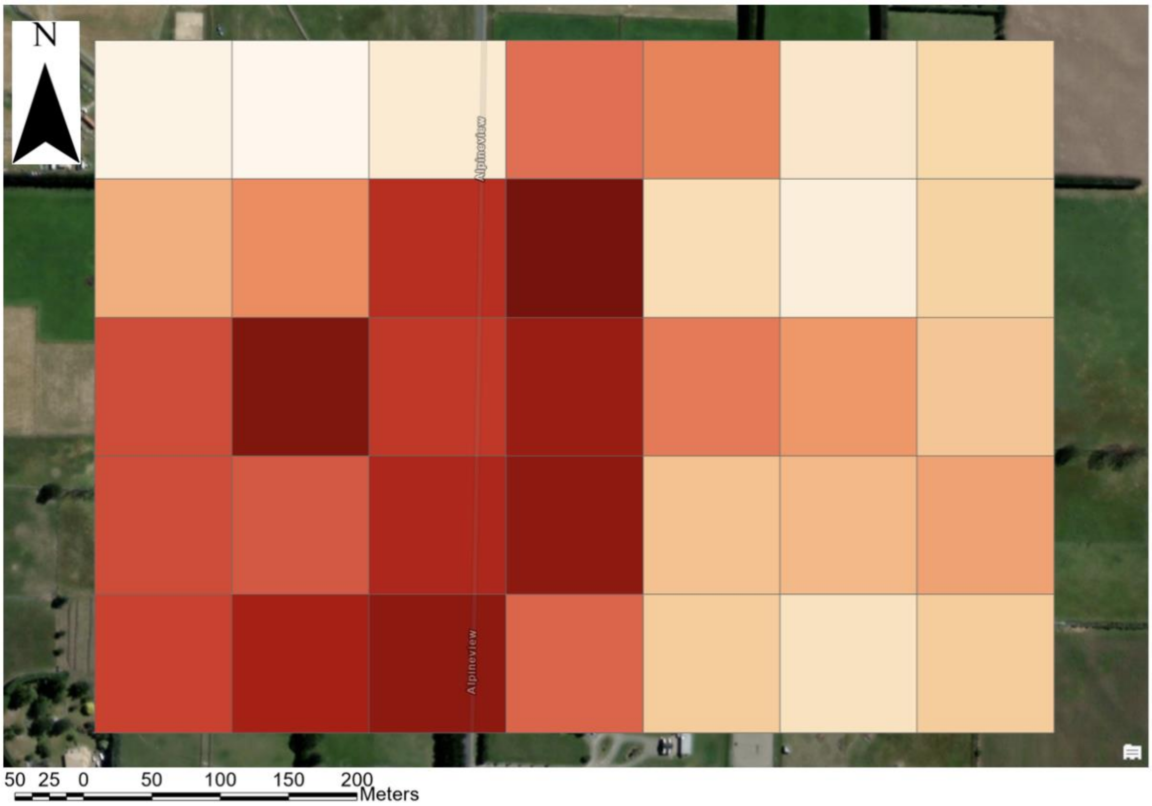

Figure 8) Grid heat map of the case study site that visually represents the concentration of infrastructure and hedgerows. Darker red grids indicate a higher density of both, suggesting a greater risk of fire. In contrast, lighter or white grids represent areas with lower concentrations, indicating a 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.

Fire Risk Assessment (Risk Index)

Risk Index			
Risk Rating	Closest Distance to Infrast	Fuel Load	Vegetation Type
3	<10m	High > 2000 (m3)	Non-native
2	>10m <30m	Medium <2000 >1000 (m3)	Mixed
1	>30m	Low <1000 (m3)	Native
Total Risk Score			
High	> 75 Points		
Medium	50-75 Points		
Low	< 50 Points		
Multipler			
Number of High-Rsik Hedgerows		Multipler	
1		1	
2		1.5	
3		2	
4+		2.5	

Table 1) Fire Risk Index for Hedgerows and Shelterbelts. This table outlines the criteria used to determine the risk rating of a given location. The risk score is based on the closest distance to infrastructure, fuel load, vegetation type, and the number of high-risk hedgerows. A higher risk rating indicates a greater likelihood of fire occurrence and potential damage.

Table 1 shows the fire risk assessment framework which focuses on three key factors: proximity to infrastructure, fuel load, and vegetation type. This framework categorises vegetation within 10 metres of infrastructure as high risk, vegetation between 10-30 metres as medium risk, and vegetation beyond 30 metres as low risk. This method prioritises proximity as a critical factor in the potential spread of fires to infrastructure. A fuel load exceeding 2000 cubic metres is categorised as high risk, between 1000-2000 cubic metres as medium risk, and less than 1000 cubic metres as low risk. This ensures that areas with dense, flammable vegetation are identified as higher risk due to their potential to fuel large fires. Non-native vegetation is categorised as high risk, mixed vegetation as medium risk, and native vegetation as low risk.

The overall property risk was split into three categories. High risk received a score of 3, medium risk a 2, and low risk a 1. Each hedgerow and shelterbelt on a property would be evaluated using these criteria. Properties scoring over 75 were classified as high risk, those scoring between 50-70 as medium risk, and those scoring below 50 as low risk.

Additionally, if a hedgerow receives a score of 9, indicating it is high-risk in all three categories (being within 10 meters of infrastructure, having a fuel load over 2000 cubic meters, and consisting of non-native vegetation), a multiplier is applied based on the number of high-risk hedgerows present on the property. Hedgerows that score less than 9 are still evaluated separately and do not receive a multiplier. This approach ensures that properties with multiple high-risk hedgerows are accurately assessed and do not mistakenly fall into a lower risk category.

Planting Site	Species (Dominant)	Species (Secondary)	Native/non native/mixed	Closest Distance from property (m)	Fuel Load: Volume (m^3)	Individual Risk	Total Property Risk
1	*Pinus radiata*	n/a	Non-native	1. 24.56	2337.9	8	71
2	*Pinus radiata*	n/a	Non-native	2. 25.2	1281.3	7	
3	*Pinus radiata*	n/a	Non-native	2.35.7	1462.9	6	
4	*Pinus radiata*	n/a	Non-native	2. 42.8	1442.3	6	
5	*Pinus radiata*	n/a	Non-native	2. 6	1249.2	8	
6	*Pinus radiata*	n/a	Non-native	2. 10.2	682.5	6	
7	*Pinus radiata*	n/a	Non-native	2. 5.8	820.6	7	
8	*Pinus radiata*	n/a	Non-native	4. 3.8	2664.9	9	
9	*Nematolepis*	n/a	Non-native	1. 22.2	792.2	8	
10	*Pittosporum tenuifolium*	*Ilex aquifolium, Thuja occidentalis, Pittosporum eugenioides, Sophora microphylla*	Mixed	1. 5.5	538.02	6	

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.

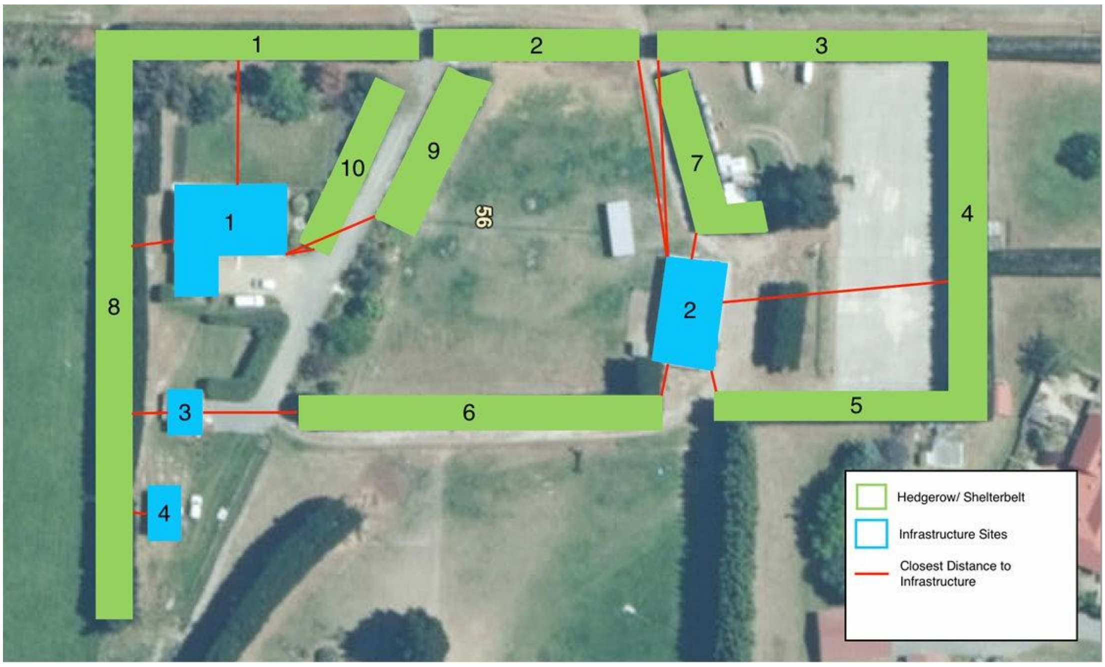

Figure 9) Spatial Distribution of Fire Risks Across the Field Site in West Melton. Each planting site and infrastructure site was allocated a number which was used in the risk index, providing a quantitative assessment of the potential for wildfire spread. Hedgerows and shelterbelts are shown in green and infrastructure in blue, with the red lines highlight the shortest distance between them.

The field site consisted of 10 main hedgerows and shelterbelts and 4 main buildings (Table 2 and Figure 9). Most plantings were non-native Pinus Radiata, which scored 3 on fire risk scale. The proximity analysis revealed that certain plantings were dangerously close to infrastructure. Site 8, for example, was 3.8 metres from a building and had a fuel load of over 2,600 cubic metres, making it the highest-risk area on the property. The overall property risk score was 71, placing it in the medium-risk category. This score indicates that although the property is not classified as high risk, mitigation efforts are necessary to reduce fire hazards.

Figure 9 provides a spatial perspective of the fire risks across the field site. This map displays the hedgerows and shelterbelts (green) relative to infrastructure (blue), with red lines indicating the closest points between vegetation and buildings. The labels correspond to the risk index, linking spatial features to quantitative risk scores.

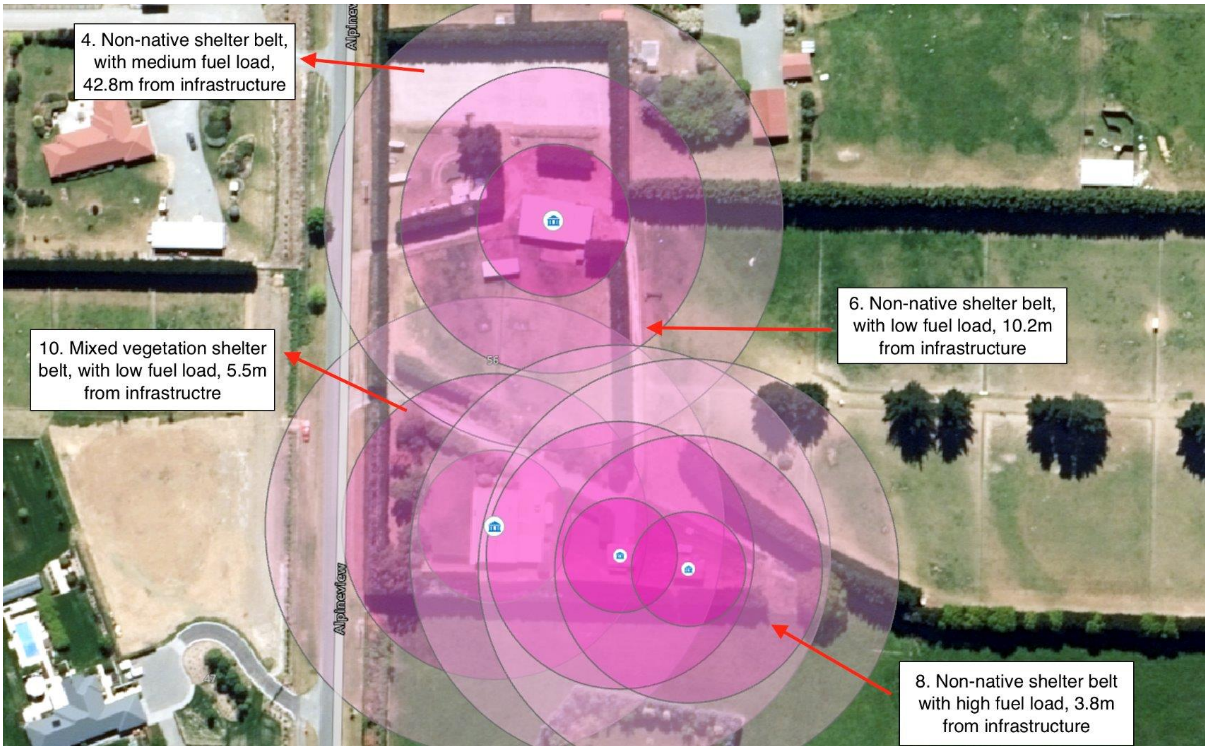

Figure 10) Buffer zones around key infrastructure at the case study site in West Melton. This was completed using FENZ recommended 10,30 and 50 metre distances. The number in each text box corresponds with the planting site allocated in the field study which provides context of how risk changes with 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.

Discussion

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 medium risk classification, highlighting the need for proactive fire management to mitigate potential fire cycles caused by invasive species (Smith et al., 2008). Results can be used as a pilot study and be replicated at a larger scale. Understanding the distribution and spatial relationship of hedgerows and infrastructure around Canterbury can identify more at-risk areas using a grid heatmap. A heatmap model will help emergency responders, including firefighters (FENZ) to focus on high-risk locations of hedgerows and better predict fire behaviour to prioritise mitigation efforts before fires occur. Hu et al (2023) emphasizes the significance of having predictive models to improve community safety and the effects of wildfires. This map approach could also support FENZ in advising property owners or implementing effective management strategies, as studies have shown that targeted actions like vegetation clearing, pruning and firebreaks can significantly reduce fire hazards (Hevia et al., 2018; Curran et al., 2017). This heat map will work in combination with a risk index that homeowners can fill out, providing homeowners with the ability to understand their private property's risk and apply their own mitigation methods or alert FENZ. By advancing community engagement in risk management, Paton and Buergelt (2012) study highlights how it can empower residents, enhancing their capacity to confront fire risks effectively. Together, these outputs are significant, as they will help to reduce the impacts of wildfires in several ways. There is very limited research specifically examining the impact of hedgerows and shelterbelts on fire risk, underscoring the importance of this study.

Vigorous work was completed to increase accuracy and reduce the impacts of the limitations. This was done by following the methodology and spending time validating results. This started by finding, trailing and testing various datasets to find the highest resolution, therefore, minimising the chance of incorrect classifications. Large amounts of training data were produced, and re-classification was completed when the computation was incorrect. Ground-truthing was conducted to enhance the reliability of spatial analyses by confirming the accuracy of vegetation assessments (Satyanarayana et al., 2011). This measured the risk of the case study site to see if the manually measured risk aligned with spatial analysis results.

The results have helped to answer the research question partially. Several limitations have impacted the results, diminishing the effectiveness in fully answering the question. Firstly, this project had to be completed at a much smaller scale than intended. During the spatial data collection and analysis process various geospatial techniques were explored, however, to meet the project's deadline, a more streamlined approach was used. The LINZ house data set was trialled, but it only contained points of individual houses and did not include sheds or outbuildings. There was limited availability of high-quality data during this project which is a widely acknowledged issue in GIS and thematic mapping (Foody, 2001). A Planet Lab student membership was applied for to gain access to multispectral data; however, the account was approved too late into this research project. The limited timeframe hindered the effective incorporation of this data into the analysis. As a result, the risk maps and classifications did not have a high level of detail, which could result in less accurate identification of at-risk locations. Additionally, converting the classification raster into point data was time-consuming producing over three million points for the small study area. Due to time constraints high volumes of datasets could not be processed, limiting the scalability of the analysis to larger regions of Canterbury. Potentially, different methods could have been used with more automated aspects, however, the lack of advanced coding skills restricted this project.

Many limitations also arose when ground truthing, which was essential for validating the spatial analysis. One major limitation occurred when estimating fuel load, as it was based on the volume of hedgerows alone. This assumes a great deal as hedgerows can be composed of different densities, moisture levels and leaf litter. This led to significant variations in fuel load which may affect the accuracy of the flammability assessment. In the risk index, species flammability was generalised into categories of non-native, mixed, and native. Native species were classified as low fire risk which is limiting because not all NZ native species necessarily have low flammability, due to different characteristics (Fire and Emergency NZ, n.d.). Due to time restraints, these variations in fuel load and specie type, were unable to be accounted for, which may have resulted in under or overestimating the fire risk. Furthermore, due to time constraints, only one rural case study site was ground truthed. This limited the ability to validate more areas which may have affected the validity of broader conclusions drawn.

Conclusion

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. These finding underscore the importance of developing a comprehensive risk index, allowing landowners and planners to systematically evaluate fire hazards on individual properties. By implementing targeted mitigation strategies, such as the careful management of high-risk vegetation and the establishment of safe buffer zones, it is possible to reduce the fire risks posed to infrastructure. The research presented in this report provides FENZ with well-grounded results and methodologies for future work.

Future research could build upon this pilot study at a larger scale, increasing efficiency and requiring access to additional, higher-quality data sets to enhance the accuracy and reliability of findings. Additionally, it would be beneficial to explore more effective methods for evaluating fuel load, as this is a critical factor in assessing fire risk. For example, using multispectral LiDAR data could be a beneficial in estimating fuel load. Furthermore, studies should consider refining the weighting of infrastructure in the heat map to better represent risk, potentially incorporating factors such as prevailing wind direction. This adjustment could amplify the analysis of areas with dense hedgerows and nearby infrastructure. Developing an automated system for data analysis would streamline the process, reducing the time and labour involved in manual analysis, and facilitating quicker, more consistent results across a broader scale.

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- Justin Harrison – Field Equipment Support

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