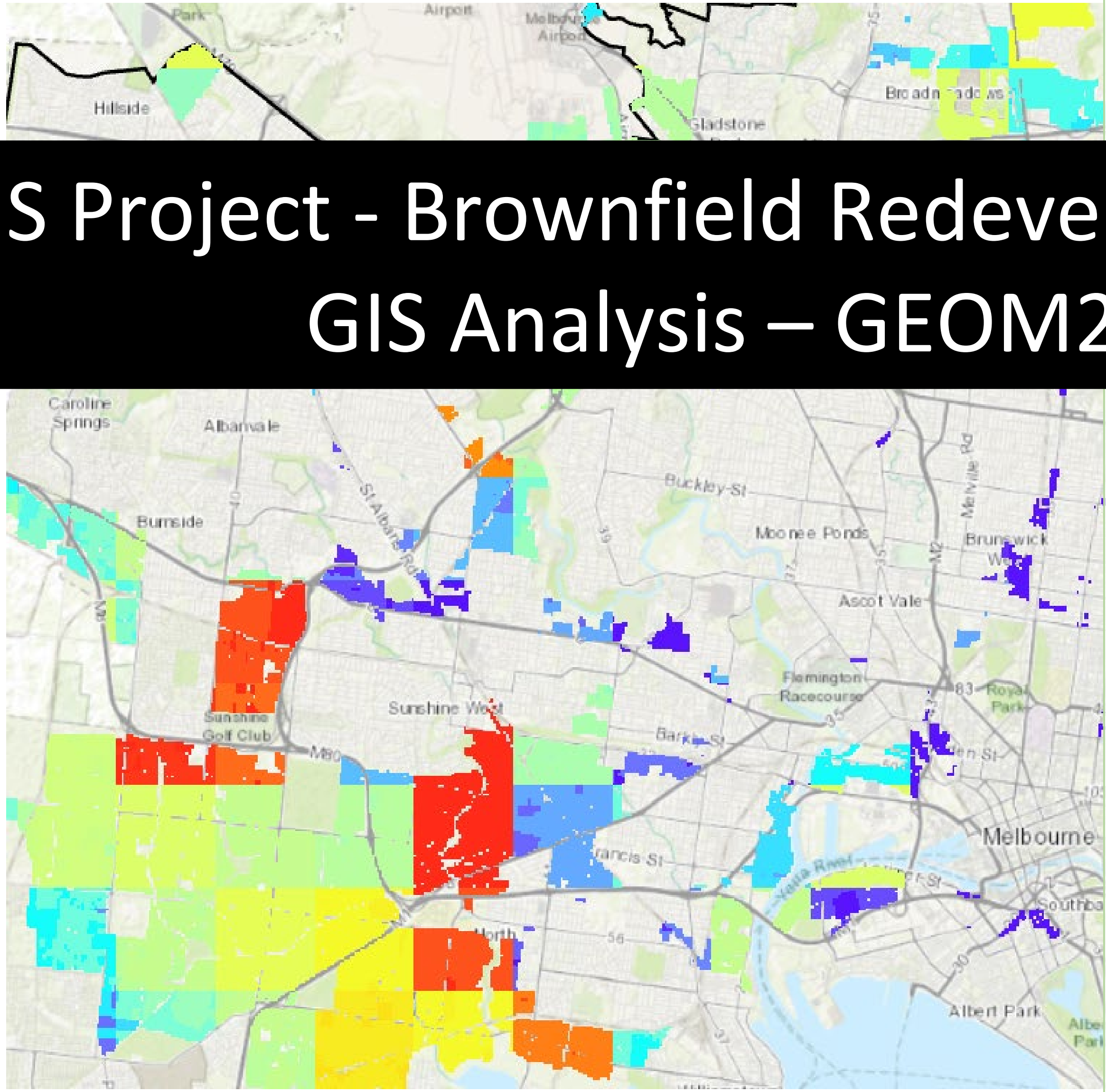
GIS Project - Brownfield Redevelopment Index
GIS Analysis – GEOM2152



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Executive Summary

This project aims to identify suitable sites for brownfield redevelopment across Melbourne metropolitan using GIS techniques. Brownfields are often contaminated and underused properties from industrial activities which present opportunities for urban revitalisation. A classification index is developed incorporating socio-economic and environmental factors to assess the redevelopment potential of these sites across Melbourne. Key datasets included current industrial land data across Melbourne, population density, unemployment rates and personal incomes accessed using Mesh Block and Statistical 1 datasets as well as EPA sites and public transport sites. Kriging interpolation was used to create surface maps to visualise demographic data and buffer zones were used to identify sites near public transportation, commercial zones and public open space. Results indicated high scoring areas for redevelopment are primarily in central and inner suburbs however redevelopment opportunities in these areas are limited.

Aim

This project uses GIS to identify suitable sites for brownfield redevelopment across the Melbourne metropolitan area. Brownfields are contaminated, underused properties often resulting from industrial activities, such as old factories and warehouses. Industrial heritage preserves these historical industrial sites, integrating them into modern culture and art. Transforming brownfields into cultural spaces, such as museums or exhibit areas, aligns with contemporary needs for flexible and unique spaces. Likewise, brownfield sites can be redevelopment into residential, mixed-use or other commercial uses (Ippolitoi et al., 2023). Brownfields are often located in obsolete, vacant, and often contaminated urban sites. However, these sites are typically located where infrastructure and amenities exist which can be redeveloped to create walkable neighbourhoods, enhance public transportation, and boost local economics. Although brownfield reclamation faces challenges such as high cleanup costs, limited investment resources, uncertain timelines, and liability issues related to contamination making redevelopment difficult (Chrysochoou et al,. 2012).

This project aims to develop a classification index in GIS to sort out appropriate sites for redevelopment across Melbourne. Relevant stakeholders can then use this information to proceed with urban revitalisation. Many scholars have accomplished this task in the past. (Wang, Kilgour and Hipel 2014) method for assessing brownfield redevelopment in Ontario Canada involved combining GIS spatial analysis with Ordered Weighted Averaging (OWA) and Interpolation techniques. OWA integrates multiple geographic factors using spatial logic operators and simple additive weighting. It allows decision-makers to manage complex criteria through linguistic quantifiers, which express risk preferences and adjust the weights of criteria. The likelihood of contamination is calculated by identifying contamination criteria, expressing judgments at sample points, and using interpolation methods. While (Chrysochoou et al,. 2012)adopted a multi-criteria analysis (MCA) approach, similar to Chen et al. (2009), categorising brownfield sites by socioeconomic, environmental, and smart-growth dimensions rather than strict rankings. Using New Haven, Connecticut as a case study, they developed a socio-economic index that included property values, unemployment rates, population density, and targeted development indicators to identify Connecticut towns with high economic development potential. An intersection density layer to show pedestrian and transit-friendly areas with bus and rail access was created as well as an environmental index incorporating proximity to open space, soil type, proximity to water bodies, zoning, and characterization of flood plains or wetlands.

Generally, the adaptive reuse of brownfields involves four phases: 1. **Mapping**: Creating an inventory of brownfields, detailing ownership, environmental conditions, and potential uses. 2. **Visualizing**: Gathering community and stakeholder input through public sessions and design competitions. 3. **Decision Making and Financing**: Evaluating economic and social impacts, feasibility, costs, benefits, and funding sources for redevelopment proposals. 4. **Evaluating**: Collecting feedback and adjusting strategies based on ongoing monitoring and community input (Ippolitoi et al., 2023). This project aims to complete phase one of the four phase system by creating a brownfield index for Melbourne which can be further analysed down the line by relevant stakeholders.

Methodology

The method integrates multiple socio-economic and spatial datasets using GIS techniques to identify and prioritise brownfield redevelopment sites. A classification index was created inspired by (Chrysochoou et al,. 2012) which was discussed in the aim and introduction section. Many of the datasets we have chosen were similar to the ones they used in their developed classification index. The index identifies what data influences potential sites for brownfield redevelopment. Table 1 shows the datasets used in the study and Table 2 shows the chosen classification Index. For the Classification index, a higher score indicates an industrial area more suitable for redevelopment.

Table 1: Datasets

Title	Intended Use	Format	Source/URL	Download Date
Urban Development Program - Industrial Land 2021	Identifies Industrial land across Metropolitan Melbourne. Land parcels are labelled as occupied, underutilised or vacant.	Shapefile	*https://datashare.maps.vic.gov.au/search?md=9fab1b03-63db-56e4-92b6-be9265548a89*	4/04/2024

Vicmap Planning - Planning Scheme Urban Growth Boundary Codelist	Indicates the long-term limits of urban development in Metropolitan Melbourne. All datasets are clipped to this boundary	Shapefile	*https://datashare.maps.vic.gov.au/search?md=e636d731-52ca-595f-a596-e926f1e09bdc*>	18/04/2024
Vicmap Transport - Railway Line	Identifies Railways and Tramways across Metropolitan Melbourne to see if Brownfield land is accessible by public transport.	Shapefile	*https://discover.data.vic.gov.au/dataset/vicmap-transport-railway-line*>	4/04/2024
Principal Public Transport Network (PPTN) Point Elements	This dataset represents all train stations across metropolitan Melbourne. development is encouraged close to train stations to support more diverse and dense development.	Shapefile	*https://discover.data.vic.gov.au/dataset/principal-public-transport-network-pptn-point-elements*	4/04/2024
Melbourne Industrial and Commercial Land Use Plan Commercial - Existing	Identifies existing Commercial land uses across Metropolitan Melbourne. Land can be separated by significance. (Central, State, Regional and Local Importance) Central, State and Regional lands are displayed to see which brownfield sites are close to commercial areas.	Shapefile	*https://discover.data.vic.gov.au/dataset/melbourne-industrial-and-commercial-land-use-plan-commercial-existing*>	17/04/2024
Public Open Space - Walkable 400m Catchments	Identifies areas in Metropolitan Melbourne that are within 400m of Public Open Space.	Shapefile	*https://discover.data.vic.gov.au/dataset/public-open-space-400m-walkable-catchment*	17/04/2024
EPA Victoria Priority Sites Register (PSR) - Location Polygons	PSR identifies sites where contamination of land and or groundwater is present. These sites present an unacceptable risk to human health or the environment and would require active management to reduce the risk to human health and the environment.	Shapefile	*https://discover.data.vic.gov.au/dataset/epa-victoria-priority-sites-register-psr-location-polygons*	17/04/2024

EPA Victoria Preliminary Risk Screen Assessments(PRSA) - Location Polygons	PRSA identify sites with potential contamination and determine whether a full environmental audit is needed. While not as severe as sites on the PSR, these sites still have identified risks and may require further investigation and remediation, posing challenges to redevelopment.	Shapefile	<*https://discover.data.vic.gov.au/dataset/epa-victoria-preliminary-risk-screen-assessmentsprsa-location-polygons*	27/05/2024
EPA Victoria Environmental Audit Reports - Location Polygons	EPA Audit Reports identify sites that have undergone environmental audits and may have been issued statements of contamination or suitability for use. Sites requiring an audit are often those with known or suspected contamination issues.	Shapefile	*https://discover.data.vic.gov.au/dataset/epa-victoria-environmental-audit-reports-location-polygons1*>	27/05/2024
Mesh Blocks	Mesh Blocks are the smallest geographic areas defined by the Australian Bureau of Statistics (ABS) and serve as the foundational building blocks for larger regions in the Australian Statistical Geography Standard (ASGS). They identify broad land uses such as residential, commercial, and primary production areas. There are 368,286 Mesh Blocks across Australia.	CSV	*https://www.abs.gov.au/statistics/standards/australian-statistical-geography-standard-asgs-edition-3/jul2021-jun2026/main-structure-and-greater-capital-city-statistical-areas/mesh-blocks*	
Statistical Area Level 1	Statistical Areas Level 1 (SA1s) are the smallest geographic areas used in the Australian Statistical Geography Standard (ASGS) to maximize geographic detail for Census of Population and Housing data. They are designed to cover the whole of Australia without gaps or overlaps, each typically containing a population of 200 to 800 people.	CSV	*https://www.abs.gov.au/statistics/standards/australian-statistical-geography-standard-asgs-edition-3/jul2021-jun2026/main-structure-and-greater-capital-city-statistical-areas/statistical-area-level-1*	

Table 2: Classification Index

Dataset	Classification Index	Classification Explanation
Population Density	Population Density 196.55 - 397.662 (1 Point) 397.663 - 519.68 (2 Points) 519.681 - 593.711 (3 Points) 593.712 - 638.627 (4 Points) 638.628 - 665.878 (5 Points) 665.879 - 710.793 (6 Points) 710.794 - 784.824 (7 Points) 784.825 - 906.842 (8 Points) 906.843 - 1,107.954 (9 Points) 1,107.955 - 1,439.43 (10 Points)	Higher Population densities often indicate areas with existing infrastructure, greater economic benefits, and a ready market for commercial development hence a higher score for areas with higher population.
Unemployment	VALUE 0 - 1.2 (1 point) 1.201 - 1.973 (2 points) 1.974 - 2.471 (3 points) 2.472 - 2.792 (4 points) 2.793 - 3.29 (5 points) 3.291 - 4.063 (6 points) 4.064 - 5.263 (7 points) 5.264 - 7.126 (8 points) 7.127 - 10.017 (9 points) 10.018 - 14.506 (10 points)	Higher Unemployment rates suggest areas that need economic revitalisation and job creation hence higher points for areas of high unemployment.
Personal Income	VALUE -3.216 - 69.99 (1 point) 69.991 - 105.639 (2 points) 105.64 - 178.845 (3 points) 178.846 - 329.176 (4 points) 329.177 - 637.884 (5 points) 637.885 - 1,271.823 (6 points) 1,271.824 - 2,573.634 (7 points) 2,573.635 - 5,246.933 (8 points) 5,246.934 - 10,736.622 (9 points) 10,736.623 - 22,009.834 (10 points)	Higher personal income areas are more likely to attract investment and can afford higher redevelopment costs hence higher points for areas with higher personal incomes.
Public Open Space - Walkable 400m Catchments	400m Walkable Catchment (10 points)	Areas with walkable open space are more attractive for redevelopment as they offer amenities to enhance the quality of life hence their inclusion in the index.
Melbourne Industrial and Commercial Land Use Plan Commercial - Existing	400m Walkable Catchment (10 points)	Proximity to commercial land use areas is beneficial for re-development due to aggregation of other commercial areas hence there inclusion in the index.

Tram Stops	400m Catchment (5 Points)	Proximity to tram stops enhances accessibility. The time to walk 400m is approximately 5 minutes. The score for trams are not as high as accessibility to train stations due to slower travel times and less capacity that travel via train.
Train Stations	400m Catchment (10 Points) 800m Catchment (5 Points)	Train station proximity is highly valuable for redevelopment projects due to enhanced accessibility and connectivity. The time to walk 400m is approximately 5 minutes while 800m is approximately 10 minutes. 5 minutes of access is scored 10 points while 10 minute walk is scored for 5 points.
EPA Victoria Priority Sites Register (PSR)	PSR site (0 points) Not a PSR site (20 Points)	PSR sites are areas where contamination of land and or groundwater presents an unacceptable risk to human health or the environment. These sites required active management and compliance with notices to mitigate risks. For a site to be PSR site it would be a significant hindrance to its redevelopment potential hence the high score of 20 points for each site that isn't a PSR site
EPA Victoria Environmental Audit Reports	Audit Report Site (0 Points) Not a Audit Site (15 Points)	EPA Audit Report sites include sites that have undergone environmental audits and may have issued statements of contamination or suitability for use. Sites requiring an audit are often those with known or suspected contamination issues. The audit is required to investigate potential issues.
EPA Victoria Preliminary Risk Screen Assessments (PRSA)	PRSA Site (0 Points) Not a PRSA site (10 Points)	PRSA identify sites with potential contamination and determine whether a full environmental audit is needed. While not as severe as sites on the PSR, these sites still have identified risks that may require further investigation.

Method:

The process for determining the most suitable areas for redevelopment involves several key steps, ensuring a comprehensive analysis that accounts for both social, economic and environmental factors. ArcGIS is utilised in this project to create the brownfield classification index. The main dataset used in the report Industrial Land 2021 layer shows all industrial Land in Melbourne and whether it is occupied, underutilised or vacant. For this study, underutilised land will be classified as occupied land as there are only small pockets of underutilised land in the peri-urban fringe. The method aims to see which areas of Industrial land would be suitable for brownfield redevelopment.

Key factors contributing to high scores include population density, as areas with higher population density are attractive for redevelopment due to existing infrastructure and a ready market for commercial development. Higher unemployment rates also contribute, indicating a need for economic revitalisation and job creation, making these areas suitable for redevelopment. Additionally, areas with higher personal incomes can attract investment and afford higher redevelopment costs. Proximity to amenities, such as public open spaces, commercial areas, tram stops, and train stations, enhances quality of life and accessibility, making these sites more desirable. Lastly, environmental safety plays a crucial role, with sites not listed as EPA priority or audit sites scoring higher due to fewer contamination risks.

Figure 1: GIS Method

Kriging (interpolation) is applied to datasets such as unemployment, personal income, and population density to create continuous surface rasters from point data. Kriging models are valuable when data are spatially correlated and offer several advantages over traditional interpolation techniques like inverse distance weighting or nearest neighbour. These advantages include providing a measure of uncertainty (kriging variance), accounting for direction-dependent relationships (spatial anisotropy), assigning weights based on spatial correlation rather than analyst assumptions, allowing predictions beyond the range of observations, and combining data measured over different spatial supports, enabling downscaling or upscaling (Goovaets 2019).

These rasters are then clipped to local government areas within Melbourne's metropolitan area and reclassified based on defined value ranges shown in Table 2, resulting in reclassified rasters. For vector data, polygon to raster conversion transforms vector data (for walkable catchments and commercial land use into raster format, generating raster datasets. Buffer zones are created around train stations and tram stops (400m and 800m), and then converted to raster format. These rasters are then reclassified using the values shown in Table 2 producing reclassified rasters for walkable catchments, commercial land use, and public transportation. Additionally, datasets from EPA Victoria are incorporated: the Priority Sites Register (PSR), Environmental Audit Reports, and Preliminary Risk Screen Assessments (PRSA). These layers are also converted into raster format and their value is shown in Table 2. All reclassified rasters are combined using a raster calculator to create a composite raster layer indicating suitable areas for redevelopment, considering multiple factors including unemployment, income, density, accessibility to open spaces, proximity to commercial areas and public transport, and contamination risk. This composite raster layer is further refined by extracting areas based on the industrial occupancy status (occupied, vacant) resulting in three classification indices indicating different types of suitable areas for redevelopment (Occupation Index), (Vacancy Index). By creating this map further analysis can be conducted to identify particular sites that could be redeveloped for commercial uses.

Raster Calculator:

The following is the code written into the raster calculator to create the final raster map incorporating all elements

```
Con(IsNull("Reclass_Tram800"), 0, "Reclass_Tram800") +
Con(IsNull("Reclass_trainv3400m"), 0, "Reclass_trainv3400m") +
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Con(IsNull("Reclass_PSR_1"), 0, "Reclass_PSR_1") +
Con(IsNull("Reclassify_Open_Space"), 0, "Reclassify_Open_Space") +
Con(IsNull("Reclass_Commercial"), 0, "Reclass_Commercial") +
Con(IsNull("PopDenseReclassified"), 0, "PopDenseReclassified")
```

- Each Con(IsNull("LayerName"), 0, "LayerName") statement checks if the cell in the specified raster layer is NULL.
- If the cell is NULL, it assigns a value of 0.
- If the cell is not NULL, it uses the cell's value classified in raster. E.g. areas 400m train a train station 10 points areas not within 400m 0 points.

Results

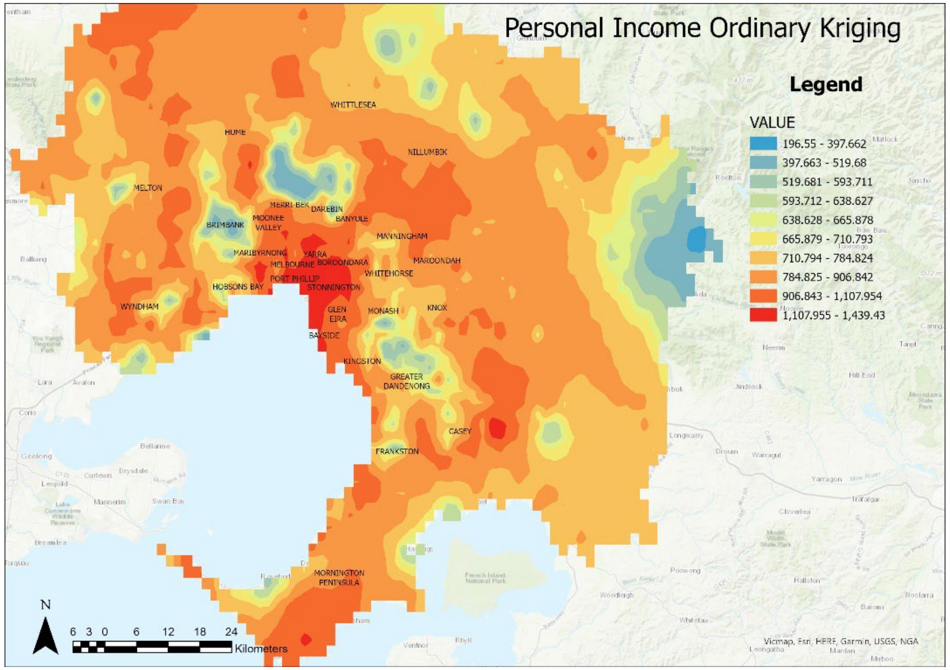

Figure 2: Personal Income using Ordinary Kriging

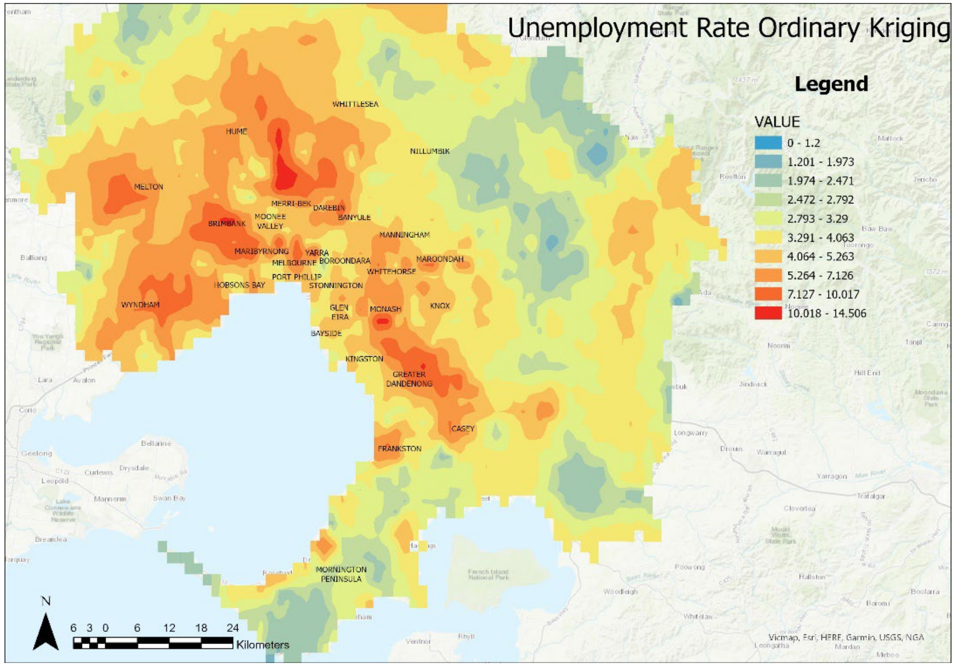

Figure 3: Unemployment Rate using Ordinary Kriging

Figure 2 shows high-income areas are concentrated in the central and inner suburbs towards the East and South of Melbourne CBD including LGA's of Melbourne, Yarra, Boroondara and Stonnington. Moderate to high-income areas extend further out to the middle suburbs while low-income areas are found in the outer suburbs. This distribution suggests higher incomes closer to the city centre and lower incomes in the outer suburbs. This suggests that any industrial sites located close to the CBD would be areas suitable for redevelopment.

Figure 3 shows high unemployment areas are primarily located in the North and Western LGA’s such as Hume, Melton and Brimbank with pockets of high unemployment also found around Monash and Greater Dandenong to the Southeast. Low Unemployment is mainly featured in central and inner suburbia in LGA’s such as Melbourne and Yarra. The map illustrates how unemployment rates are higher in the northern and western suburbs, gradually decreasing towards the central, southern, and eastern parts of Melbourne. Development targeting these regions with high unemployment could encourage.

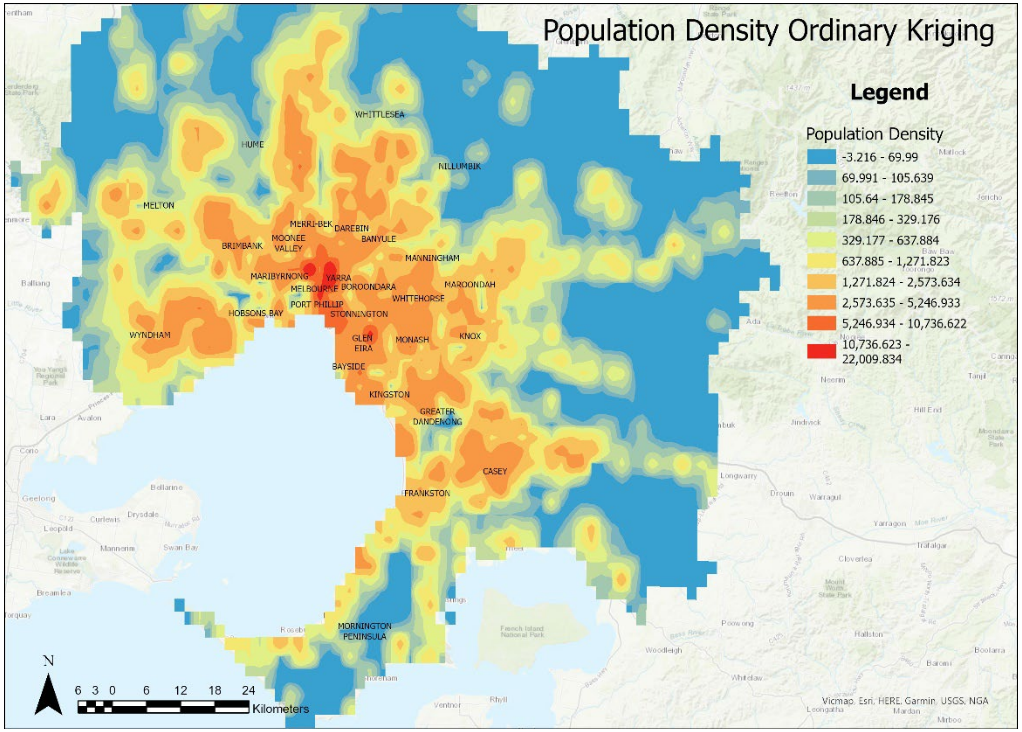

Figure 3: Population Density using Ordinary Kriging

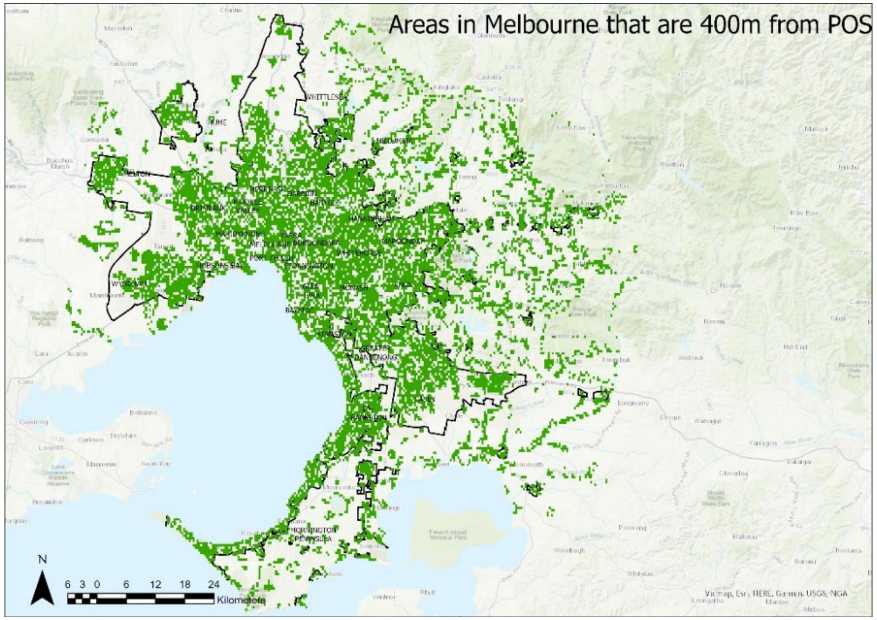

Figure 5: Areas in Melbourne 400m within POS

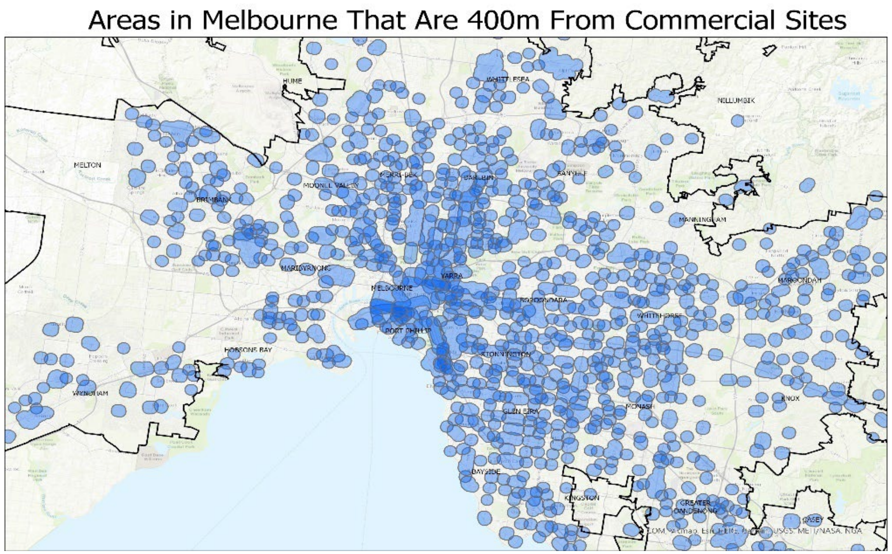

Figure 6: Areas in Melbourne that are 400m from Commercial Sites

Figure 4 shows that high population densities are concentrated in the Melbourne CBD and its surrounding areas. Moderate to high-density areas extend into the middle suburbs and low-density areas are in the outer suburbs and rural fringe areas. Areas closer to the CBD would be more suitable for redevelopment to reach more population.

Areas in Melbourne that feature POS and commercial sites within 400m are high indicating that many sites across Melbourne would be suitable for redevelopment when meeting these requirements. This is shown in Figure 5 and Figure 6.

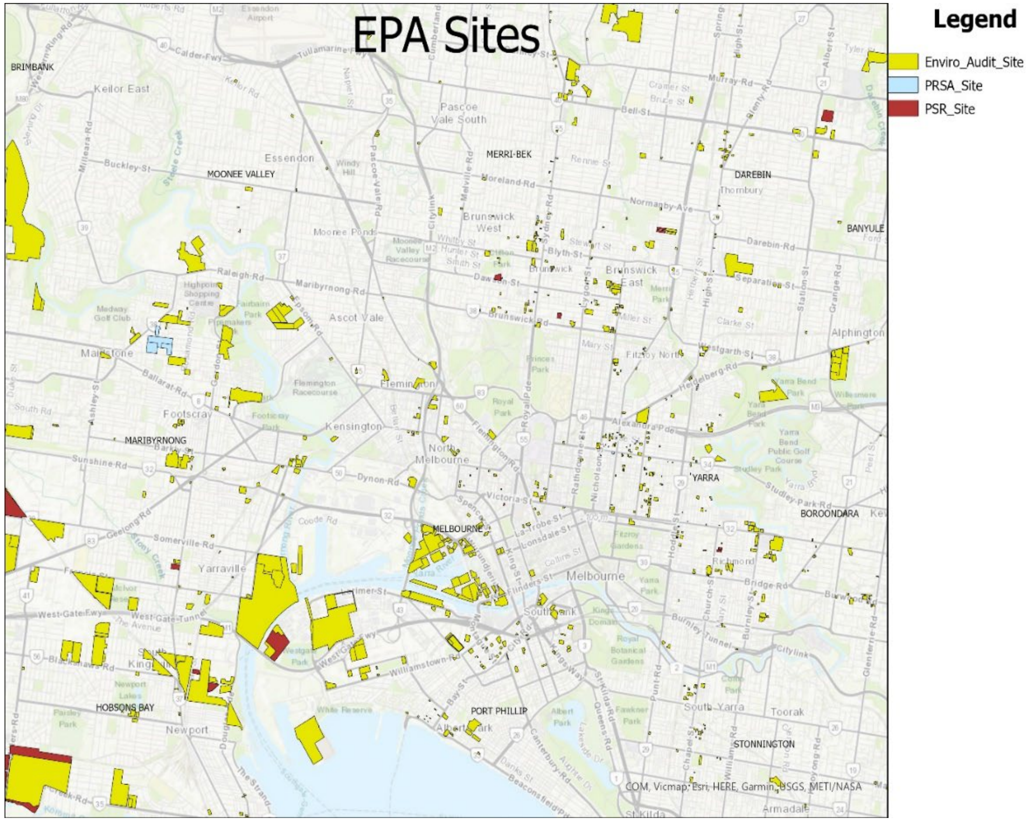

Figure 7: EPA Sites in Melbourne

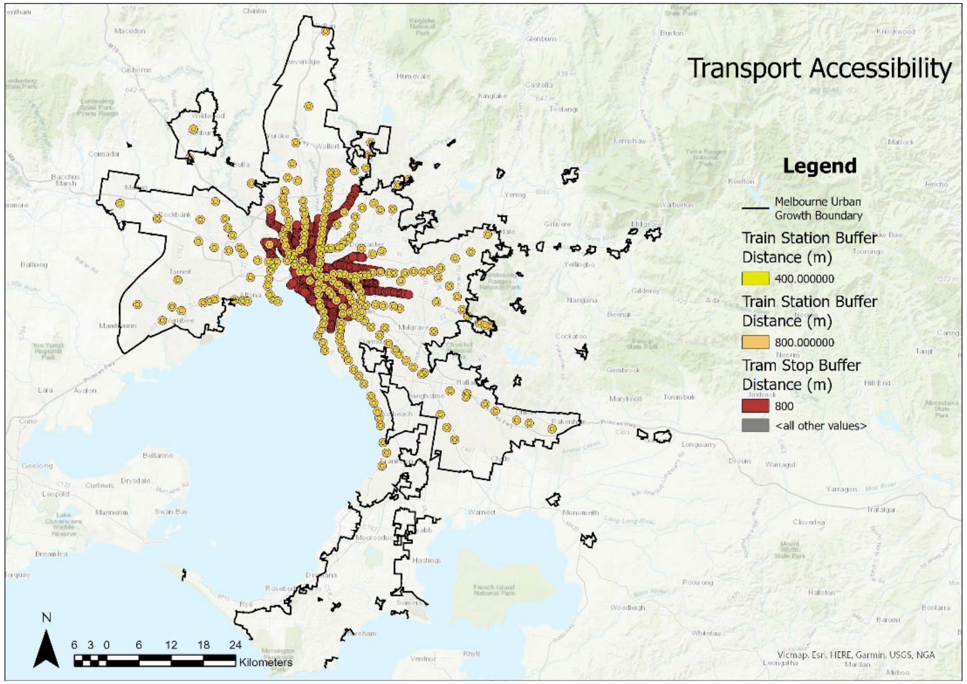

Figure 8: Transport Accessibility In Melbourne

Figure 7 shows that Central Melbourne has a high concentration of EPA sites, particularly numerous environmental audit sites. The western suburbs, including Maribyrnong and Footscray, also feature several EPA sites, reflecting the region's industrial activity and the need for environmental oversight if redevelopment was to take place. Northern suburbs like Moonee Valley, Merri Bek, and Darebin, along with eastern suburbs such as Yarra and Boroondara, show scattered EPA sites. This distribution pattern suggests that areas with higher industrial activities, historical contamination, or greater population density necessitate more rigorous environmental audits and monitoring efforts. In terms of transport accessibility shown in Figure 8, Central Melbourne and its inner suburbia show high transport accessibility with both train and tram access. Outer Suburbia does feature some access to train stations however it doesn't have the same accessibility as inner and centre Melbourne.

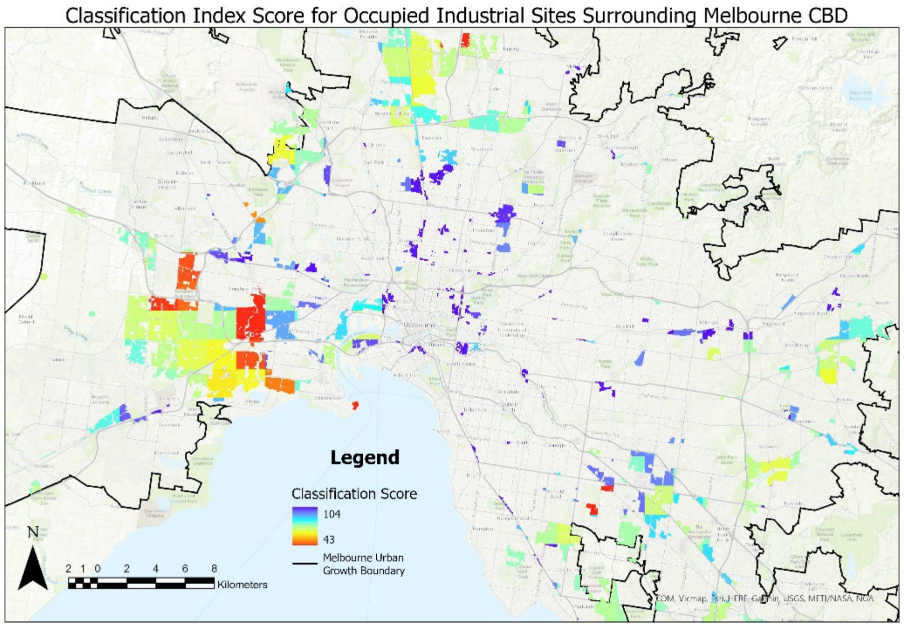

Figure 9: Classification Index Score for Occupied Industrial Sites

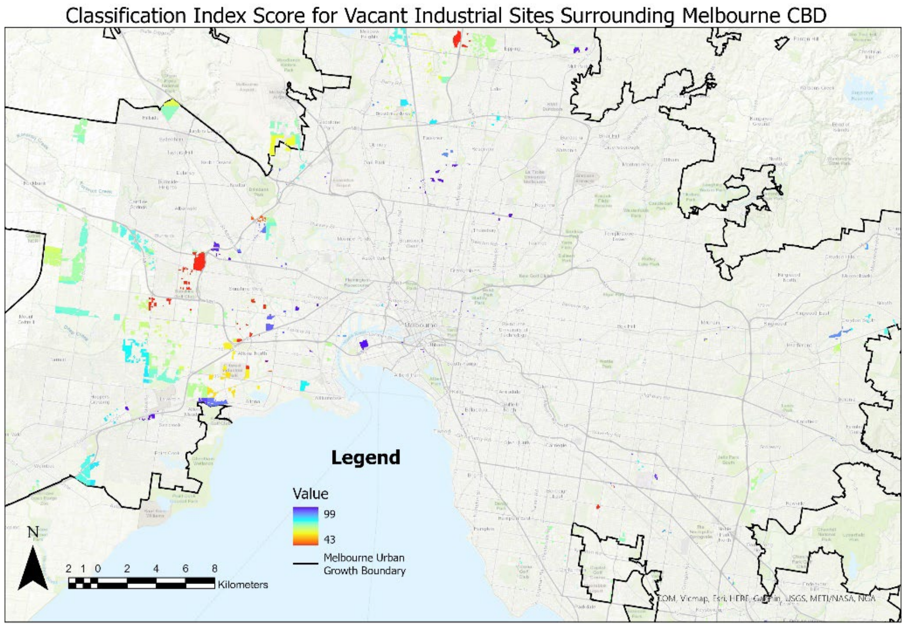

Figure 10: Classification Index score for Vacant Industrial Sties

Classification Index Maps.

The following maps (Figure 9 and Figure 10) are created by combing all layers via the raster calculator tool in ArcGIS to score them from the highest score possible of 115. Industrial areas that have high-scoring areas (blue and green) are primarily located in the central and eastern suburbs of Melbourne which show greater potential for redevelopment due to high population density, economic revitalisation needs, and good access to transport and amenities. However eastern Melbourne does only show industrial sites that are occupied and not vacant. Low-scoring areas (red and orange) are mainly in the western and northern suburbs and outskirts, with less need for redevelopment and more environmental risks or infrastructure challenges. There is a trend that higher scores exist around the CBD and inner suburbs. This is due to higher transport accessibility and favourable demographic conditions. However, some sites in the urban fringe do score higher perhaps due to favourite EPA conditions and accessibility to train stations. The next section of the report will identify areas of interest and sites across Melbourne that have vacant industrial areas and high scores via the classification index.

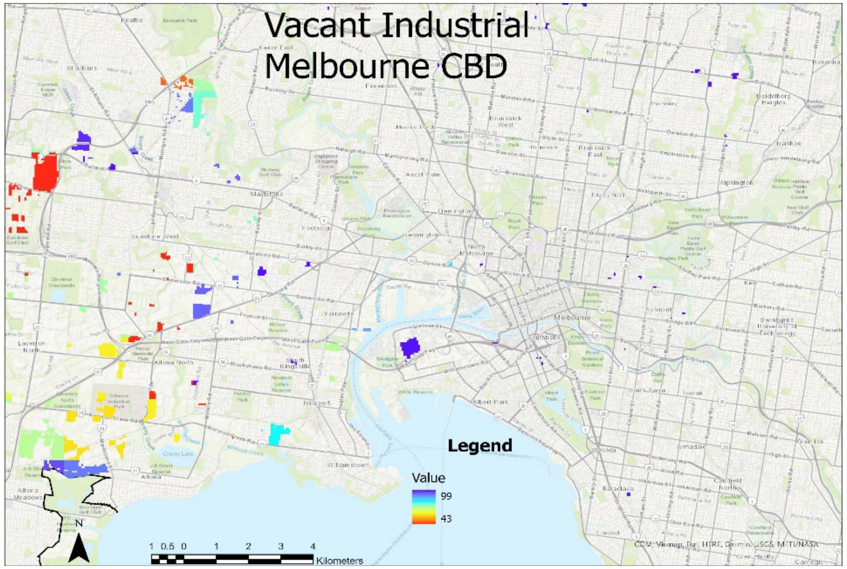

Figure 11: Vacant Industrial Sites surrounding Melbourne CBD

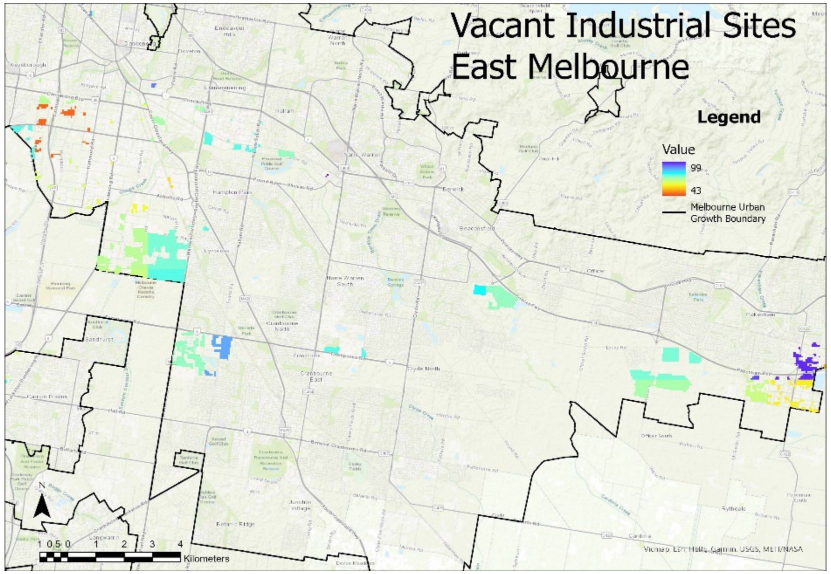

Figure 12: Vacant Industrial Sites towards the East of Melbourne

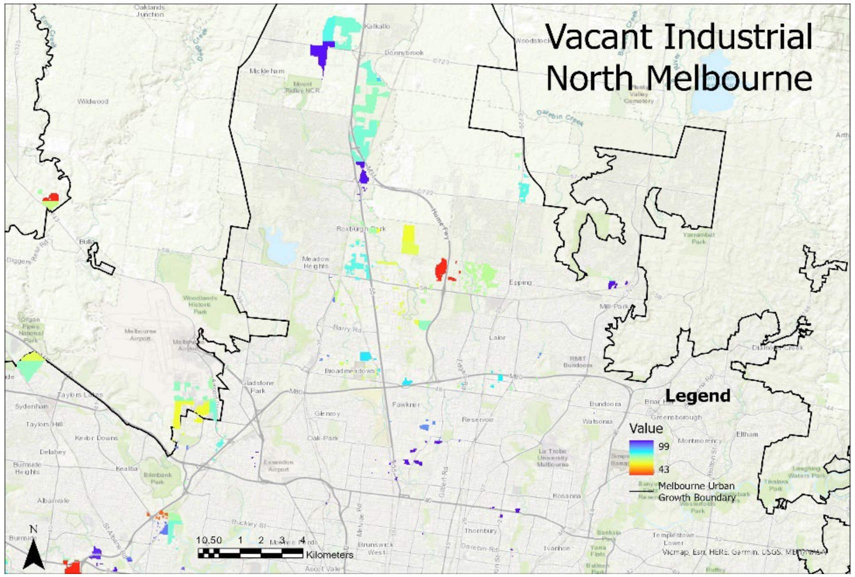

Figure 13: Vacant Industrial Sites towards the North of Melbourne

The first area of interest is surrounding Melbourne's CBD. From the map, there are sites of interest in Docklands, The Western Suburbs of Yarraville, Footscray as well as a pocked of vacant sites in Brunswick and North Melbourne. Towards the very East of Melbourne Metropolitan, there are sites of interest located in Pakenham and Cranbourne that have scored highly in the index that could benefits from redevelopment. Looking at sites towards the North of Melbourne there are sites of interest in Coburg North and Fawkner that could benefit from redevelopment as well as large number of sites in Craigieburn and Roxburgh Park that are currently sitting vacant that have scored highly on the Index

Site Analysis

Figure 14: 79 Stephenson St, South Kingsville VIC 3015

Figure 15: Google Earth image of South Kingsville Place

One site that achieved a high score in the 90s is a vacant lot in South Kingsville (Figure 14) , located west of Melbourne. This site is currently being redeveloped into South Kingsville Place, which will feature numerous sustainable, modern homes. Although the lot is no longer vacant, its redevelopment demonstrates the effectiveness of the index, as it accurately identified the site's potential for redevelopment.

Figure 16: 88-90 Laurens St, North Melbourne VIC 3003

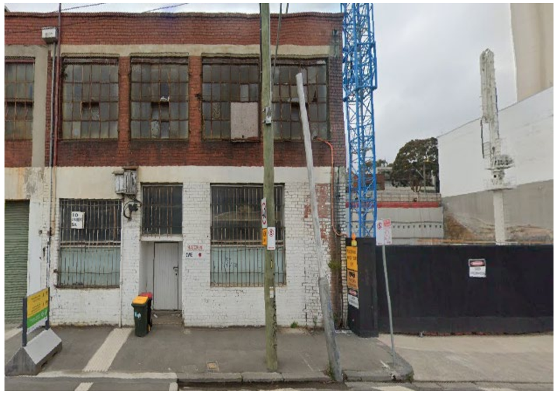

Figure 17: 88-90 Laurens St.

Figure 16 shows one site in North Melbourne that achieved a high score in the 90s that would be a suitable spot for redevelopment. The site is located next to the proposed Adren Street metro station. Looking at Figure17 Part of the site seems to be undergoing redevelopment while another building is available for redevelopment.

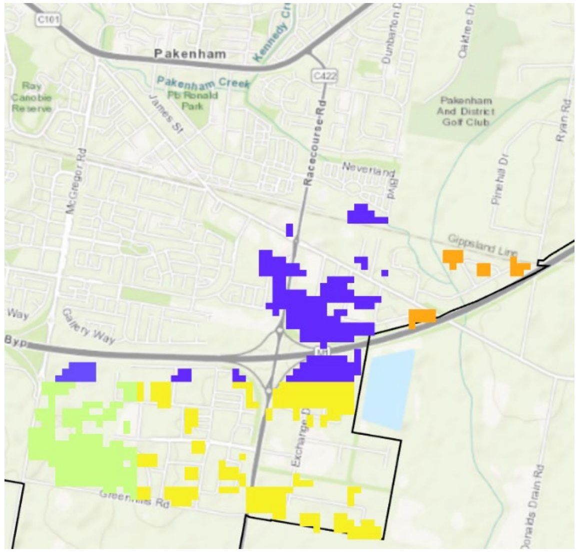

Figure 18: Vacant Sites in Pakenam

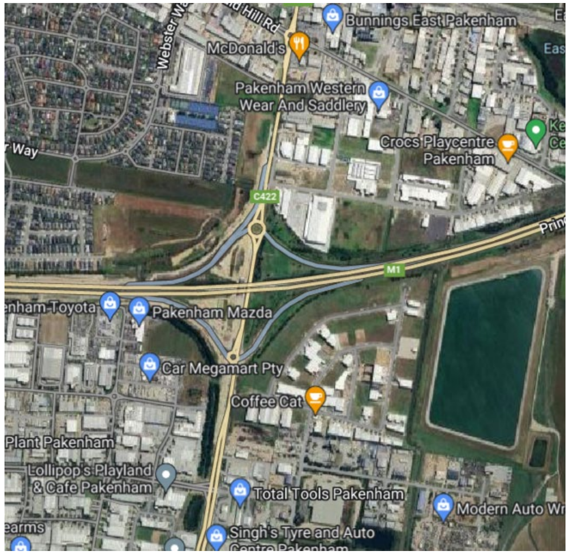

Figure 19: Google Earth image of Pakenam

Figure 18shows some areas in Pakenham scoring highly on the index with scores of 90, the current map reveals challenges in identifying suitable development areas. This difficulty arises due to the concentration of local industrial areas within the region and potential inaccuracies in the industrial dataset, which may fail to distinguish between vacant and utilized blocks. Consequently, most sites appear to be in use. Further refinement of the classification index may be necessary to assign lower scores to areas with a high concentration of industrial activity compared to other sites.

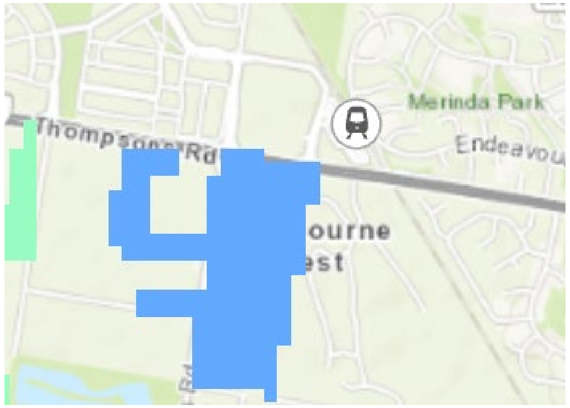

Figure 20: Vacant Sites in Cranbourne East

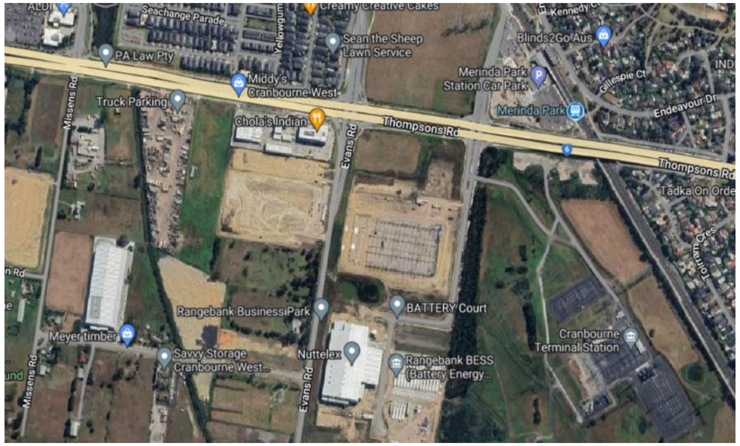

Figure 21: Google Earth image of Vacant Sites in Cranbourne East

Looking at Figures 20 and 21 we can see that the industrial sites in Cranbourne East would be suited for redevelopment. Currently vacant the site scores highly due it its accessibility to Merinda Park train station. The site could benefit from mixed-use development featuring residential and commercial development at mid to high densities.

Discussion

The results of the brownfield classification index reveal that the highest-scoring areas for redevelopment are predominantly located in the central, inner west, inner north suburbs of Melbourne. The inner East of Melbourne also scored well however there are limited sites available for redevelopment. These sites show high potential for redevelopment due to their high population density, economic revitalization needs, and excellent transport accessibility. The high scores in these areas indicate a significant opportunity for transforming underutilised industrial sites into vibrant, sustainable urban spaces. Some sites in the outer suburbs would also be beneficial for redevelopment. The ones that score high are accessible to train networks such as Cranbourne. Likewise, these areas feature access to public open space and have positive scores via the EPA audit sites. Low-scoring areas are primarily found in the outer western and northern suburbs. These regions face more challenges due to lower population density, fewer transport links, and greater environmental risks via the EPA audit.

The findings underscore the importance of strategic urban planning in brownfield redevelopment. High-scoring areas near the CBD and inner suburbs present prime opportunities for creating walkable neighbourhoods, enhancing public transportation, and boosting local markets. Redeveloping these sites can lead to increased property values, improved quality of life, and a broader tax base for the city. The index also highlights the need to address environmental concerns, particularly in areas with high industrial activity. One of the major challenges with brownfield redevelopment is the uncertainty surrounding the costs and time needed for site investigations and cleanup activities. Furthermore, prioritising brownfields for investigation, remediation, and redevelopment should heavily consider the risks to human health and the environment (Song et al,. 2022).

Limitations

The classification index provides useful information but has some limitations. First, the data might not be entirely accurate, especially when distinguishing between vacant and utilised industrial areas. Secondly, the grouping of industrial areas could skew results, leading to high scores in regions with significant industrial activity, which might not be suitable for commercial or residential redevelopment. Incorporating a land use layer into the classification index could help, assign higher scores to areas near residential and commercial uses and lower scores to those near industrial uses. Lastly, the data doesn't reflect recent changes or new developments, so it needs regular updates to remain relevant and accurate.

Another limitation of the classification index is the inability to determine the exact score for each location due to the map being in raster format. Additionally, the final raster layout does not reveal how each layer contributed to the score, such as whether a location received points for high population density or if it was classified as an audit site by the EPA. To obtain this information, one would need to use ArcGIS and examine each layer for the specific location.

Conclusion

The brownfield classification index developed in this project provides a valuable tool for identifying suitable sites for redevelopment across Melbourne. By leveraging GIS techniques and integrating socio-economic and environmental factors, the index offers a comprehensive assessment of redevelopment potential. The insights gained from this study can inform urban planning decisions, promote sustainable development, and enhance the quality of life in Melbourne's metropolitan area.

References

Chrysochoou, M. *et al.* (2012) 'A GIS and indexing scheme to screen brownfields for area-wide redevelopment planning', *Landscape and Urban Planning*, 105(3), pp. 187–198. doi:10.1016/j.landurbplan.2011.12.010.

Goovaerts, P. (2019) 'Kriging interpolation', *Geographic Information Science & Technology Body of Knowledge*, 2019(Q4). doi:10.22224/gistbok/2019.4.4.

Ippolito, A. *et al.* (2023) 'A GIS referenced methodological approach for the Brownfield redevelopment', *Computational Science and Its Applications – ICCSA 2023 Workshops*, pp. 461–474. doi:10.1007/978-3-031-37120-2_30.

Song, Y. *et al.* (2022) 'Identifying urban candidate brownfield sites using multi-source data: The case of Changchun City, China', *Land Use Policy*, 117, p. 106084. doi:10.1016/j.landusepol.2022.106084.

Wang, Q., Marc Kilgour, D. and Hipel, K.W. (2014) 'Numerical methods to calculate fuzzy boundaries for brownfield redevelopment negotiations', *Group Decision and Negotiation*, 24(3), pp. 515–536. doi:10.1007/s10726-014-9417-3.

Project Journal

Week 1-4: Initial Planning and Data Collection

Tasks Done:

- Defined project objectives and goals.
- Started work on the GIS Proposal Document
- Develop a method for the Final GIS Proposal
- Identified key datasets required for the analysis, including industrial land, public open space, contamination, train stations and wetlands.
- Downloaded Local Government Area (LGA) polygons and census data.
- Joined census data to LGA polygons and performed initial demographic calculations.

Challenges:

- Ensuring the accuracy of data collected from various sources.
- Integrating multiple datasets into a coherent framework for analysis.
- Developing a thorough method for this project

Reflection:

- Early planning and clear definition of project goals were crucial in guiding the subsequent steps. The process of integrating census data with LGA polygons provided a solid foundation for more detailed analysis.

Week 4-8: Data Processing and Analysis

Tasks Done:

- Complete GIS Proposal
- Utilized the Feature to Raster tool for converting train stations, tram stops, public open spaces, and commercial areas to raster format.
- Added more datasets including tram stops and access to commercial sites.
- Performed interpolation of census data using various methods:
- IDW and Kersen Density for Unemployment (didn't work well)
- Kriging for Population Density, Unemployment, and Income (preferred)

Challenges:

- Handling the large volume of data in ArcGIS and ensuring computational efficiency.
- Converting vector data into raster format
- Addressing the limitations of different interpolation methods.

Reflection:

- Kriging emerged as the preferred interpolation method due to its ability to handle spatial correlations effectively by looking at error reports and visual interpretation

Week 8-10: Development of Classification Index

Tasks Done:

- Developed a classification index to show brownfield sites using inspiration from literature research
- Aimed to use interpolation methods in the classification index.
- Explored ways to utilise hot spot analysis for assessment.

Challenges:

- Determining the relevance and weight of each factor in the classification index. Each dataset was to be ranked from 0 through to 10.
- Figuring out how to utilise hot spot analysis in the report

Reflection:

- The creation of the classification index was a pivotal step in the project. It provided a structured approach to identifying and prioritising brownfield sites for redevelopment.

Week 10-11: Presentation Preparation

Tasks Done:

- Meeting with Gang-Jun to discuss how to potentially use hot spot analysis and how to merge the datasets into one classification index
- Re-evaluated census data to correct potential errors. From the meeting with Gang-Jun, I realised I was using the wrong census data and learned about using Mesh Blocks and Statistical Data 1 instead of downloading census data for each LGA in Melbourne
- Focused on developing the classification index and using interpolations methods as hot spot analysis was not necessary for this assessment
- Downloaded and integrated mesh block data for detailed population analysis.
- Researched how to develop the classification index using GIS with AI assistance and experimentation with many failed attempts before having a successful model
- Constructed the final classification index and completed all GIS operations in time for the presentation in week 11.

Challenges:

- Developing the classification index with no prior experience
- Unsure if enough learnt in tutorials have been applied to this project
- Using new and updated census data, starting again with much of the project
- Managing time effectively to meet project milestones.

Reflection:

- The use of mesh block data provided more detailed and accurate population information, enhancing the reliability of the classification index. Completing the GIS operations on time before the presentation was a significant achievement, reflecting good time management and planning.

Week 12-13 : Post-Presentation Improvements

Tasks Done:

- Complete the presentation. Gained valuable feedback from peers
- Identified ways to improve the classification index based on feedback from the presentation. Modified EPA layers from one to three based on suggestions from Byron, increasing their impact on the index. Originally only 1 EPA layer was used in the report
- Attempted to find other methods for network analysis suggested by Gang-Jun but found the buffer tool to be adequate.

Challenges:

- Incorporating feedback effectively while maintaining project scope.
- Balancing additional improvements with the remaining project timeline.

Reflection:

- Feedback from the presentation was invaluable in refining the classification index. The adjustments to the EPA layers made the index more accurate by removing sites in the index that featured contamination which may have originally scored high

Week 13-16: Final Report

Tasks Done:

- Completed the final report despite personal challenges such as illness.
- Reflected on the overall project, noting the successful development of the index and identifying areas for future improvement.
- Minimal changes to the GIS operations that were completed by week 11
- Wrote up the Final Report

Challenges:

- Overcoming personal health issues to complete the project on time.
- Ensuring the final report was comprehensive and accurately reflected the project's findings.

Reflection:

- The project demonstrated the importance of flexibility and resilience. Despite challenges, the project was completed successfully. Future projects could benefit from further refinement of interpolation methods and more frequent data updates and additional datasets into the classification index