CLIMATE RESILIENCE INDEX

MEASURING AND MAPPING THE SUSTAINABILITY AND VULNERABILITY OF MELBOURNE'S NEIGHBOURHOODS

Methodology Report
Tract Consultants x OneMap

ONEMAP

ACKNOWLEDGEMENT OF COUNTRY

We pay our respects to the Traditional Custodians of Country throughout Australia, their Elders and ancestors, recognising their rich heritage and enduring connection to Country and acknowledging the ongoing sovereignty of all Aboriginal and Torres Strait Islander Nations.

We recognise the profound connection to land, waters, sky and community of the First Nations peoples, with continuing cultures that are among the oldest in human history. We recognise that they are skilled land shapers and place makers, with a deep and rich knowledge of this land which they have cared for, protected and balanced for millennia.

Our Country, 2022
88 x 119 cm Acrylic on canvas
Original artwork by
Alfred Carter
Gunaikurnai

QUALITY ASSURANCE

Climate Resilience Index
Measuring and mapping the sustainability and vulnerability of Melbourne's neighbourhoods
Methodology Report

Revisions

No.	Date	Description	Prepared By	Reviewed By	Project Principal
00	04 October 2024	Methodology Report	AB, SD, & EA	MC, EM & LC	LC

A MESSAGE FROM

Georgina de Beaujeu
Climate and Biodiversity Strategist

Humanity has exceeded planetary boundaries.[1] To move back within safe operating zones, we urgently need to put society on a pathway to a "positive vision of a good quality of life in harmony with nature."[2]

To do this we need to transform our communities to live in balance with nature and embrace a diversity of climate mitigation and adaptation strategies.

Developing a shared understanding of the local impacts of climate change and biodiversity loss is a key step in enabling change. A shared understanding can lead to interventions being defined and collectively pursued.

The Climate Resilience Index (CRI) offers a publicly accessible, visual and comparative tool to foster this conversation within and between community, Government and the private sector.

Communities living in areas of relative disadvantage bear the brunt of climate change and biodiversity loss, such as deaths from extreme heat days, but often do not have the resources to advocate for change.

In addition, city liveability indexes seldom reflect the importance of human-nature connection and biodiversity to humanity's immediate health and long term survival. If more indexes integrated biodiversity, awareness of the benefits of investing in urban nature may be elevated.

The CRI starts to respond to these two key considerations by including structural connectivity of green spaces at suburb level.

We hope this tool enables you to discuss climate and biodiversity resilience with your community or organisation. We can only achieve real change by working together, so please let us know how we can evolve the Index to better enable this critical conversation.

Georgina de Beaujeu

Climate and Biodiversity Strategist

1   Richardson, K. et al. (2023). Earth Beyond Six of Nine Planetary Boundaries. Science Advances 9(37). DOI: 10.1126/sciadv.adh2458
2   Pörtner et al. (2021). IPBES-IPCC Co-sponsored Workshop Biodiversity and Climate Change Report, IPBES and IPCC. https://doi.org/10.5281/zenodo.4782538

CONTENTS

APPENDICES

ABBREVIATIONS

ABS	Australian Bureau of Statistics
GCCSA	Greater Capital City Statistical Area
MB	Mesh Block
SA1	Statistical Area
UCL	Urban Centres and Localities
UGB	Urban Growth Boundary

1   EXECUTIVE SUMMARY

AS THE IMPACTS OF THE CLIMATE CRISIS CONTINUE TO EVOLVE, HOW ARE MELBOURNE'S NEIGHBOURHOODS ADDRESSING SUSTAINABILITY, VULNERABILITY, AND RESILIENCE?

The 'Climate Resilience Index' developed by Tract, alongside our affiliate company One Map, is a new and innovative publicly available tool that evaluates the capacity of Melbourne's neighbourhoods to effectively address climate change. As planners and designers, Tract believes it is our responsibility to make use of our collective knowledge to support the creation of climate responsive and biodiversity positive neighbourhoods. Therefore, this project has been guided by Tract's internal Climate and Biodiversity Committee which involves investment in research to inform and enable our practitioners to engage in climate action.

Climate resilient neighbourhoods include qualities such as compactness with proximate access to services and infrastructure, low vulnerability to climate change impacts, and active support of biodiversity.

Therefore, the Index geospatially evaluates the determinants of Melbourne's urban environments that contribute to climate resilience, including its built and natural features, communicated via an online interactive map at various geographic scales. The four key indicators that contribute to the overall Index comprise amenities, transport and movement, environment and biodiversity, and hazard resilience. The Index seeks to support climate resilience neighbourhoods through providing a baseline of existing levels of climate resilience, that enables progress against key indicators to be measured into the future.

This summary report provides an overview of the project background and methodology including its scope, analysis scales, indicators, analysis techniques, weighting as well as key insights and capabilities.

We invite all practitioners and communities to explore the Climate Resilience Index and investigate ways to support climate and biodiversity positive neighbourhoods.

Explore the Climate Resilience Index

Climate Resilience Index

- 70 - 100
- 65 - 70
- 60 - 65
- 55 - 60
- 50 - 55
- 45 - 50
- 40 - 45
- 0 - 40
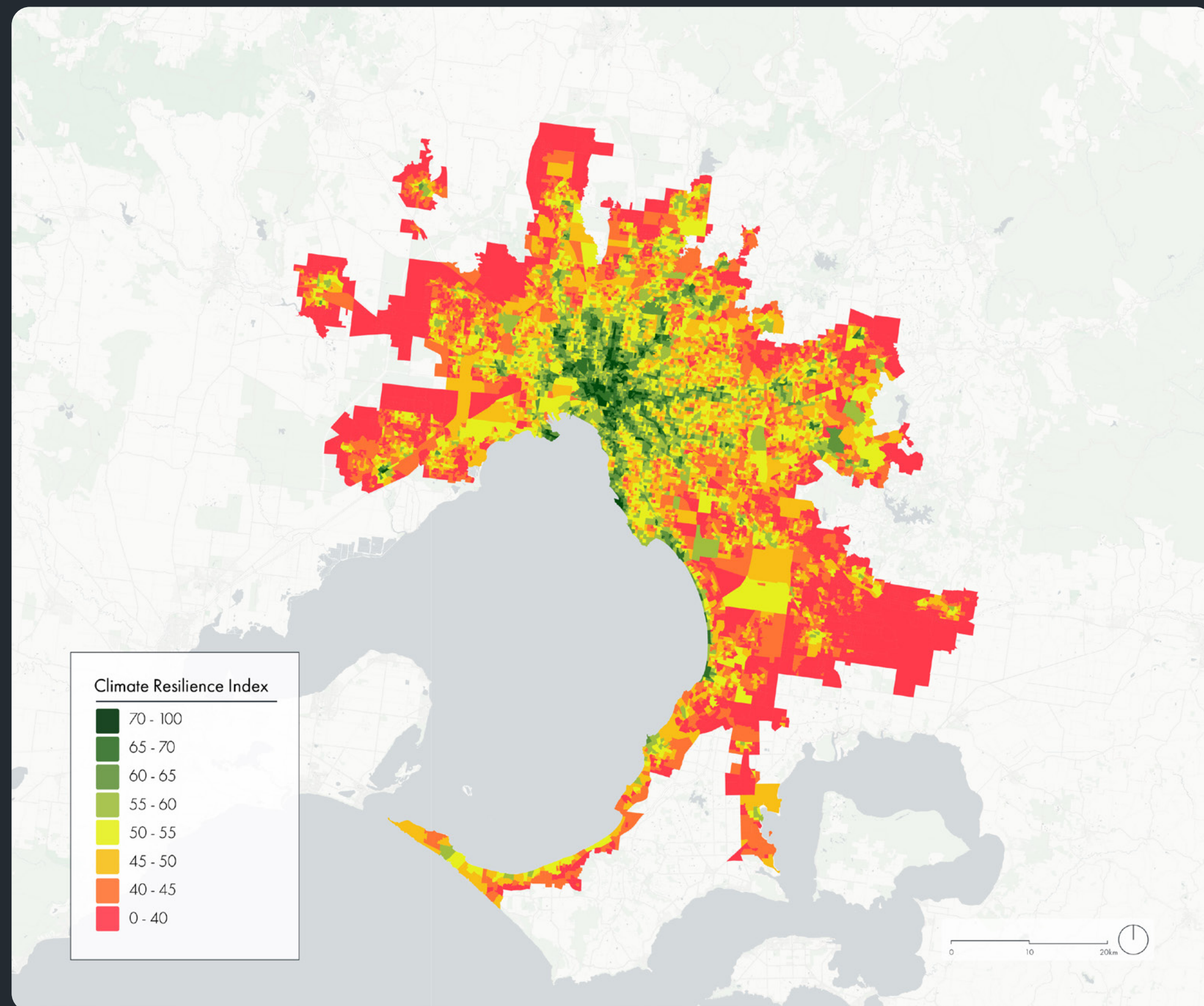
Figure 1.   Climate Resilience Index - Metropolitan Melbourne

Tract x OneMap   Climate Resilience Index - Methodology Report   04 October 2024   08 / 48   Tract x OneMap   Climate Resilience Index - Methodology Report   04 October 2024   09 / 48

2   LITERATURE REVIEW

OUR CITIES ARE FACED WITH VARIOUS COMPLEX URBAN CHALLENGES, THAT RAISE QUESTIONS ABOUT THE TYPE OF CITY WE WANT TO CREATE AND LIVE IN AS WELL AS THE EQUITY OF OUR URBAN SPACES.

These challenges range from increasing urban heat and consequential health impacts, to significant impacts on habitat and biodiversity due to urban expansion, as well as balancing housing growth and infrastructure demand to support compact living.

The literature reviewed as part of this research project identified key criteria and themes that contribute to climate resilient, biodiverse, sustainable and liveable cities.

Based on this review, a climate resilient neighbourhood is defined by the following key factors:

- Provision of services, amenities and economic opportunities in proximity to housing.
- High quality public transport as well as walking and cycling options.
- Quality green infrastructure including open space and an urban forest.
- Measures in place to adapt to climate hazards including extreme heat, flooding and bushfire.

It is noted that these key areas are considered to be central for the purpose of this study, as each relates to the practice of planning and design.

URBAN CLIMATE RESILIENCE

The theory of resilience is defined by the 'ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change.'[1]

In applying the theory of resilience to urban areas, the city is a complex social and ecological system that is faced with a multitude of potential disturbances. Specifically, climate change forms a key research area given the intersecting challenges that threaten to disrupt the functioning of cities.[2] This includes challenges such as flooding, urban heat, public health, environmental protection and infrastructure demand. Therefore, the city must be flexible and diverse, hold capacity under pressure, and have allowance for 'sudden shocks' to respond to a range of climate scenarios.[3]

Urban climate resilience is understood as the resourcefulness of a city to address its functional needs (climate mitigation) as well as its response to climate risks (climate adaptation).

[1] Intergovernmental Panel on Climate Change (IPCC). (2007). Climate Change 2007 – Synthesis Report. https://www.ipcc.ch/site/assets/uploads/2018/02/ar4_syr_full_report.pdf
[2] Li Kong, X. M. & Guangwen Hu, Z. Z. (2022). The application of resilience theory in urban development: a literature review. Environmental Science and Pollution Research, 29, 49651-49671. https://doi.org/10.1007/s11356-022-20891-x
[3] Tyler, S. & Monech, M. (2012). A framework for Urban Climate Resilience. Climate and Development, 4(4), 311-326. http://dx.doi.org/10.1080/17565529.2012.745389

The key literature and resulting themes are outlined in the following section.

Literature	Outline	Themes

C40 Cities – Scaling Up Climate Action
 	
C40 Cities. (2024). Scaling Up Climate Action. https://www.c40.org/what-we-do/scaling-up-climate-action/
	Summary of high impact sectors of relevance to climate action in cities globally	• Adaptation and water
		• Air quality
		• Energy and buildings
		• Food systems
		• Transportation
		  • Prioritising public transport, walking and cycling
		• Ports and shipping
		• Urban planning and design
		  • Transit oriented development
		  • 15 minute cities
		• Waste management

Australian Urban Observatory – Liveability Index Australian Urban Observatory (AUO). (2023). What We Measure. https://auo.org.au/measure/	Composite score of measures related to aspects of liveability including Social Infrastructure, Walkability, Public Transport, Public Open Space, Housing Affordability, and Local Employment calculated for 21 Australian Cities	• Walkability comprises street connectivity, dwelling density and access to services (daily living destinations) • Transport comprises access, frequency and mode share. • Public open space includes the catchment to open space and size of the space. • Employment – percentage of employed persons living and working in the same Statistical Area 3.

Literature	Outline	Themes
Convention on Biological Diversity - Singapore Biodiversity Index Chan, L., Hillel, O., Werner, P., Holman, N., Coetzee, I., Galt, R., and Elmqvist, T. (2021). Handbook on the Singapore Index on Cities' Biodiversity (also known as the City Biodiversity Index). https://www.cbd.int/doc/publications/cbd-ts-98-en.pdf	Measure of urban biodiversity based on 28 indicators	• Proportion of natural areas in the city. • Connectivity measures or ecological networks to counter fragmentation. • Proportion of protected natural areas. • Climate regulation – benefits of trees and greenery. • Recreational services. • Health and wellbeing – proximity/accessibility to parks.

Using Open Data and Open-Source Software to Develop Spatial Indicators of Urban Design and Transport Features for Achieving Healthy and Sustainable Cities, 2022
 	
Boeing et al. (2022). Using open data and open-source software to develop spatial indicators of urban design and transport features for achieving healthy and sustainable cities. The Lancet Global Health. 10. 18. 10.1016/S2214-109X(22)00072-9.
	Provides spatial indicators for 25 diverse cities in 19 countries in relation to urban design and transport features that support health and sustainability.	• Daily living score (percentage of population with access):
		  • Healthy food market or supermarket within 500 metres.
		  • Convenience store.
		  • Public transport stop within 500 metres with regular service (less than 20 minutes and less than 30 minutes).
		  • Public open space including space more than 1.5 hectares within 500 metres.
		• Walkability:
		  • Population per square kilometre.
		  • Intersections per square kilometre.
		  • Daily living score (see above).

3 METHODOLOGY

3.1 GEOGRAPHIC SCOPE

The study aims to analyse the capacity for urban neighbourhoods to address climate change impacts in Melbourne. The geographic scope is broadly defined by the contiguous urban extent of Metropolitan Melbourne and key associated urban areas.

The designation of the Study Area boundary was informed by Census areas as defined by the Australian Bureau of Statistics (ABS) as well as strategic areas as defined by planning policy. Therefore, the following parameters were used as a basis for the Study Area boundary:

Locations within the Greater Capital City Statistical Area ('GCCSA') of Melbourne.

'GCCSAs are designed to represent the functional area of each of the eight State and Territory capital cities which includes populations who regularly socialise, shop or work within the city, but may live either in the city or in the small towns and rural areas surrounding the city.' [1]

Areas classified as Urban Centres and Localities (UCLs).

'Urban Centres and Localities (UCLs) represent areas of concentrated urban development. They are identified using dwelling and population density criteria and data from the 2021 Census of Population and Housing. Urban Centres and Localities (UCLs) are defined using Statistical Areas Level 1 (SA1s) that meet density and/or urban infrastructure criteria.' [2]

'Statistical Areas Level 1 (SA1s) are considered 'urban' if they meet one or more of the following criteria:

- The SA1 has an urban Mesh Block* population greater than or equal to 45% of the total SA1 population and a dwelling density greater than or equal to 45 dwellings per square (sq) kilometre (km).
- The SA1 has a population density greater than or equal to 100 persons per sq km and a dwelling density greater than or equal to 50 dwellings per sq km.
- The SA1 has a population density greater than or equal to 200 persons per sq km.' [2]

'Major Urban' and 'Other Urban' areas were included within the Study Area boundary. 'Bounded Localities' were excluded as these represent non-contiguous rural townships.

Areas within Metropolitan Melbourne including 31 municipalities (outlined below).

'Also known as Greater Melbourne, metropolitan Melbourne is the geographical area that defines Melbourne as a city and the capital of the state of Victoria.' [3]

Additional logical revisions have been made to the Study Area boundary in order to remove small portions of neighbourhoods that may not be representative of the broader suburb.

[1] Australian Bureau of Statistics. (ABS). (2021). Greater Capital City Statistical Areas. https://www.abs.gov.au/statistics/standards/australian-statistical-geography-standard-asgs-edition-3/jul2021-jun2026/main-structure-and-greater-capital-city-statistical-areas/greater-capital-city-statistical-areas
[2] ABS. (2022). Urban Centres and Localities. https://www.abs.gov.au/statistics/standards/australian-statistical-geography-standard-asgs-edition-3/jul2021-jun2026/significant-urban-areas-urban-centres-and-localities-section-state/urban-centres-and-localities
[3] Victoria State Government (2024). Metropolitan Melbourne. https://liveinmelbourne.vic.gov.au/discover/melbourne-victoria/metropolitan-melbourne

LOCAL GOVERNMENT AREAS

The study area includes locations within the following municipalities:

- Banyule
- Bayside
- Boroondara
- Brimbank
- Cardinia
- Casey
- Darebin
- Frankston
- Glen Eira
- Greater Dandenong
- Hobsons Bay

- Hume
- Kingston
- Knox
- Manningham
- Maribyrnong
- Maroondah
- Melbourne
- Melton
- Monash
- Moonee Valley
- Merri-bek

- Mornington Peninsula
- Nillumbik
- Port Phillip
- Stonnington
- Whitehorse
- Whittlesea
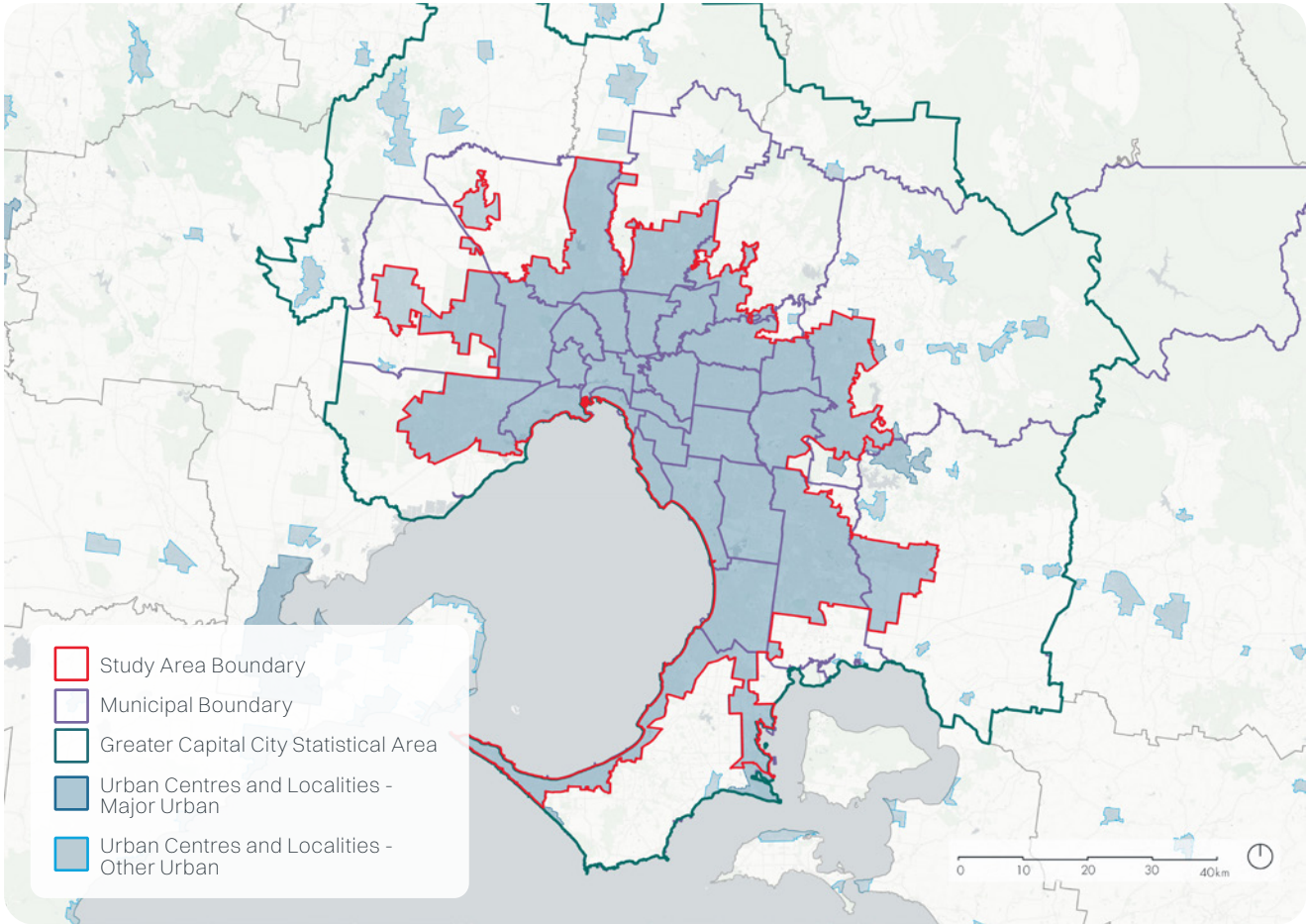- Wyndham
- Yarra
- Yarra Ranges

GEOGRAPHIC LIMITATIONS

Growth Areas

Suburbs currently undergoing development that are within the study area boundary defined above are retained in the analysis. It is noted that the results for these areas may be misleading as construction is not complete and a level of maturation has not been achieved. Notwithstanding, growth areas are retained within the final index output in order to provide a baseline for potential future assessment. Growth areas are indicated via a hatch in the final mapping output.

- Mambourin
- Truganina (Mt Atkinson)
- Weir Views
- Strathtulloh
- Thornhill Park
- Rockbank
- Aintree

- Deanside
- Bonnie Brook
- Fraser Rise
- Kalkallo
- Donnybrook
- Wollert
- Officer

- Officer South
- Clyde North
- Clyde
- Cardinia
- Junction Village
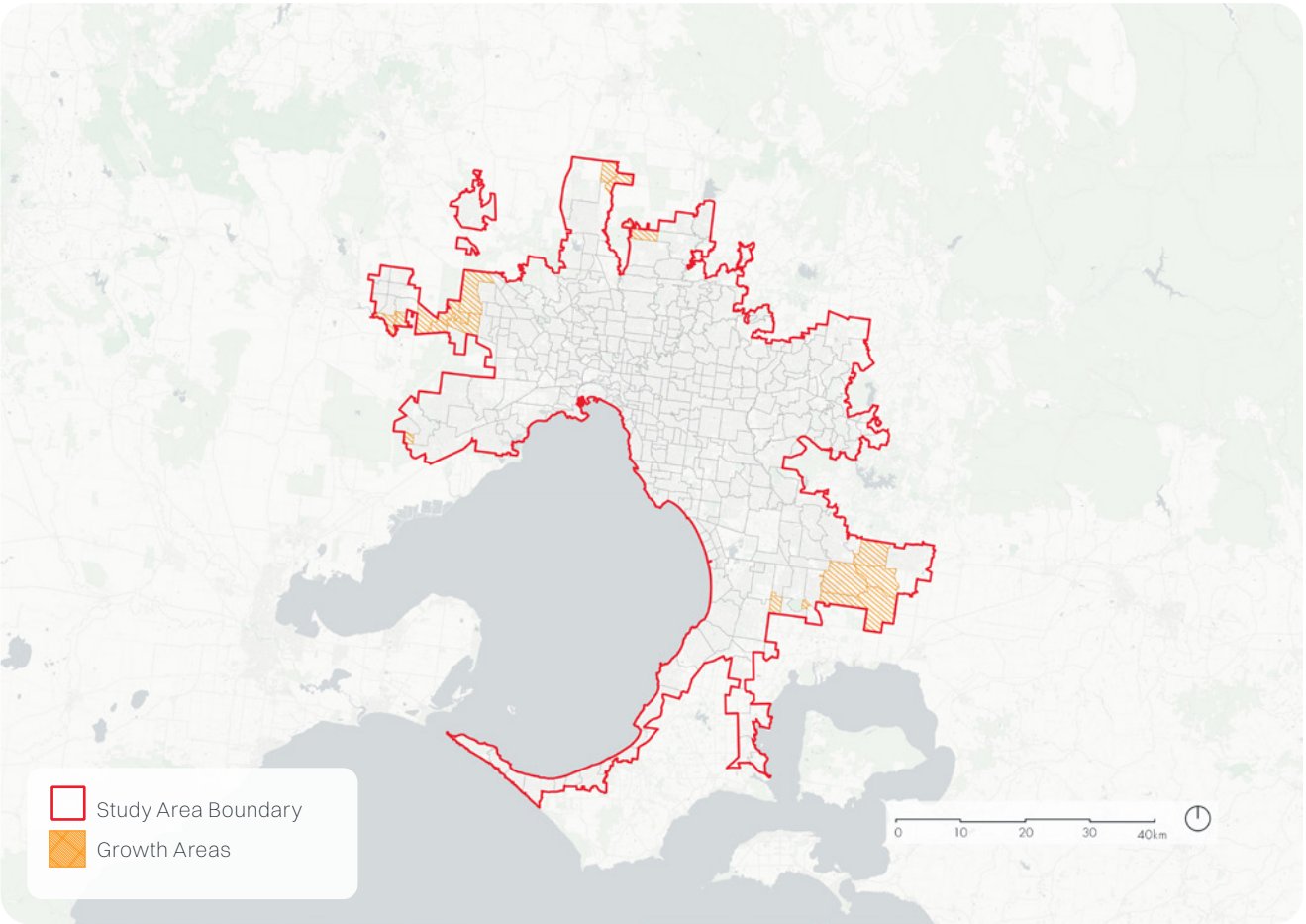- Cranbourne South
- Devon Meadows

Figure 2.   Geographic Scope

Figure 3.   Growth Areas

3.2 ANALYSIS SCALE

THE OUTPUTS OF THE ANALYSIS ARE AGGREGATED TO A RANGE OF SCALES TO ENSURE A BROAD RANGE OF APPLICATIONS AND FINE-GRAIN DETAIL. THE CENSUS AREAS, DEFINED BY THE ABS, WERE USED FOR CONSISTENCY AND STANDARDISATION WITH OTHER DATASETS.

Data was analysed based on the following areas and scales:

a. Suburbs and Localities – to enable publication and comparison between suburbs via a ranking.

- 'Suburbs and Localities, formerly State Suburbs, are an ABS Mesh Block approximation of the officially recognised boundaries of suburbs (in cities and larger towns) and localities (outside cities and larger towns) as defined by the State and Territory governments of Australia.'[1]

b. Statistical Area 1 ('SA1') – to enable finer grain analysis of neighbourhoods and break down the built form context within suburbs.

- 'SA1s are built from whole Mesh Blocks and have a population between 200 and 800 people.'[2]

c. Mesh Block ('MB') – to utilise as a base level for analysis and extract the nuance of a place.

- 'Mesh Blocks (MB) are the smallest geographic areas defined by the ABS and form the building blocks for the larger regions of the Australian Statistical Geographic Standard. Most Mesh Blocks contain 30 to 60 dwellings... They broadly identify land use such as residential, commercial, industrial, parkland etc.' [2]

1 ABS. (2021). Suburbs and Localities. https://www.abs.gov.au/statistics/standards/australian-statistical-geography-standard-asgs-edition-3/jul2021-jun2026/non-abs-structures/suburbs-and-localities
2 ABS (2022). Census Geography Glossary. https://www.abs.gov.au/census/guide-census-data/geography/census-geography-glossary

BLOCK
ABS Mesh- 60-120 residents

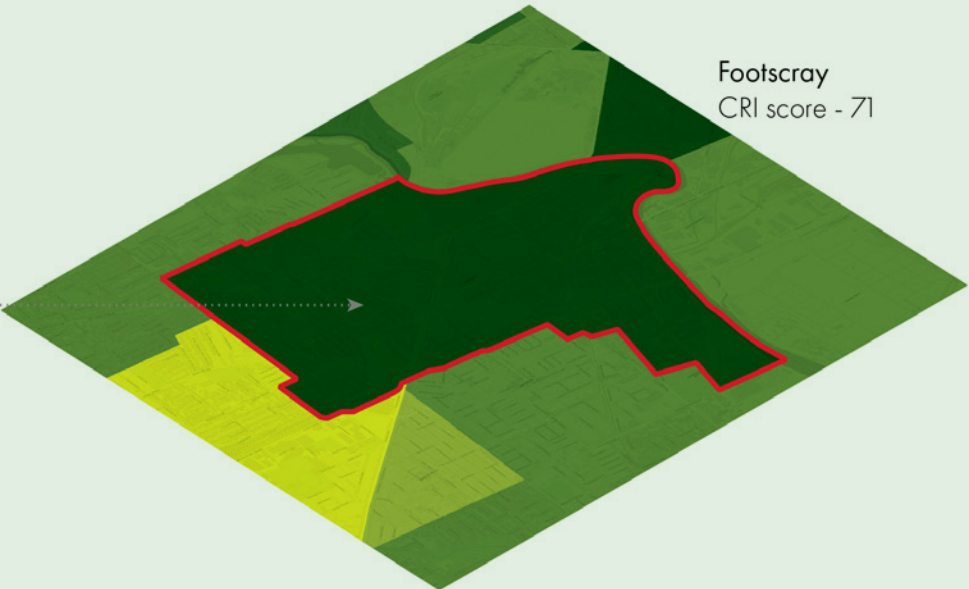Footscray (North-west - The Crescent)
CRI score - 51

NEIGHBOURHOOD
ABS Statistical Area 1 – 200-800 residents

Footscray (North-west)
CRI score - 55

SUBURB
ABS Suburbs and Localities

Footscray
CRI score - 71

Figure 4. Units of Analysis Diagram

3.3   INDICATORS

The study adopts a series of indicators based on the understanding of contributing factors to climate resilient neighbourhoods as well as commonly used indicators in literature. Furthermore, the scope of the indicators are of relevance to planning policy including strategic land use planning. The four key indicators framing the analysis, and what is measured within each, are as follows:

AMENITIES

Evaluates efficiency of land use including access to core services, amenities, recreation space, education & employment opportunities.

TRANSPORT & MOVEMENT

Considers proximity to functional and frequent public transport, and a permeable pedestrian network.

ENVIRONMENT & BIODIVERSITY

Analyses the proportion of canopy coverage, blue and green space, and ecological connectivity.

HAZARD RESILIENCE

Evaluates areas prone to flooding, coastal inundation, bushfire risk and urban heat effects.

Each indicator comprises a network of sub-indicators to ensure that the study includes a wide range of relevant considerations and best reflects how we experience our neighbourhoods. A summary of the indicators, relevant sub-indicators and key data sources is provided at Appendix B.

Thematic Limitations

The scope of the study was defined by data availability, quality, coverage and publish date. Further areas for investigation that could not be incorporated in this study include the following:

- Cycling infrastructure and network connectivity.
- Understorey vegetation.
- Hard surfaces and permeability.
- Air quality and pollution.
- Erosion and landslip.
- Waste management.
- Population and dwelling density (addressed elsewhere).

#1 AMENITIES

#1.1 Core services — Proximate access to a diversity of core services for everyday needs such as healthcare, supermarkets and community facilities.

#1.2 Recreation — Proximate access to a diverse range of green space and recreational facilities.

#1.3 Retail & other facilities — Access to a range and concentration of amenities including food and drink, retail, entertainment, cultural and religious facilities and public services.

#1.4 Education facilities & employment — Proximate access to education facilities including primary, secondary and tertiary education and opportunities for employment.

#2 TRANSPORT & MOVEMENT

#2.1 Public transport — Walkable access to train, tram and bus services and availability of frequent services.

#2.2 Walkability — Walkable access to amenities and extent of permeability within the pedestrian network.

#3 ENVIRONMENT & BIODIVERSITY

#3.1 Green & blue space — Proportion of area covered by open space and blue space (rivers, lakes and creeks).

#3.2 Tree canopy cover — Proportion of land covered by tree canopy.

#3.3 Ecological connectivity — Proportion of natural areas that provide structural connectivity to conserve, enhance and restore native biodiversity.

#3.4 Protected areas — Extent of land designated for protection.

#4 HAZARD RESILIENCE

#4.1 Bushfire risk — Proportion of area affected by Bushfire Management Overlay and Bushfire Prone Area controls.

#4.2 Flood, inundation & sea level rise — Proportion of area affected by projected sea level rise, coastal inundation and flooding.

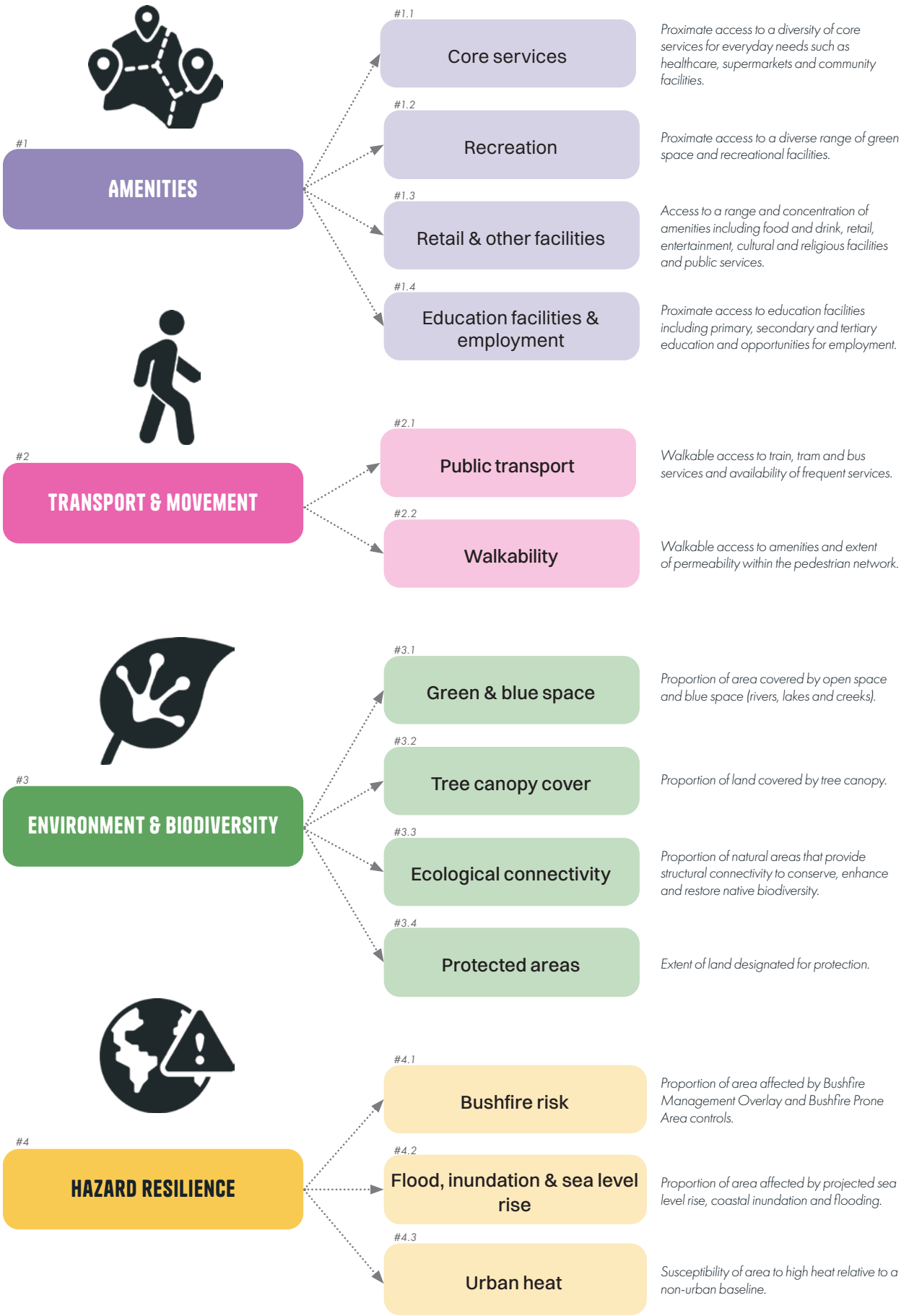**#4.3 Urban heat** — Susceptibility of area to high heat relative to a non-urban baseline.

Figure 5.   Indicators & Sub-Indicators Diagram

3.4   DATA ANALYSIS

THE STUDY UTILISES VARIOUS ANALYSIS APPROACHES THAT BEST REFLECT THE WAYS IN WHICH WE EXPERIENCE OUR NEIGHBOURHOODS.

A summary of the analysis approaches as they relate to each sub-indicator is provided at Appendix B.

CATCHMENTS & COVERAGE

Much of the analysis is based on the walkable catchment (400 metres or 800 metres), via the pedestrian network, to a certain feature. These features include public transport stops, parks and various amenities.

Additionally, for select indicators, the proportion of a certain feature in relation to an area is of greater relevance. This includes the canopy tree coverage or green and blue space coverage within an area. In these cases, the study measures the proportion of the area that is covered.
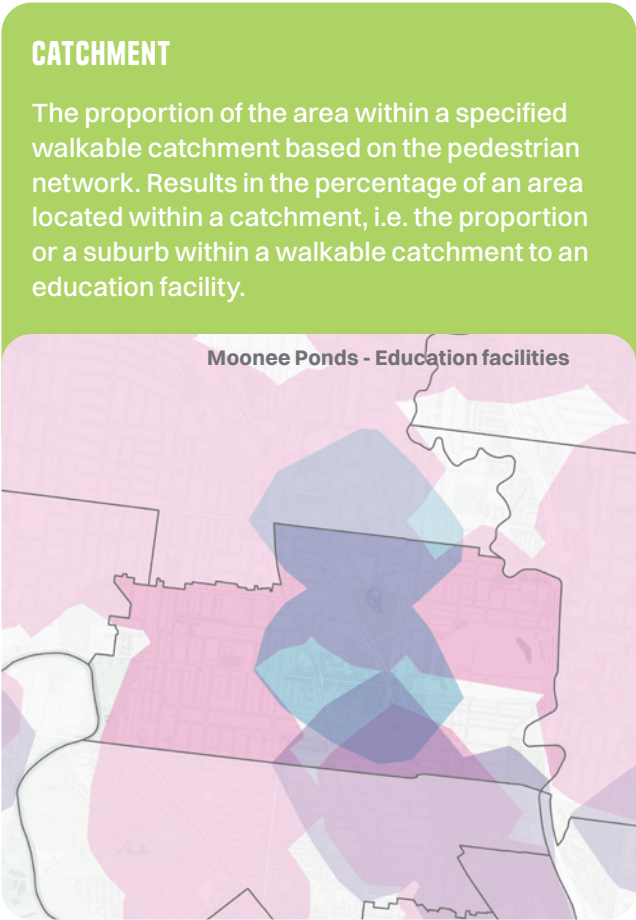
CATCHMENT

The proportion of the area within a specified walkable catchment based on the pedestrian network. Results in the percentage of an area located within a catchment, i.e. the proportion or a suburb within a walkable catchment to an education facility.

Figure 6.   Catchment Analysis

COVERAGE

The percentage of an area covered by a feature, i.e. the proportion of a suburb that is prone to flooding, inundation or sea level rise.
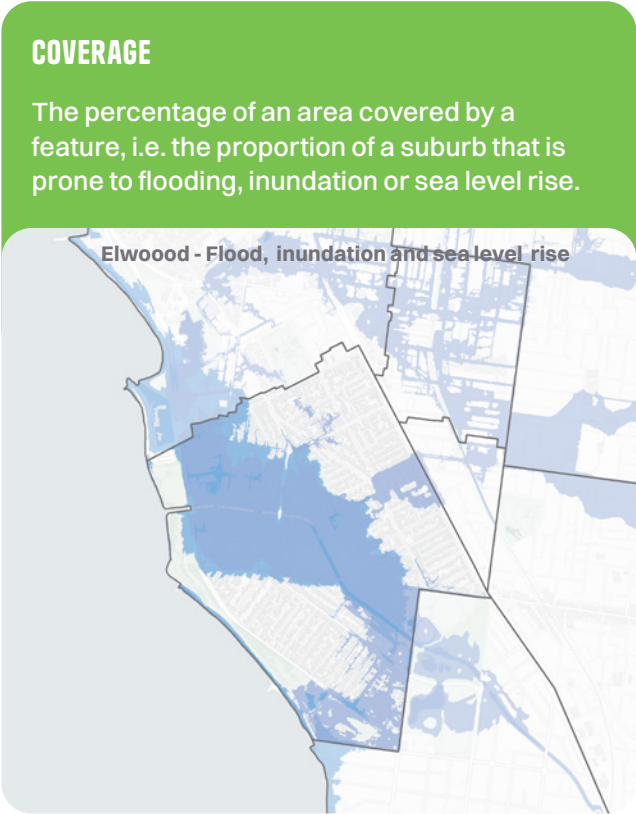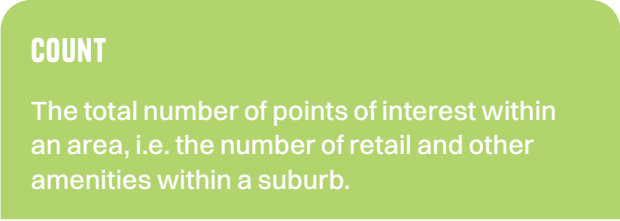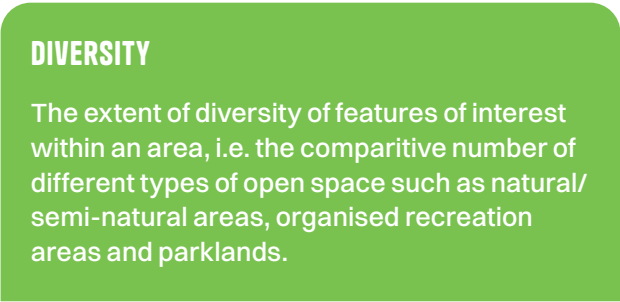

Figure 7.   Coverage Analysis

COUNT

The analysis involved calculating the number of points of interest within an area to determine the availability and concentration of a service. The number of points were layered in conjunction with catchments where relevant, i.e. catchment of amenities.

COUNT

The total number of points of interest within an area, i.e. the number of retail and other amenities within a suburb.

Figure 8.   Count Analysis

DIVERSITY

In addition to the number of facilities in an area (e.g. amenities or open space), it was necessary to analyse the diversity of different types. A higher score was allocated to area with a greater range of features of interest.

DIVERSITY

The extent of diversity of features of interest within an area, i.e. the comparitive number of different types of open space such as natural/ semi-natural areas, organised recreation areas and parklands.

Figure 9.   Diversity Analysis

FREQUENCY

The public transport sub-indicator included analysis of frequency to determine service availability within an area. Therefore, the highest score was allocated to areas with a frequency of 12 or more services on average during peak hours. Frequency below this level was normalised to standardise the values to a common scale. The frequency value was layered in conjunction with catchments, i.e. access to the highest frequency of service within the available catchment.
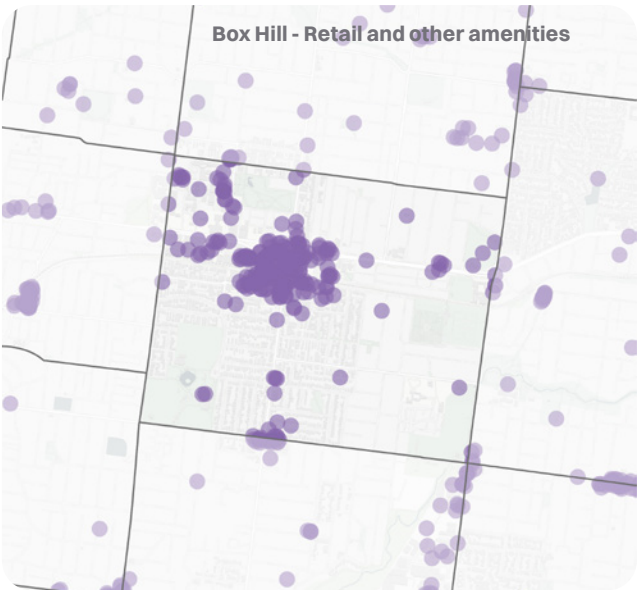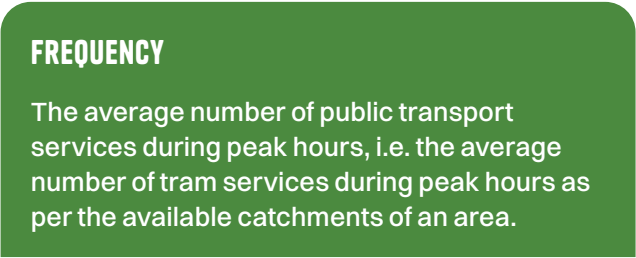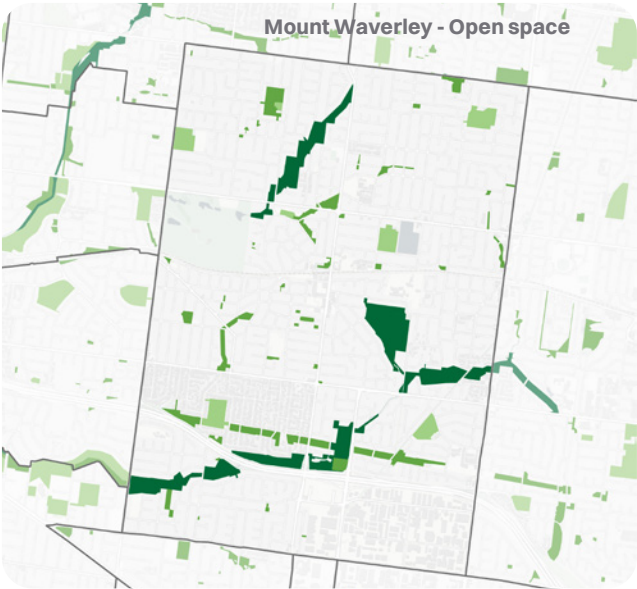
FREQUENCY

The average number of public transport services during peak hours, i.e. the average number of tram services during peak hours as per the available catchments of an area.

Figure 10.   Frequency Analysis

3.5 WEIGHTING

The study sought to balance all indicators and sub-indicators evenly, unless the data, policy or the quality of a feature demonstrated that an alternative approach was necessary. Each indicator and sub-indicator were weighted as follows.

No.	Indicator / Sub-Indicator	Description	Weighting
1	**Amenities**		**100**
1.1	Core services		100
		Catchment - Supermarkets, core healthcare, emergency services, community services	50
		Diversity - Supermarkets, core healthcare, emergency services, community services	50
1.2	Recreation		100
		Catchment - Open space	37.5
		Diversity - Open space	37.5
		Count - Recreational facilities	25
1.3	Retail and other facilities		100
		Diversity - Retail, eat and drink, professional services, general healthcare, religious facilities, cultural and entertainment facilities, administration services	50
		Count - Retail, eat and drink, professional services, general healthcare, religious facilities, cultural and entertainment facilities, administration services	50
1.4	Education facilities and employment		100
		Catchment - Education facilities	50
		Catchment and count - Employment	50
2	**Transport & movement**		**100**
2.1	Public transport		200
		Catchment & frequency - Train	100
		Catchment & frequency - Tram	60
		Catchment & frequency - Bus	40

No.	Indicator / Sub-Indicator	Description	Weighting
2.2	Walkability		100
		Pedestrian network permeability	50
		Core services & retail and other facilities	12.5
		Recreation	12.5
		Employment and education	12.5
		Public transport	12.5
3	**Environment & biodiversity**		**100**
3.1	Green & blue space		100
		Coverage - Green space	Layered
		Coverage - Waterbodies	Layered
3.2	Tree canopy cover		100
3.3	Ecological connectivity		100
3.4	Protected area		100
4	**Hazard resilience**		**100***
4.1	Bushfire risk		100
		Coverage - Bushfire Prone Area	30
		Coverage - Bushfire Management Overlay (BMO)	70
4.2	Flood, inundation & sea level rise		100
		Coverage - Land Subject to Inundation Overlay (LSIO)	Layered
		Coverage - Special Building Overlay (SBO)	Layered
		Coverage - Flood Overlay (FO)	Layered
		Coverage - Urban Flood Zone (UFZ)	Layered
		Coverage - Coastal Inundation: Sea level rise & storm surge	Layered
4.3	Urban heat	Heat index	100
CLIMATE RESILIENCE INDEX			**100**

4 KEY INSIGHTS

4.1 INDEX CAPABILITIES

The Climate Resilience Index is a foundational tool to create momentum for practitioners and community to recognise key challenges in our urban environments and seek out targeted solutions. It has capacity to inform strategic decision making at a metropolitan scale while also considering the cumulative impact of small-scale interventions.

The Index seeks to support improvements in neighbourhood resilience through the following capabilities:

- Provides a rich and user-friendly evidence base to support community advocacy for neighbourhood improvement.
- Holds potential to meaningfully inform metropolitan scale strategic planning including for activity centres and housing growth.
- Integrates biodiversity values on a metropolitan scale into a land use planning framework, emphasising human and nature connections.
- Specifies how broader scale climate challenges are experienced on a local level.
- Enables evidence-based assessment of competing strategic objectives and identifies gaps, needs and priorities.

The tool allows users to zoom in to the scale of a neighbourhood block therefore providing a high level of detail and granularity, often overlooked. This is integral as the level of data aggregation can reveal the complexities of specific locations and particularly highlight differences within a suburb. For example, open space and tree canopy may be concentrated within a certain area therefore these benefits may not be evenly distributed. These fine grain results will assist with decision making to ensure that interventions are based upon accurate data and adopt a socially equitable response.

The intention of the Index is not to specify an area as having the goal of climate resilience as there are improvements that can be made in all our neighbourhoods. We encourage you to explore the findings of the Index for yourself and find ways to take action.

User Interface

The Index identifies the factors that contribute to a sustainable urban environment through a custom-built User Interface (UI) in the form of an online interactive map. This enables the complex data to be accessible in a format that can be easily understood by both the design and development industry, as well as to the broader community.

The Index adopts a graphic language that clearly shows areas that are high performing whilst also showing areas in which improvements can be made. It achieves a unique look, feel, and user experience that is optimised for desktop, mobile and colourblind users. The Climate Resilience Index sets a new standard for research diffusion and public engagement.
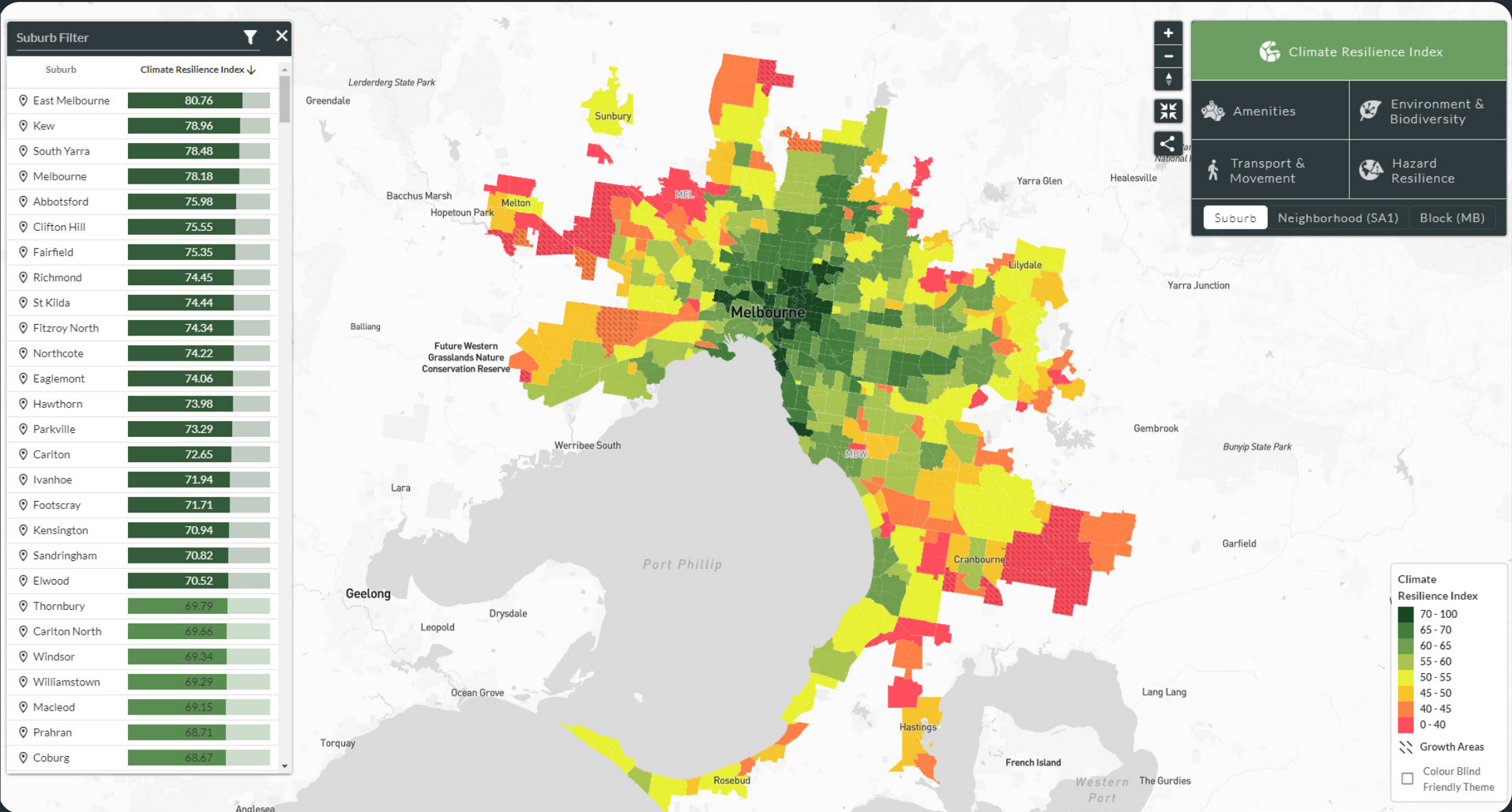
Figure 11. User Interface

4.2 PROJECT FINDINGS

The Climate Resilience Index combines four indicators focusing on various factors that impact the capacity of Melbourne's neighbourhoods to respond to climate change. The results of each indicator demonstrate differing spatial patterns showing the diversity of our city. In order to take action on climate change, we need to consider the specific challenges and opportunities of each neighbourhood.
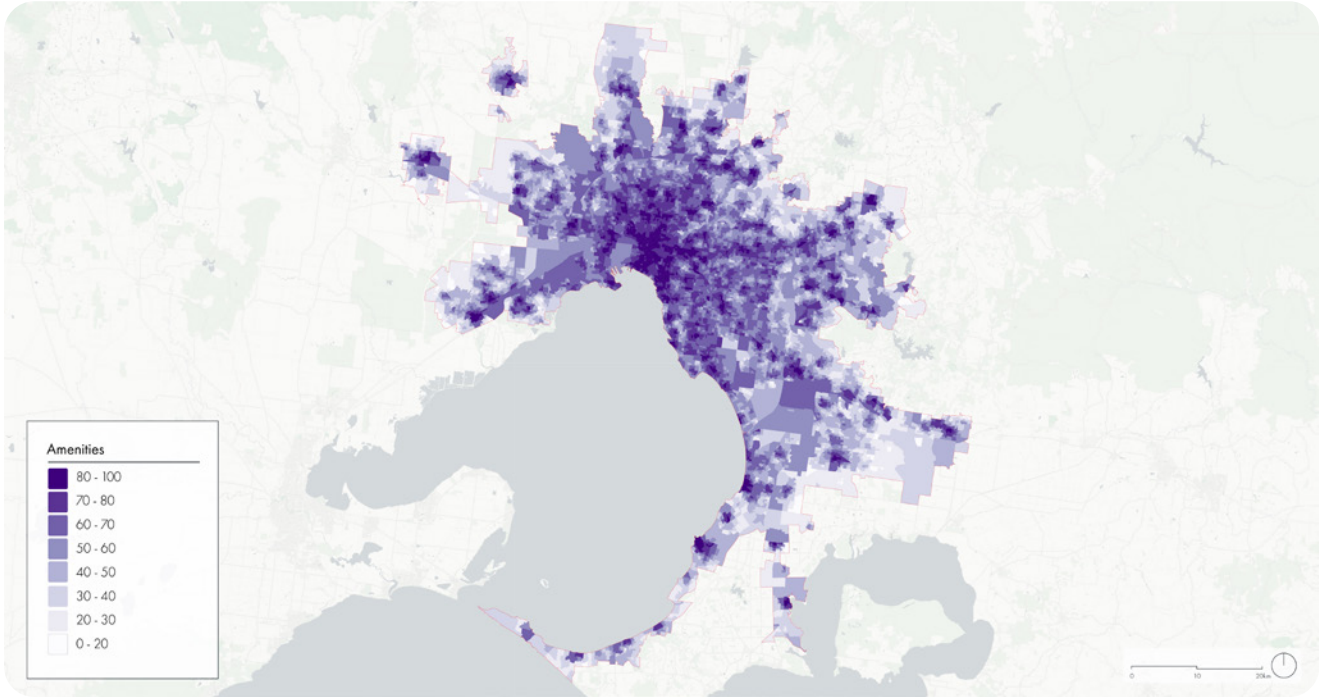
Figure 12. Amenities Indicator (SA1)
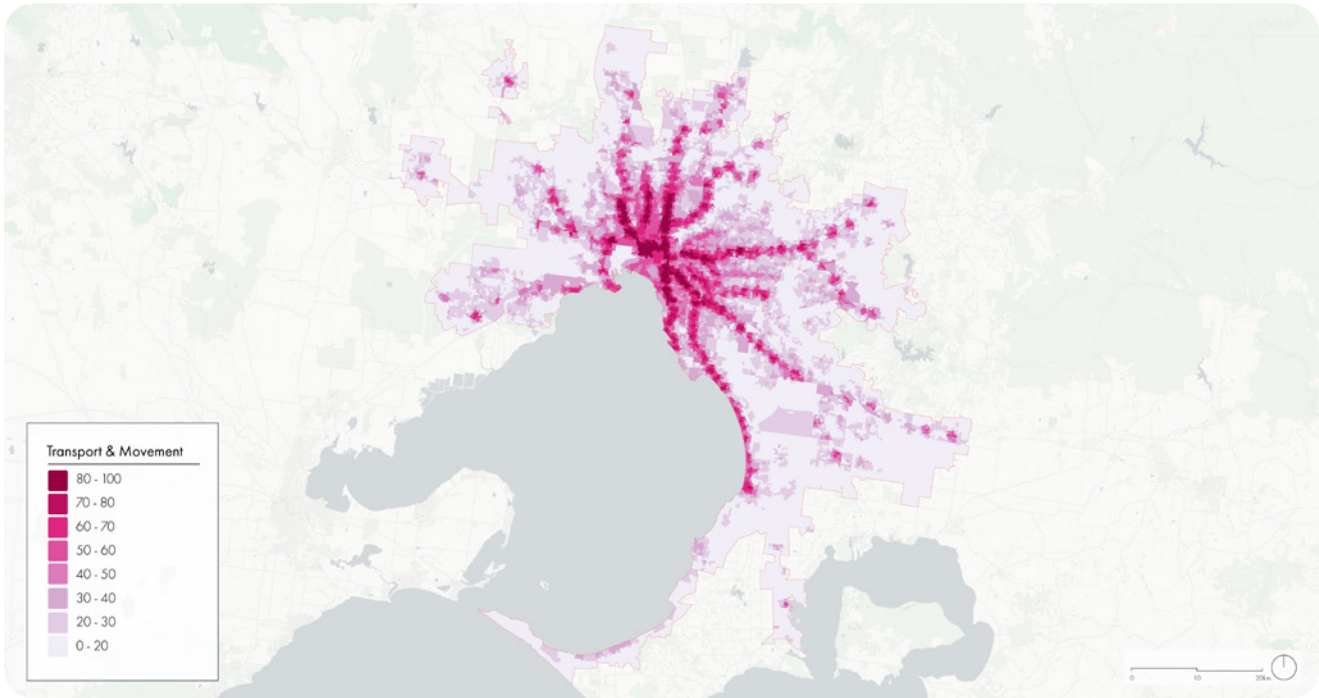
Figure 13. Transport and Movement Indicator (SA1)
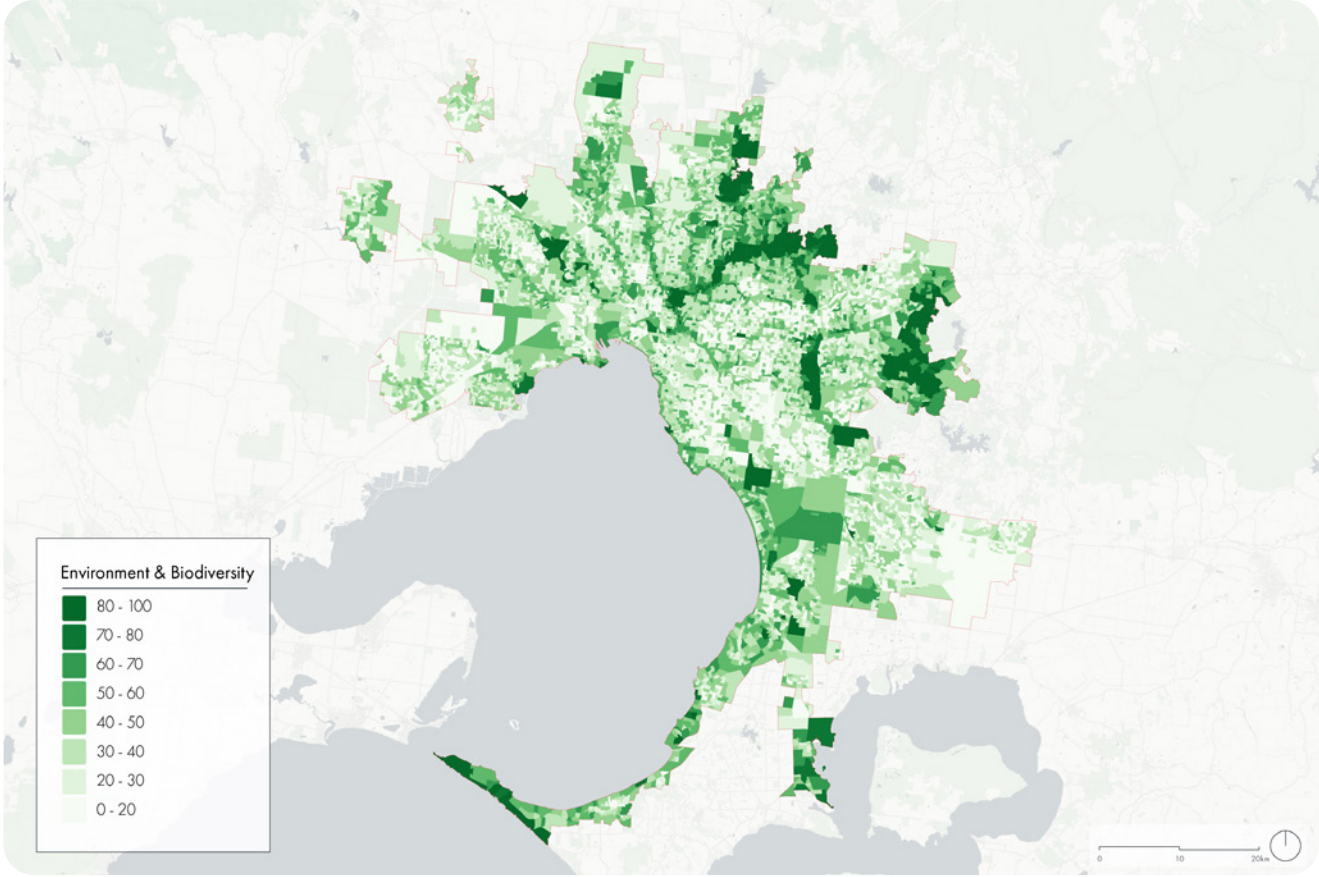
Figure 14. Environment and Biodiversity Indicator (SA1)
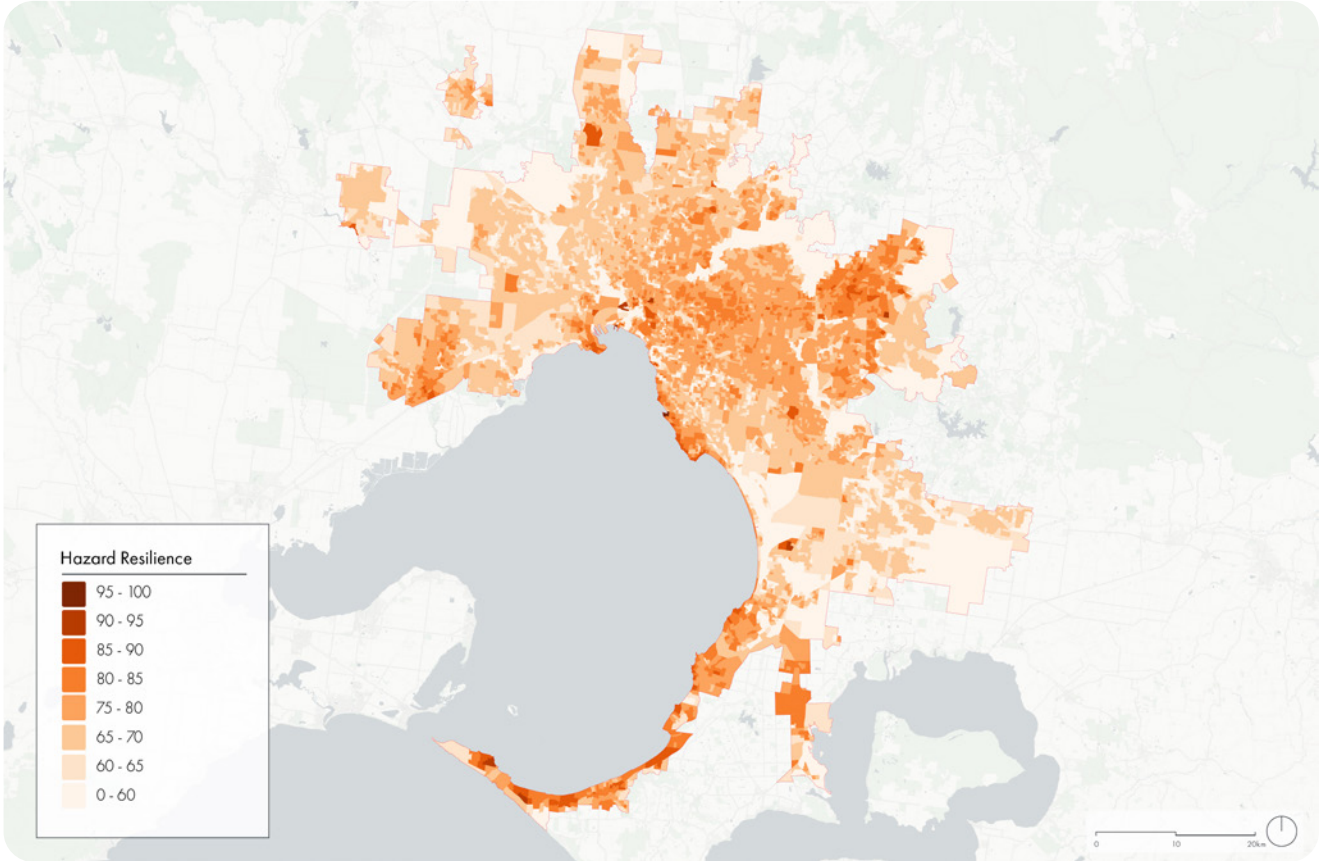
Figure 15. Hazard Resilience Indicator (SA1)
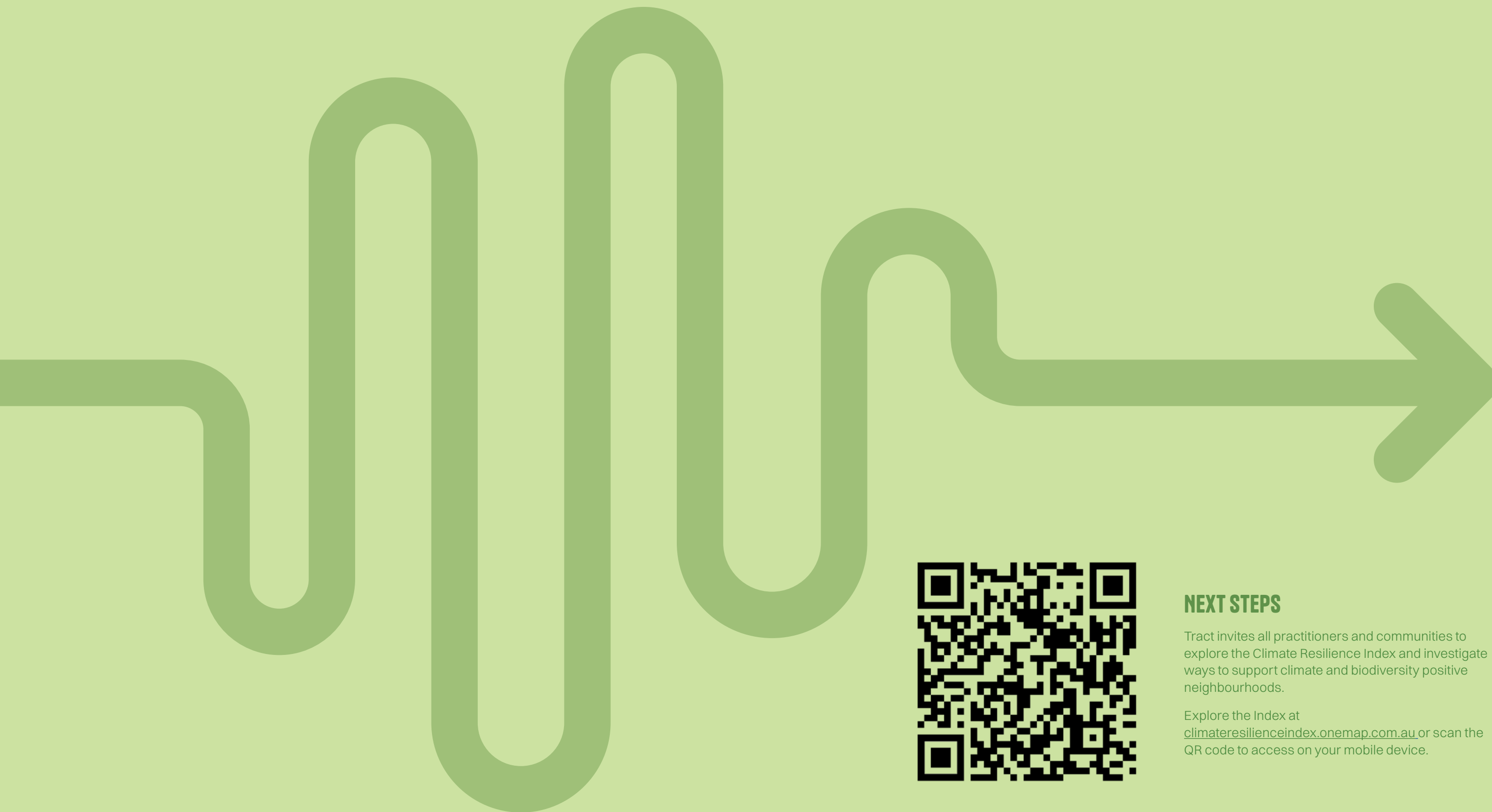
NEXT STEPS

Tract invites all practitioners and communities to explore the Climate Resilience Index and investigate ways to support climate and biodiversity positive neighbourhoods.

Explore the Index at climateresilienceindex.onemap.com.au or scan the QR code to access on your mobile device.

APPENDICES

APPENDIX A   REFERENCES & DATA SOURCES

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1	Amenities
1.1	Core Services
Description	Proximate access to a diversity of core services that provide everyday or critical services. This includes healthcare, supermarkets, community services and emergency facilities.
Data Attribution	Department of Energy, Environment and Climate Action [DEECA]. (2023). Vicmap Features of Interest [Data set]. https://discover.data.vic.gov.au/dataset/vicmap-features-of-interest.
	Overture Maps Foundation - Places. (2023). Overture [Data set]. https://overturemaps.org/.
	Woolworths Store Locations. (2024). Derived from Woolworths Data. https://www.woolworths.com.au
	Coles Store Locations. (2024) Derived from Coles Data. https://www.coles.com.au
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	Le Max Group Supermarket Locations. (2024). Derived from Le Max Group Data. https://www.lemaxgroup.com.au
	FoodWorks Store Locations. (2024). Derived from FoodWoorks Data. https://www.foodworks.com.au
	Friendly Grocer Store Locations. (2024). Derived from Friendly Grocer Data. https://friendlygrocer.com.au
Feature Selection	• Supermarkets: • Woolworths, Coles, Aldi, IGA, Foodworks, Friendly Grocer, Leos (Supermarket dataset). • Healthcare: • Health facilities including maternal/child health centre, and community health centre (Features of Interest dataset). • Health facilities including doctors' clinic, general practice (Overture dataset). • Hospitals including day procedure centre, general hospital and general hospital – emergency (Features of Interest dataset). • Community services: • Community venues including hall, community centre, senior citizens and neighbourhood house (Features of Interest dataset). • Care facilities including child care and disability support centre (Features of Interest dataset). • Emergency services: • Ambulance station, police station, fire station, SES unit, coast guard, emergency coordination centre, refuge (Features of Interest dataset).
Analysis	• Catchment - the proportion (%) of the area with walkable access (800m) to each core service. • Diversity – the higher the range of core services within a walkable distance, the higher the score. • Normalised score - scaling of scores to between 0 and100. Standardisation of values to a common scale to facilitate comparison across different input types.
Sub-Indicator Weighting	• Catchment & diversity – each analysis type is weighted equally.
Output	Proportion of area within a walkable catchment of core services. Extent of access to a diversity of core services.

1.2	Recreation
Description	Proximate access to a diversity of open space as well as recreational facilities.
Data Attribution	Department of Energy, Environment and Climate Action [DEECA]. (2023). VEAC Metropolitan Melbourne Open Space Inventory [Data set]. https://discover.data.vic.gov.au/dataset/veac-metropolitan-melbourne-open-space-inventory. Department of Energy, Environment and Climate Action [DEECA]. (2023). Vicmap Features of Interest [Data set]. https://discover.data.vic.gov.au/dataset/vicmap-features-of-interest.
Feature Selection	• Open space: • Civic square and promenade. • Natural and semi-natural area. • Organised recreation area. • Parkland and garden. • Protected area. Dataset amended and updated due to the date of issue, to include further open space that has been created since the dataset was released, captured through manually classifying Public Park and Recreation Zone (PPRZ) and Public Conservation and Resource Zone (PCRZ). Open space was categorised based on the criteria and definitions provided by the Victorian Planning Authority (VPA) as per the Open Space Classification and Hierarchy (2017). Golf course land excluded as this is generally restricted in access. • Recreation facilities: • Swimming pool, organised sports club, scout hall, community garden.
Analysis	• Catchment - the proportion (%) of the area with walkable access (400m) to open space. • Diversity – the higher the range of open space types within a walkable distance, the higher the score. • Count – number of recreational facilities within the area and the surrounds (800m buffer). The count of facilities within the buffer was weighted as half. • Normalised score - scaling of scores to between 0 and100. Standardisation of values to a common scale to facilitate comparison across different input types.
Sub-Indicator Weighting	• Catchment – 37.5/100. • Diversity - 37.5/100. • Count – 25/100.

Output	Proportion of area within a walkable catchment of open space. Extent of access to a range of open spaces. Total recreation facilities in proximity.
1.3	**Retail and other amenities**
Description	Access to a range and concentration of amenities such as food and drink, retail entertainment and cultural facilities, religious centres, public services and others.
Data Attribution	Department of Energy, Environment and Climate Action [DEECA]. (2023). Vicmap Features of Interest [Data set]. https://discover.data.vic.gov.au/dataset/vicmap-features-of-interest. Overture Maps Foundation - Places. (2023). Overture [Data set]. https://overturemaps.org/.
Feature Selection	• Food and drink premises including cafes, restaurants, bars (Overture dataset). • Retail premises including a range of shops (Overture dataset). • Entertainment and cultural venues including music venues, performing arts, cinemas, stadiums, museum and art galleries, indoor recreation facilities (Overture dataset). • Cultural facilities including art galleries, museums (Features of Interest dataset). • Religious centres including churches, temples, mosques and synagogues (Features of Interest). • Public services including municipal offices (Features of Interest dataset).
Analysis Count	• Diversity – the higher the range of amenities space types within and surrounding each area, the higher the score. • Count – how many amenities within proximity to the area. • Normalised score - scaling of scores to between 0 and100. Standardisation of values to a common scale to facilitate comparison across different input types.
Sub-Indicator Weighting	• Diversity of amenities – 50/100. • Count of amenities – 50/100.
Output	Access to a range of amenities and total amenities in proximity.
1.4	**Education facilities and employment**
Description	Access to a range of education facilities and access to a high number of jobs.

Data Attribution	Department of Energy, Environment and Climate Action [DEECA]. (2023). Vicmap Features of Interest [Data set]. https://discover.data.vic.gov.au/dataset/vicmap-features-of-interest. Department of Energy, Environment and Climate Action [DEECA]. (2022). Vicmap Planning – Planning Scheme Zone Polygon [Data set]. https://discover.data.vic.gov.au/dataset/vicmap-planning-planning-scheme-zone-polygon. Australian Bureau of Statistics [ABS]. (2021). Destination Zones [Data set]. https://www.abs.gov.au/statistics/standards/australian-statistical-geography-standard-asgs-edition-3/jul2021-jun2026/non-abs-structures/destination-zones#cite-window2

Feature Selection	• Education facilities:
	  • Kindergarten to year 12 - primary school, primary/secondary school, secondary school (Features of Interest dataset)
	  • Special school - special school (Features of Interest dataset)
	  • Further education - further education, university, tertiary institution (Features of Interest dataset)
	• Destination zones:
	  • Total employment number.
	  • Total Employment within each employment zone: Employment number is then evenly redistributed into employment zones (outlined below) by percentage of area from destination zones. This prevents residential mesh blocks picking up employment number.
	• Planning Scheme Zones (employment related):
	  • Activity Centre Zones, Business Zones, Commercial Zones, Industrial Zones, Mixed Use Zones, Capital City Sone, Comprehensive Development Zones, Docklands Zone, Priority Development Zones, Special Use Zones.

Analysis Count	• Catchment - the proportion (%) of the area with walkable access (800m) to education facilities and employment areas. • Count – concentration of jobs attributed to employment zones within proximity to the area. • Normalised score - scaling of scores to between 0 and100. Standardisation of values to a common scale to facilitate comparison across different input types.

Sub-Indicator Weighting	• Education facilities – 50/100.
	  • Kindergarten to year 12 catchment – 25/50
	  • Special school catchment – 10/50.
	  • Further education catchment – 15/50
	• Employment – 50/100.
	  • Catchment – 25/50.
	  • Count - 25/50.

Output	Proportion of area within a walkable catchment of education facilities and employment areas. Total number of jobs in proximity to area.

2	Transport & movement
2.1	Public transport

Description	Proximate access to a diversity of frequent public transport services.
Data Attribution	Department of Transport and Planning [DTP]. (2023). Public Transport a collection of PTV datasets [Data set]. https://discover.data.vic.gov.au/dataset/public-transport-a-collection-of-ptv-datasets. Department of Transport and Planning [DTP]. (2023). Timetable and Geographic Information – GTFS [Data set]. https://discover.data.vic.gov.au/dataset/timetable-and-geographic-information-gtfs.
Feature Selection	• Train stations • Tram stops • Bus stops • Service frequency
Analysis Count	• Catchment - the proportion (%) of the area with walkable access (400m and 800m) to public transport stops. • Frequency – the higher the frequency of the service during peak hours, the higher the score. • Normalised score - scaling of scores to between 0 and 100. Standardisation of values to a common scale to facilitate comparison across different input types. Therefore, service frequency above 12 normalised to 100, as per the Movement and Place network classification defined by Transport for Victoria (n.d.).

Sub-Indicator Weighting	Train – 50/100.
	• Train 800m catchment – 25/50
	• Train 800m frequency – 25/50.
	Tram – 30/100.
	• Tram 400m catchment – 21/30.
	  • Catchment – 10.5/21.
	  • Frequency - 10.5/21.
	• Tram 800m – 9/30.
	  • Catchment – 4.5/9.
	  • Frequency – 4.5/9.
	Bus – 20/100.
	• Bus 400m catchment – 14/20.
	  • Catchment – 7/14.
	  • Frequency – 7/14.
	• Bus 800m – 6/20.
	  • Catchment – 3/6.
	  • Frequency – 3/6.

Output	Proportion of area within a walkable catchment of public transport and level of service frequency.

2.2	Walkability

Description	Pedestrian network permeability and walkable access to amenities and public transport.
Data Attribution	OpenStreetMap contributors. (2024). Planet.osm dump [Data file from 20/02/2024]. Retrieved from https://extract.bbbike.org/" Refer to data attribution for sub-indicators 1.1, 1.2, 1.3, 1.4 and 2.1.
Feature Selection	• Pedestrian network including streets and paths. • Excluding waterway, highways, highway access ramps • Refer to feature selection for sub-indicators 1.1, 1.2, 1.3, 1.4 and 2.1.
Analysis Count	The walkability index combines a series of sub-indicators, as follows: • 1.1 - Core services • 1.2 - Amenities • 1.3 - Recreation • 1.4 - Employment and education • 2.1 – Public transport Additionally, an analysis of pedestrian network permeability was carried out: • Permeability is measured by proportion of 800m walking catchment based on street network against 800m crow-fly radius.

Sub-Indicator Weighting	• Core services, amenities, recreation, employment and education, public transport – 50/100.
	  • Core services and amenities – 12.5/50.
	  • Recreation – 12.5/50.
	  • Employment and education – 12.5/50.
	  • Public transport – 12.5/50.
	• Street network permeability – 50/100.
	  • Normalised score - adapted to 0 to 100 format, therefore values receive a score based on relative positioning to other values.

Output	Walkability index score.

3	Environment & Biodiversity

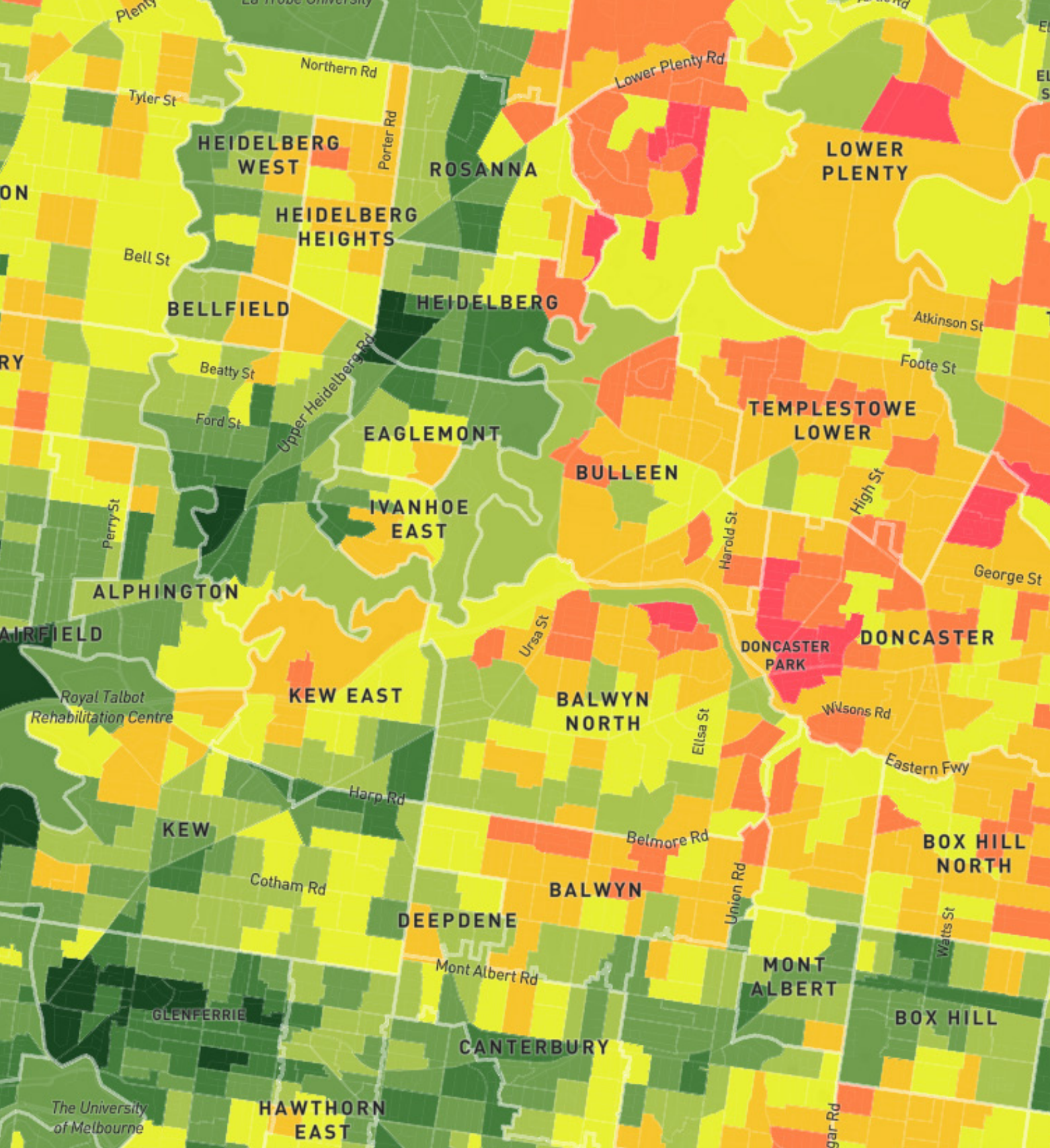| 3.1	Green and blue space
Description	Land cover of public green and blue space.
Data Attribution	Department of Energy, Environment and Climate Action [DEECA]. (2023). VEAC Metropolitan Melbourne Open Space Inventory [Data set]. https://discover.data.vic.gov.au/dataset/veac-metropolitan-melbourne-open-space-inventory. Department of Energy, Environment and Climate Action [DEECA]. (2023). Vicmap Hydro – Water Polygon [Data set]. https://discover.data.vic.gov.au/dataset/vicmap-hydro-water-polygon.

Feature Selection	• Green space:
	   • Natural and semi-natural area.
	   • Organised recreation area.
	   • Parkland and garden.
	   • Protected area.
	   • Recreation corridor.
	   • Services and utilities area.
	   • Golf course land.
	 Dataset amended and updated due to the date of issue, to include further open space that has been created since the dataset was released, captured through manually classifying Public Park and Recreation Zone (PPRZ) and Public Conservation and Resource Zone (PCRZ). Open space was categorised based on the criteria and definitions provided by the Victorian Planning Authority (VPA) as per the Open Space Classification and Hierarchy (2017). Additionally, Urban Flood Zone (UFZ) land was included.
	 • Waterbodies:
	   • Lakes, flats (subject to inundation), wetlands, pondages (saltpan and sewage) and watercourse areas.

Analysis	• Coverage - the proportion (%) of the area covered by public open space. • Normalised score - adapted to 0 to 100 format, therefore values receive a score based on relative positioning to other values.
Sub-Indicator Weighting	N/A
Output	Proportion of area covered by public green and blue space.

3.2	Tree Canopy Coverage
Description	Tree canopy cover across public and private space.
Data Attribution	Department of Energy, Environment and Climate Action [DEECA]. (2020). Vicmap Vegetation Tree Extent [Data set]. https://delwp.maps.arcgis.com/home/item.html?id=8da9b2bc20e1471fb0c3afbde856e440#overview.
Feature Selection	Derived from statewide aerial photography with minimum of 20cm pixel resolution. It includes vegetation greater than 2m in height.
Analysis Count	• Coverage - the proportion (%) of the area covered by tree canopy. • Normalised score - adapted to 0-100 format, therefore tree canopy coverage of 40% or more normalised to 100.
Sub-Indicator Weighting	N/A
Output	Proportion of area covered by tree canopy cover.

3.3	Ecological Connectivity
Description	Ecological connectivity of green and blue space. Note. The methodology of this sub-indicator follows Indicator 2 – Connectivity Measures or Ecological Networks to Counter Fragmentation as per the Singapore Index on Cities' Biodiversity (2021, pg.15).
Data Attribution	Department of Energy, Environment and Climate Action [DEECA]. (2023). Vicmap Transport [Data Set]. https://www.land.vic.gov.au/maps-and-spatial/spatial-data/vicmap-catalogue/vicmap-transport Refer to data attribution for sub-indicator 4.2.

Feature Selection	• Green and blue space:
	   • Refer to feature selection within Section 3.1.
	• Barriers:
	   • Freeways, highways, and arterial and sub-arterial roads were considered barriers to ecological connectivity for the purpose of determining connected patches.
	• Connected patches:
	   • Green and blue space areas were considered connected patches if they were within 100 metres of each other and not separated by a barrier.
	   • The connected patches, identified in the above analysis of each suburb, included patches outside the suburb boundary that retained connectivity to the patches within, in order to demonstrate broader linkages.

Analysis	• Effective mesh size - the probability that two randomly selected points within patches are in connected patches. • Coherence - each suburb was assigned a normalised score based on its effective mesh size. The coherence value is formed from the division of the effective mesh size by the total area of patches contained, or connected to a patch that was contained, within each suburb. Note. Due to consideration of the scalability of this method, the score of the suburb was replicated at a SA1 and MB level.
Sub-Indicator Weighting	N/A
Output	The ecological connectivity of green and blue space in relation to the area of the suburb.

3.4	Protected Areas
Description	Extent of area which is specified as protected and designated as a reserve or state/national park.
Data Attribution	Department of Energy, Environment and Climate Action [DEECA]. (2023). Parks and Conservation Reserves (PARKRES) [Data set]. https://discover.data.vic.gov.au/dataset/parks-and-conservation-reserves-parkres Department of Energy, Environment and Climate Action [DEECA]. (2023). Public Land Management (PLM25) [Data set]. https://discover.data.vic.gov.au/dataset/public-land-management-plm25

Feature Selection	• Parks and Conservation Reserves:
	   • Coastal reserves, education areas, historic reserve, reservoir park, state park and National Park (excluding open space categorised as organised recreation area and golf course).
	• Public Land Management:
	   • Parks Victoria managed land (excluding open space categorised as organised recreation area and golf course).

Analysis Count	• Catchment - the proportion (%) of the area that is protected.
	• Normalised score - adapted to 0-100 format, therefore coverage over 20% normalised to 100.
	   • <1% - 0
	   • <7% – 25
	   • <14% - 50
	   • <20% - 75
	   • >20% - 100
	
	The above ranges are based upon Indicator 1 – Proportion of Natural Areas in the City as per the Singapore Index on Cities' Biodiversity (2021, pg.14).

Sub-Indicator Weighting	N/A
Output	Proportion of area that is protected.

4	**Hazard Resilience**
4.1	Flooding, inundation and sea level rise
Description	Extent of area prone to flooding and inundation, and projected sea level rise and storm surge.
Data Attribution	Department of Energy, Environment and Climate Action [DEECA]. (2023). Victorian Coastal Inundation Sea Level Rise Storm Tide 2100 [Data set]. https://discover.data.vic.gov.au/dataset/victorian-coastal-inundation-sea-level-rise-storm-tide-2100 Department of Energy, Environment and Climate Action [DEECA]. (2023). Victorian Coastal Inundation Sea Level Rise 2100 [Data set]. https://discover.data.vic.gov.au/dataset/victorian-coastal-inundation-sea-level-rise-2100. Department of Energy, Environment and Climate Action [DEECA]. (2024). Vicmap Planning – Planning Scheme Overlay Polygon [Data set]. https://discover.data.vic.gov.au/dataset/vicmap-planning-planning-scheme-overlay-polygon1. Department of Energy, Environment and Climate Action [DEECA]. (2022). Vicmap Planning – Planning Scheme Zone Polygon [Data set]. https://discover.data.vic.gov.au/dataset/vicmap-planning-planning-scheme-zone-polygon.

Feature Selection	• Planning Scheme Overlays:
	  • Land Subject to Inundation Overlay (LSIO).
	  • Special Building Overlay (SBO).
	  • Flooding Overlay (FO).
	• Planning Scheme Zones:
	  • Urban Flood Zone (UFZ).
	• Sea level and storm surge areas:
	  • Storm surge.
	  • Sea level rise.

Analysis	• Coverage – the proportion (%) of the total area affected by the Land Subject to Inundation Overlay, Special Building Overlay, Flooding Overlay and Urban Flood Zone as well as projected sea level rise and storm surge vulnerability.
Sub-Indicator Weighting	N/A
4.2	Bushfire risk
Description	Extent of area at risk of bushfire.

Data Attribution	Department of Energy, Environment and Climate Action [DEECA]. (2024). Vicmap Planning – Planning Scheme Overlay Polygon [Data set]. https://discover.data.vic.gov.au/dataset/vicmap-planning-planning-scheme-overlay-polygon1. Department of Energy, Environment and Climate Action [DEECA]. (2023). Designated Bushfire Prone Area (BPA) [Data set]. https://discover.data.vic.gov.au/dataset/designated-bushfire-prone-area-bpa.
Feature Selection	• Planning Scheme Overlays: • Bushfire Management Overlay (BMO). • Bushfire Prone Area (BPA)
Analysis	• Coverage – the proportion (%) of the total area affected by the Bushfire Management Overlay (BMO) and Bushfire Prone Area (BPA).
Sub-Indicator Weighting	• Bushfire Management Overlay – 70/100. • Bushfire Prone Area – 30/100. The above weighting is based on the severity of risk associated with each category.
Output	Proportion of area prone to bushfire.
4.3	Urban heat
Description	Susceptibility to warmer temperatures in comparison to non-urban areas. Note. No analysis was undertaken on this dataset, rather the values provided were used.
Data Attribution	Department of Energy, Environment and Climate Action [DEECA]. (2018). Metropolitan Melbourne Urban Heat Islands and Urban Vegetation 2018 [Data set]. https://discover.data.vic.gov.au/dataset/metropolitan-melbourne-urban-heat-islands-and-urban-vegetation-2018
Feature Selection	N/A
Analysis	• Normalised score - scaling of scores to between 0 and 100, therefore values above 10 degrees or more normalised to 100. Standardisation of values to a common scale to facilitate comparison across different input types.
Sub-Indicator Weighting	N/A
Output	Urban heat relative to a non-urban baseline.