Impact Zones by Urban Development on Bushland

Delineated by Multi-Criteria Analysis with Variable Bufferzones

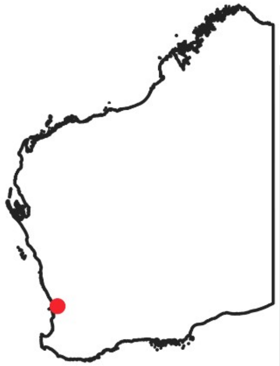
by Humphrey Boogaerdt

Presented at GeoGeeks Meeting in Perth on 2 April 2025

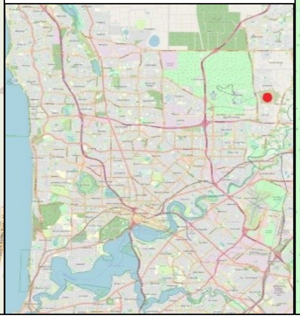
This meeting takes place on Whadjuk Noongar Boodja and I recognise that sovereignty was never ceded – this was and always will be Aboriginal Land.

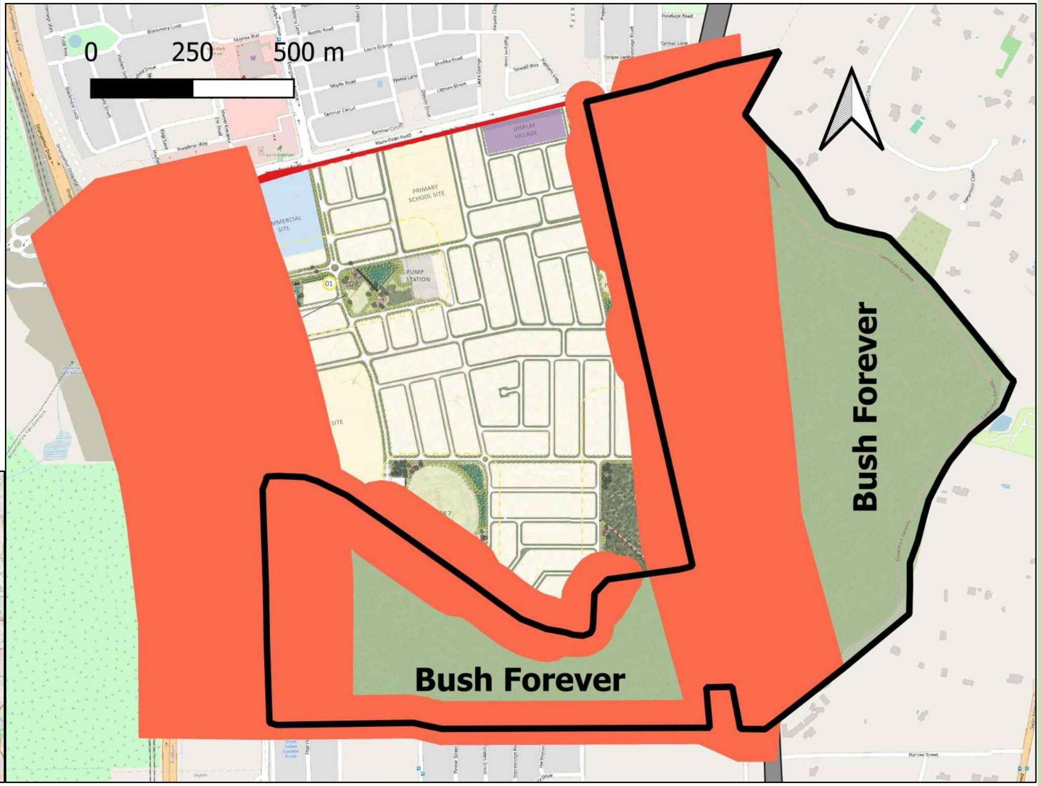
This paper is about delineating the impact of anthropogenic activity on bushland.

Map of the proposed urban development and road construction.



Location of Project at Red dot

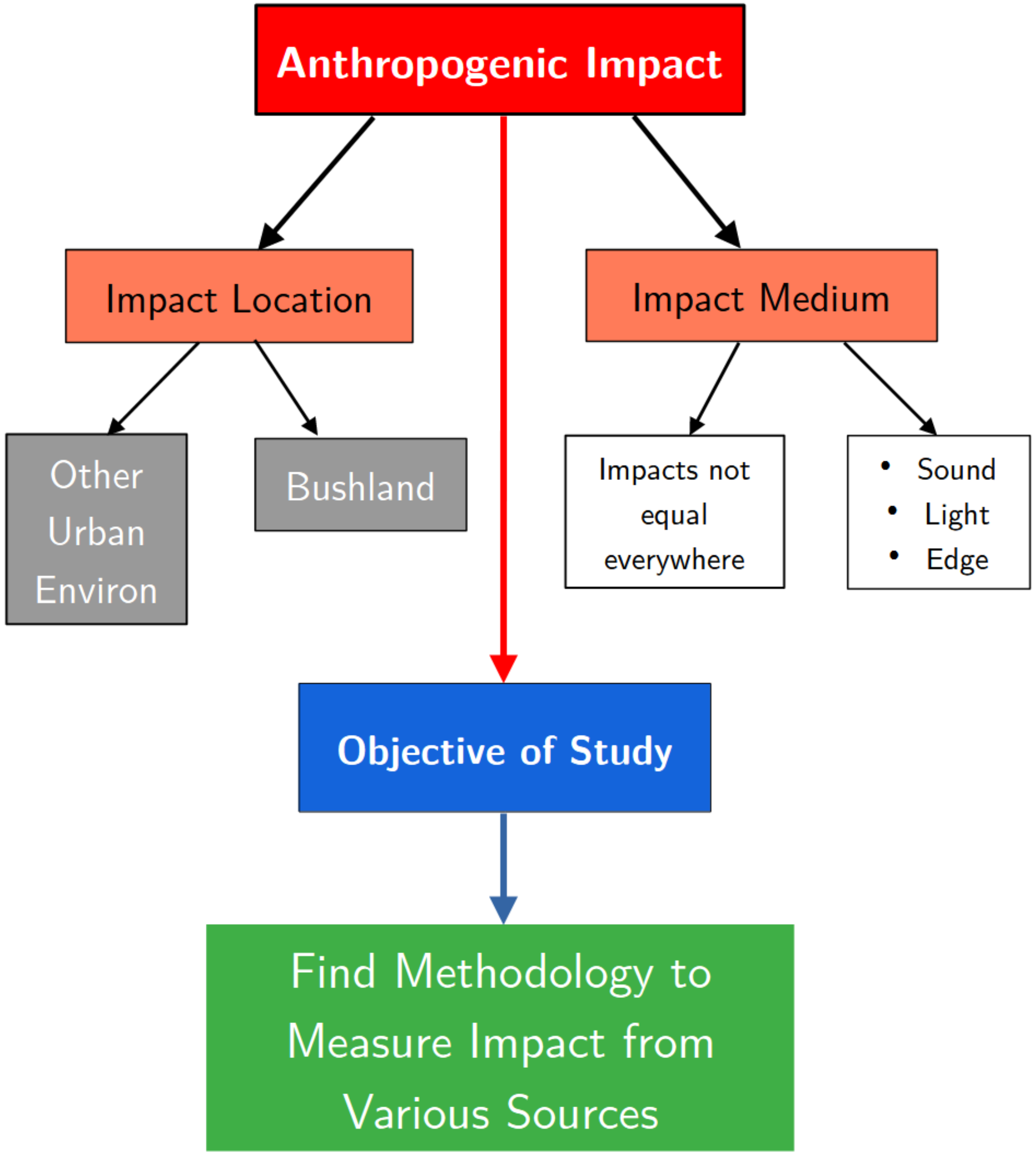


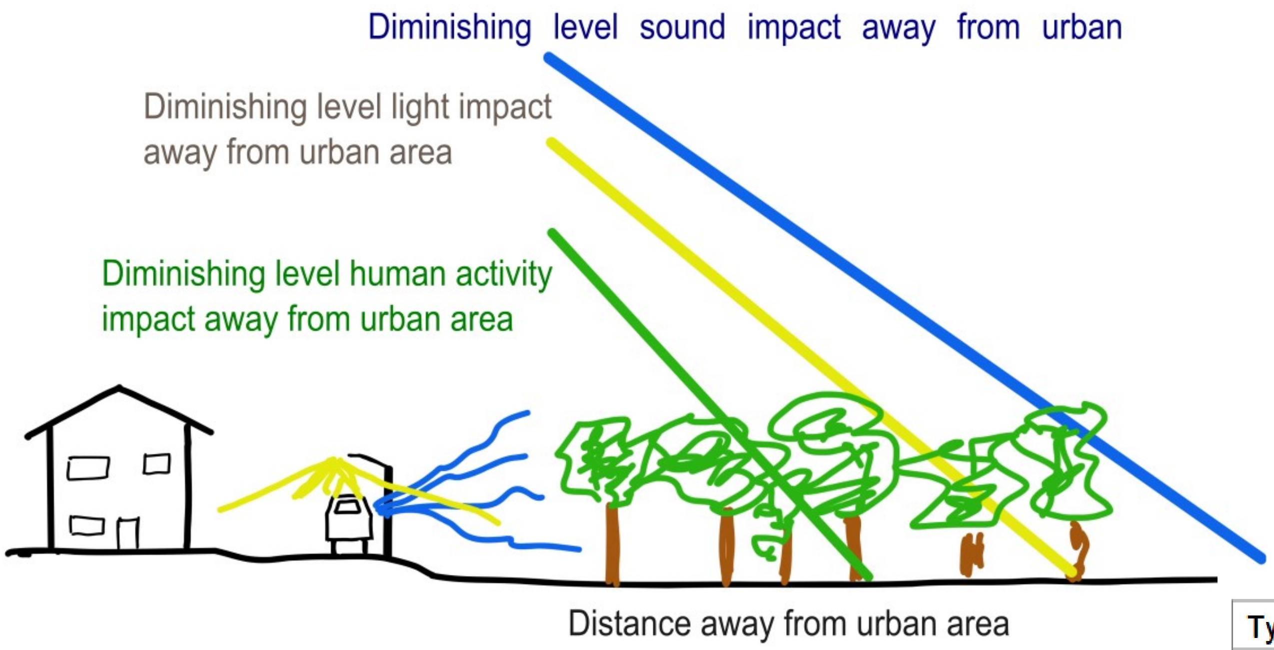


The anthropogenic impact on the Bush Forever site as described in this presentation.

Current approach to reduce impact on natural environment is a buffer around e.g. a wetland.

This approach does not indicate real anthropogenic impact on the natural environment.

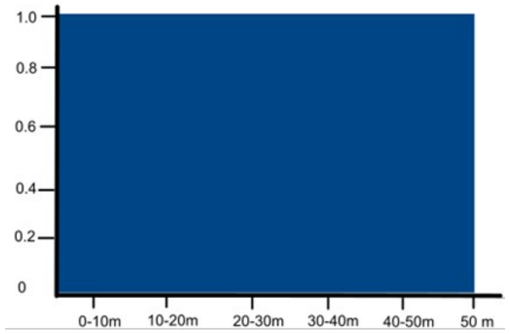




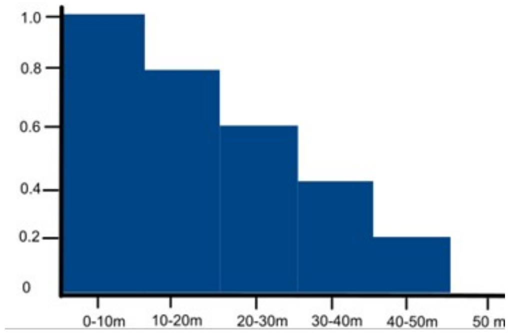
Sound and light disperse into bush from urban area

Distribution of Impacts

Type	Hierarchy	Lanes	Sound	Light	Edge
Roads	Local Connector	2	80	50	25
	Distributor B	4	80	50	25
	Distributor A	4	200	80	50
Railway			500	80	50
Housing			80	30	30
School			50	30	30
Oval			100	100	30
POS			50	30	30
Bushland			0	0	0

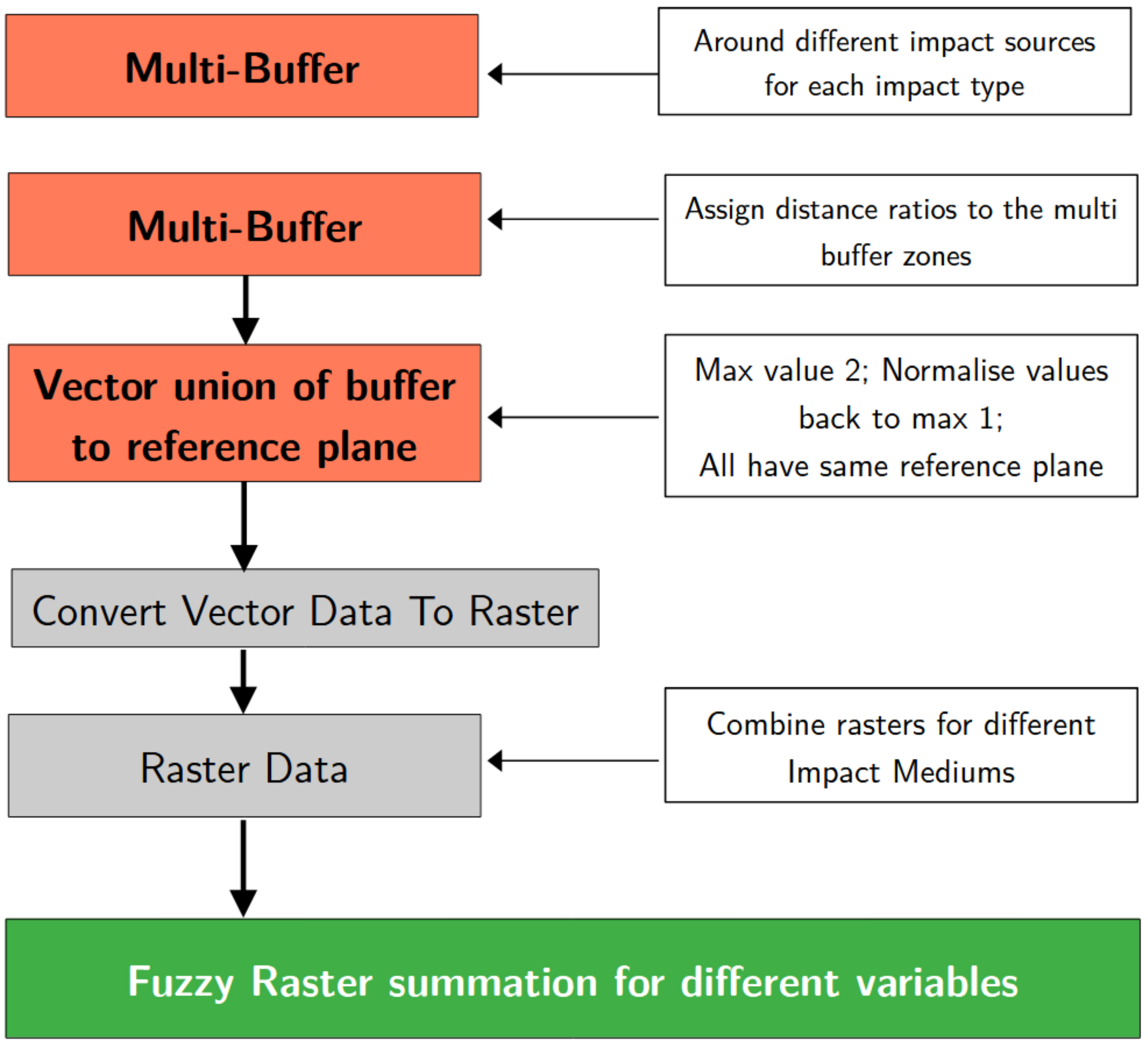


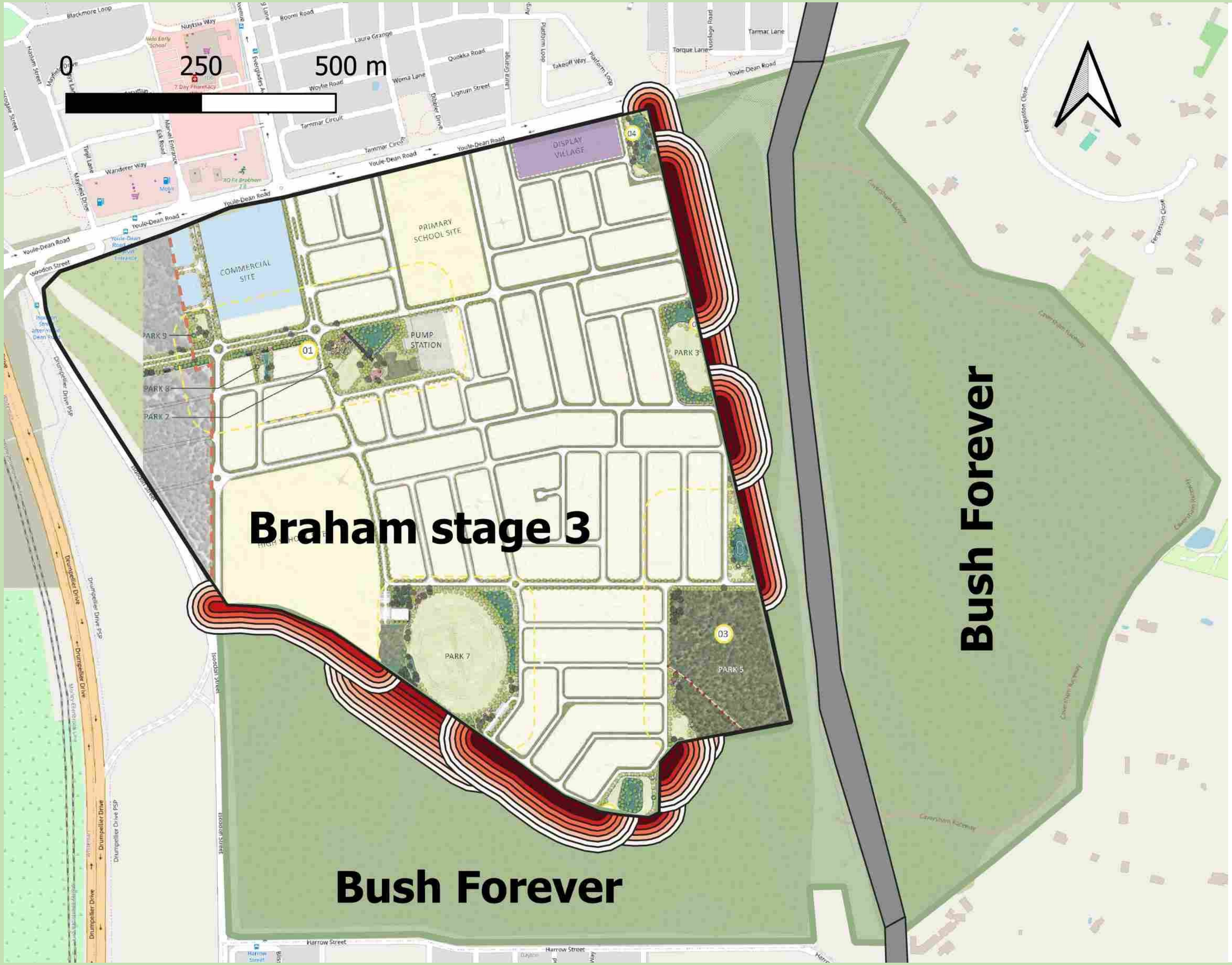
Single Buffer with value 1 for 50m



Multi-Buffer with diminishing values from 1 to 0

Work Flow

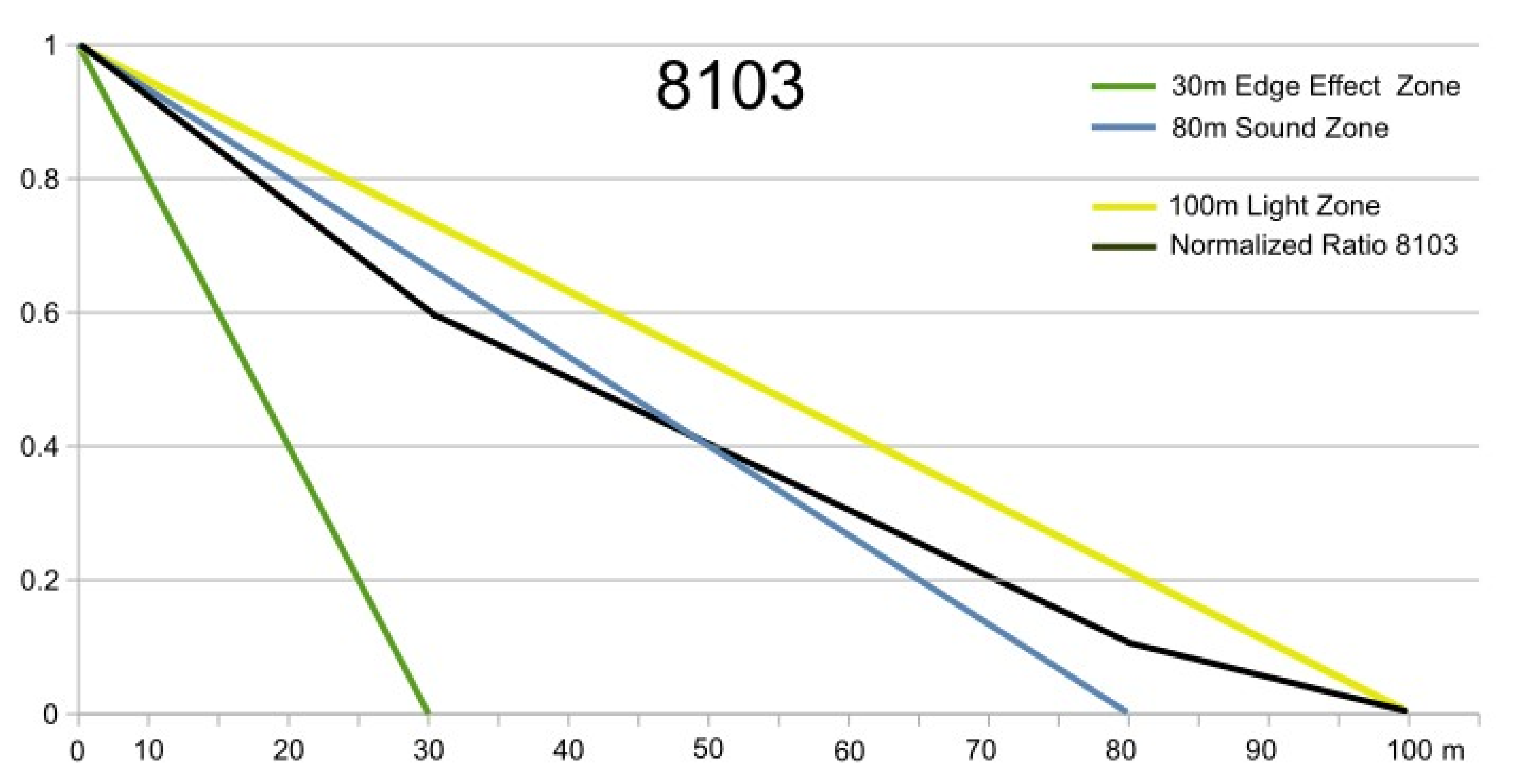




Variable & multi buffer zones at boundary urban development and Bush Forever. The centre line of the buffers coincide with the boundary of the Bush Forever site.

In this study use the 3 variables sound, light and edge effect. So, there are 3 sets of these bufferzones with different widths.

Buffers trimmed to show only impact on Bushland.



Graph of 80m Sound, 100m Light and 30m Edge Effect, shows decay from maximum value 1 to no-impact of 0.

The normalized combination of these variables is shown by the black line.

The Variables have different units

Sound	decibel
Light	lumen
Edge Effect	meters

Need to normalise and ratio them before combining

Multi-Criteria Analysis requires the variables to be normalised.

To make data available for fuzzy calculation

Example of table to calculate the normalised ratio data.
In this case for 80m Sound, 100m Light and 30m Edge Effect.

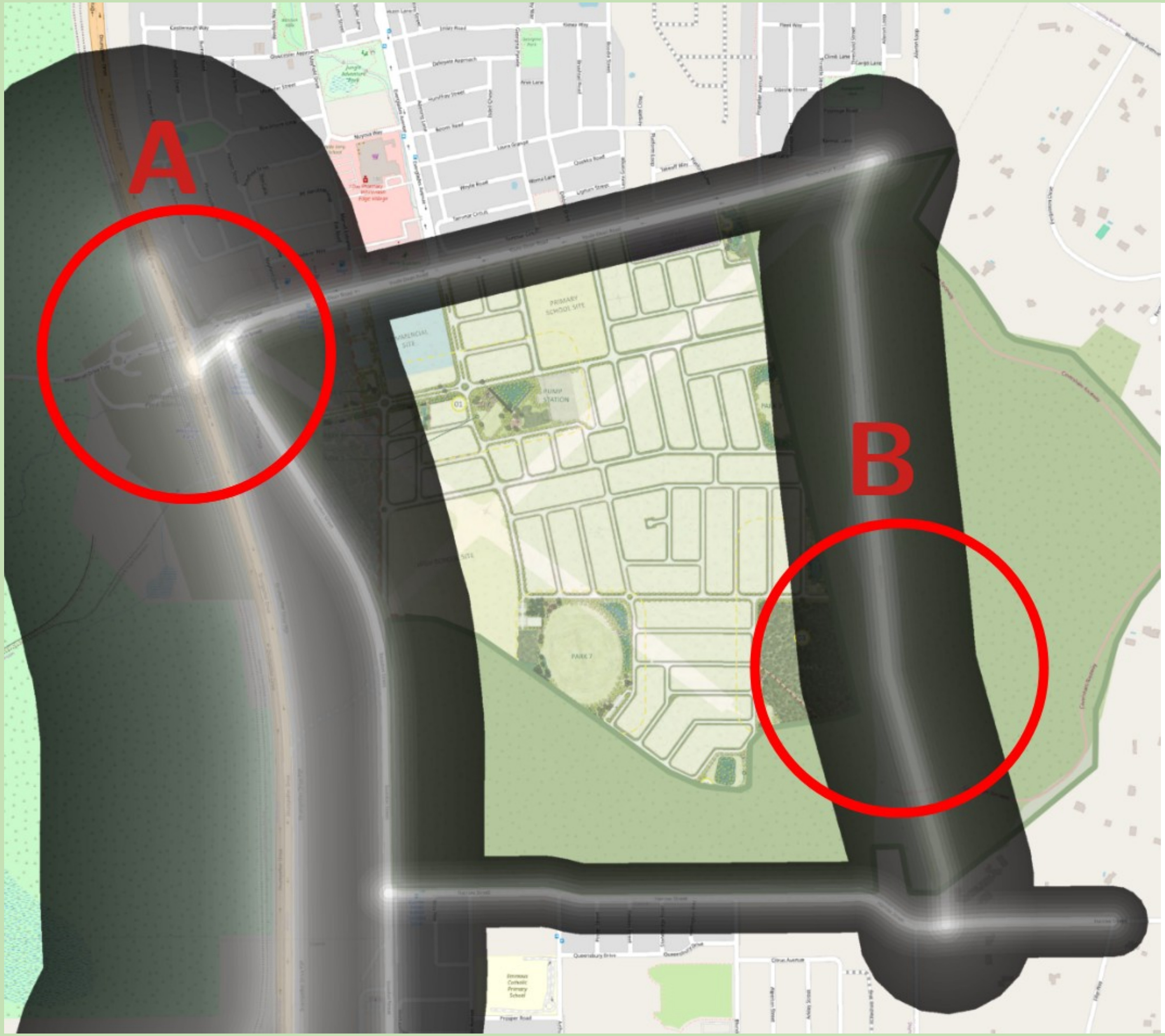
Impact Distance Ratios

Buffer	Fuzzy Value
30m Zone	Intensity
0	1.000
10	0.666
20	0.333
30	0.001

Buffer	Fuzzy Value
80m Zone	Intensity
0	1.000
10	0.875
20	0.750
30	0.625
40	0.500
50	0.375
60	0.250
70	0.125
80	0.001

Buffer	Fuzzy Value
100m Zone	Intensity
0	1.000
10	0.900
20	0.800
30	0.700
40	0.600
50	0.500
60	0.400
70	0.300
80	0.200
90	0.100
100	0.001

Intensity 8103					
Relative impacts for sound, light, edge in respect to distnance 80m, 100m, 30m					
Sound	0.38	Light	0.48	Edge	0.14
	Sum	Rat 8103	Rat 30	Rat 80	Rat 100
		1.00	0.140	0.380	0.480
		0.86	0.093	0.333	0.432
		0.72	0.047	0.285	0.384
		0.57	0.000	0.238	0.336
		0.48	0.000	0.190	0.288
		0.38	0.000	0.143	0.240
		0.29	0.000	0.095	0.192
		0.19	0.000	0.048	0.144
		0.10	0.000	0.000	0.096
		0.05	0.000	0.000	0.048
		0.00	0.000	0.000	0.000



Rasterized multi-buffer shows the decay over distance with highest intensity as white and zero intensity as black.

The multi buffers show the impact of multiple infrastructures (A) compared to lower intensity in single infrastructure (B).

It also shows where there is an overlap by different buffers highlighted by the brightest spots in the image.

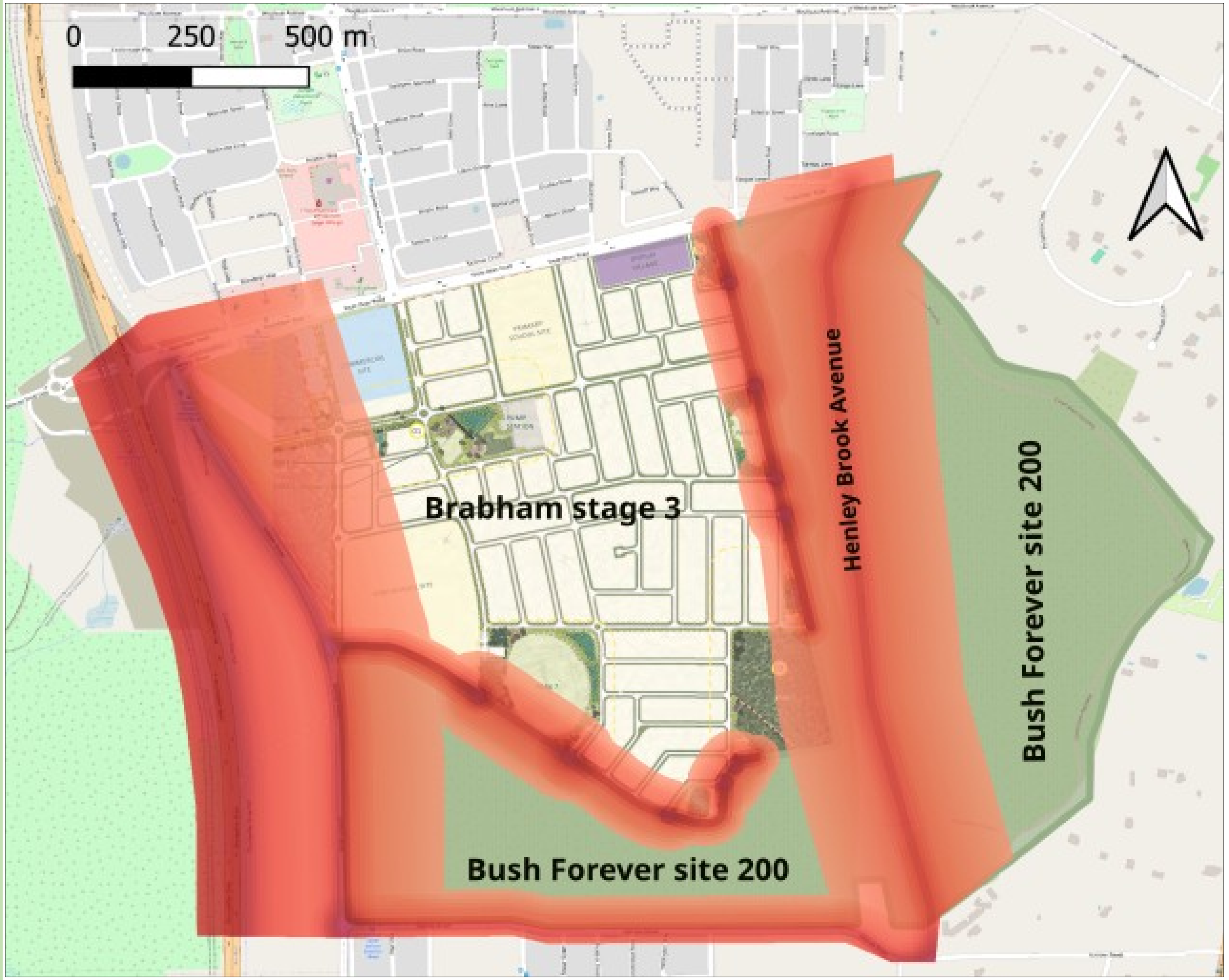
Are that artificial artefacts when buffers overlap and ‘doubling’ the effect or are they real?.

In the datasets we used and were created in this paper there are inaccuracies spatially and in attributes. Therefore, fuzzy logic provides a tool to deal with these inaccuracies.

Basic Boolean calculations would not work here since there are stepped changes in values of the normalized variables. The variables are equally weighted but proportional for the impact distances.

The outcomes of this paper are based on multi-criteria analysis using data that is suitable for the fuzzy raster manipulation.

We have chosen in this study to only look at the impacts of Sound, Light and Edge Effect, but impacts by hydrology, air pollution or ecological barriers, like roads, could be added. A variable like ecological barrier could be given a higher weight because ista larger impact on the environment.

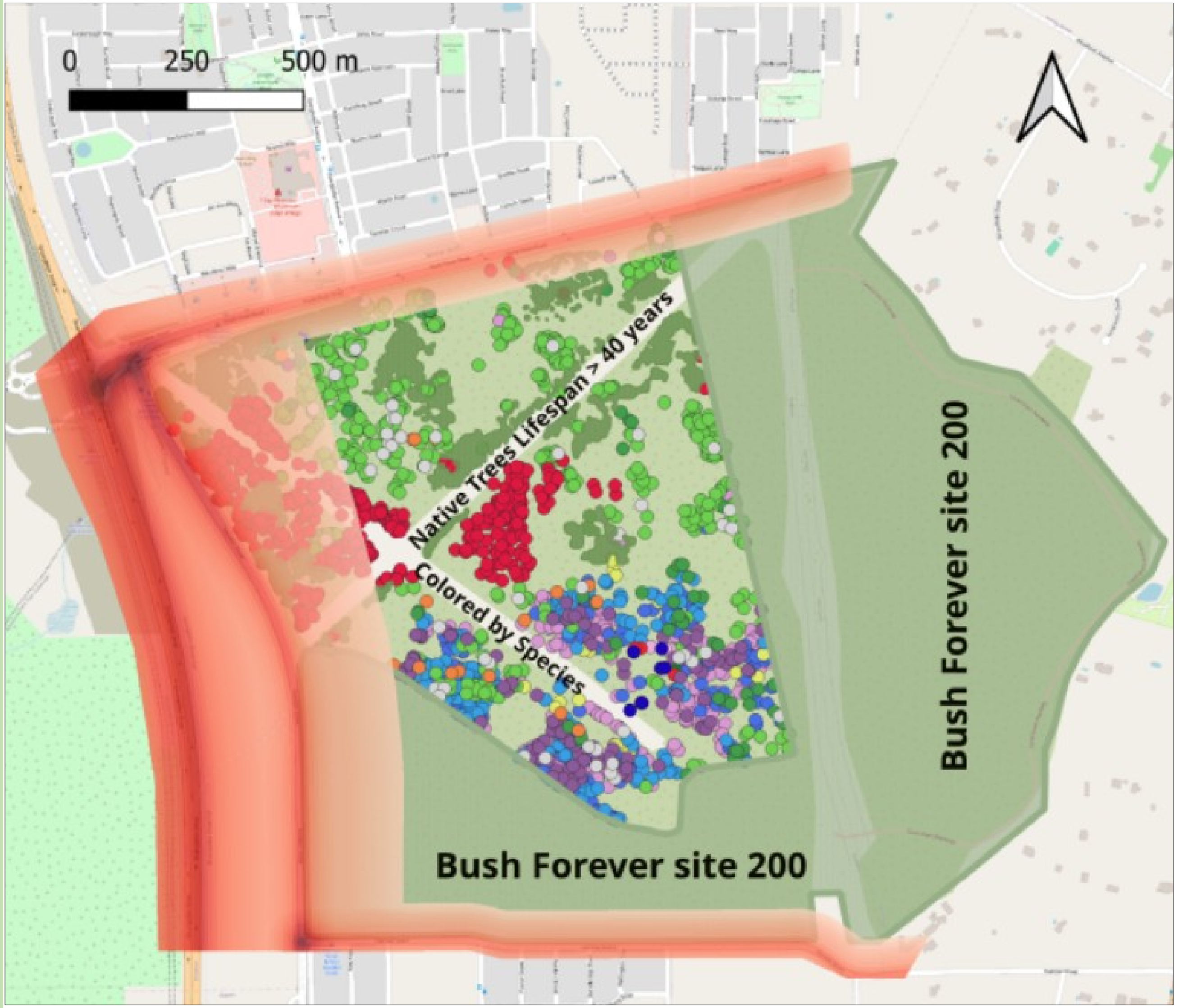


This map is the end result of combining the impact of sound, light and edge adjusted for impact distances from the source.

The surface was created with fuzzy logic calculations.

In this paper all the decays are calculated linearly. There is not enough research that indicate to select a different method.

Whole	Split	Area ha	Impact ha	Impact Percent
Bush Forever		137		
	Bush Forever – west		16	12%
	Bush Forever – east		39	28%
	Totals		54	40%



This map shows the calculated anthropogenic impact on the Bush Forever site if there was no urban development and road construction

The impact of the Bush Forever site has now been reduced to 16%.

Whole	Affected by	Area ha	Impact ha	Impact %
Bush Forever		137		
	Dayton +Drumpellier		21	15%
Brabham stage 2 (Airfield)		100		
	Brabham stage 2		16	16%
	Totals	237	37	16%

Summary

In this presentation we have tried to show that the proposed methodology using multi-buffer and multi-criteria analysis to quantify the impact of anthropogenic activities and able to visualize its results.

Combining multiple impact variables is more natural than just looking at one. However, more research in all impact variables is essential to improve the overall impact picture.

Hopefully, this spurs more research into improving field measurements of the anthropogenic impacts.

NOTE :

This presentation is based on a paper with same title "*Impact Zones by Urban Development on Bushland: Delineated by Multi-Criteria Analysis with Variable Bufferzones*" (in press) because it needs updating since the presentation was done. In time it can be downloaded from the PaYUng Contracting website www.payung.biz.

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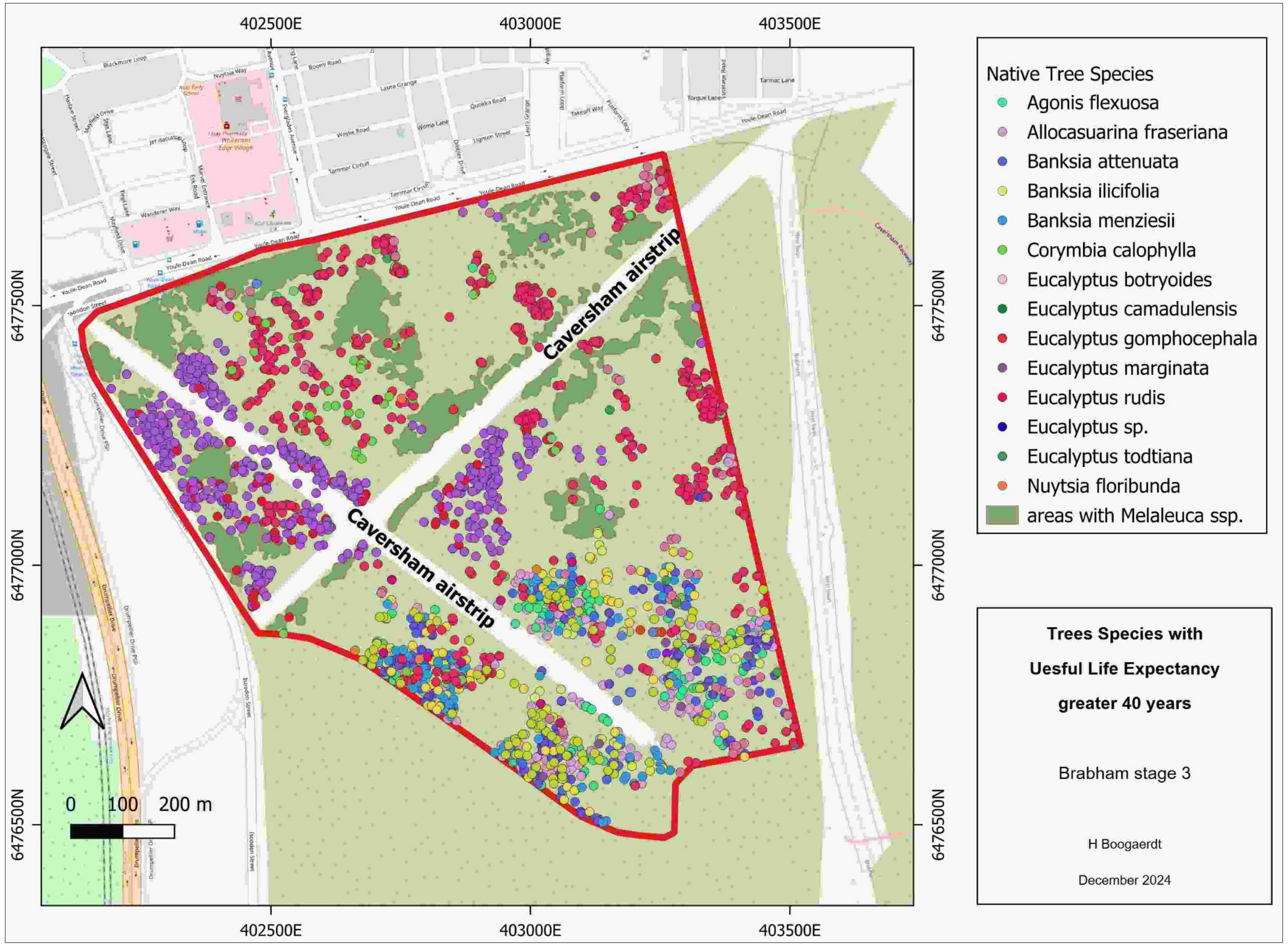
Supplementary Information



All the trees colored according to species that have a Useful Life Expectancy of greater than 40 years.

The solid green areas represent dense Melaleuca ssp. trees. They were not individually surveyed but a visual inspection indicates a large proportion are very mature and in good health.

All trees of this 100ha site bar 5ha in south- east corner will be chopped down.

(Boogaerdt, 2024a)