



Supplementary data

Clustering of green space qualities: evidence from three Australian cities

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S1. Domains and qualities

Scheme 1 refers to the Initial Scheme; Scheme 2A refers to the Amenities and Environment Scheme; Scheme 2B refers to the Land Cover (Area) Scheme; and Scheme 2C refers to the Percentage-based Land Cover Scheme. Note Schemes 2A and 2C are described in the main text, while Schemes 1 and 2B are included in the Supplementary Material.

Scheme 1 was the initial scheme which included the following domains: (1) access/topography; (2) amenities; (3) biodiversity; (4) safety; (5) land cover, including positive scoring of coastline presence, beach area, area and percentage of tree canopy, area of outdoor swimming pools and water and, negative scoring of area and percentage of bare earth, open grass, shrubs, and area of roads; and (6) surrounding trees. These domains were amended from the seven domains in Del Rosario *et al.* ^[5]. The access/topography domain was renamed and the beach/coast domain was incorporated into the land cover domain. Land uses were changed to only include certain surrounding tree cover qualities of green spaces. As the surrounding ABS-derived land use categories were quite different to each other (e.g. Education, Hospital/Medical, Residential *etc.*), their calculation together would not be practically meaningful as a cluster.

This scheme was superseded by the Amenities and Environment and Percentage-based Land Cover Schemes, as they are conceptually more coherent, without some of the earlier assumptions about which land cover types are positive or negative.

Qualities included in the initial scheme are shown in Supplementary Table S1.



Table S1. Scheme 1: green space cluster domains and respective green space qualities.

No	Domain	Negative score	Quality	Description
1	Access/Topography n = 8		PathLen_w0sum	Length of pathways within green space
			BikeLen_w0sum	Length of bikeways within green space
			TrainLR100_w0sum	Number of Railway Stations within and surrounding a green space (within 100 m buffer)
			Bus_100_w0sum	Number of Bus Stops within and surrounding a green space (within 100 m buffer)
			Ferry_100_w0sum	Number of ferry wharves within and surrounding a green space (within 100 m buffer)
			AreaSlope6_w0sum	Area of green space which is greater than 6 degrees of Slope
			PerimeterRatioMN_w1mean	Ratio of Perimeter (P) to perimeter standardised by area (A)
			PerSlope6_eq	Percentage of space which is greater than 6 degrees of Slope
2	Amenities n = 7		Toilet_100_w0sum	Number of public toilet facilities within and surrounding a green space (within 100 m buffer)
			Cafe_100_w0sum	Number of cafes within and surrounding a green space (within 100 m buffer)
			Rest_100_w0sum	Number of restaurants within and surrounding a green space (within 100 m buffer)
			Superm_100_w0sum	Number of supermarkets/greengrocers within and surrounding a green space (within 100 m buffer)
			parkrun_ind	Presence of parkrun event within green space
		Negative	Hotels_100_w0sum	Number of hotels/bars within and surrounding a green space (within 100 m buffer)
		Negative	TA_100_w0sum	Number of takeaways within and surrounding a green space (within 100 m buffer)
3	Biodiversity n=5		Birds_Max	Number of bird species/species habitat likely to occur within green space
			Flora_Max	Number of flora species/species habitat likely to occur within green space
			Mammals_Max	Number of mammal species/species habitat likely to occur within green space
			BVin_m2_w0sum	Area of land with biodiversity value within green space
			Shannon_Index_eq	Shannon biodiversity index within green space
4	Safety n = 5	Negative	AlcAssault_Max	Density of alcohol-related assaults within green space
		Negative	MalDamage_Max	Density of malicious damage within green space
		Negative	NDAssault_Max	Density of non-domestic violence assaults within green space
		Negative	Robbery_Max	Density of robberies within green space
		Negative	StealPerso_Max	Density of steal from persons within green space
5	Land cover n = 13		Coast100_ind	Presence of coastline within green space
			Beach100_w0sum	Area of beach within and surrounding a green space (within 100 m buffer)
		Negative	AreaSEarth_w0sum	Area of bare earth within green space
		Negative	AreaSGrass_w0sum	Area of open grass within green space

Table S1. Cont.

No	Domain	Negative score	Quality	Description
5		Negative	AreaSOther_w0sum	Area of other vegetation e.g. shrubs within green space
			AreaSTrees_w0sum	Area of tree canopy within green space
		Negative	PerSEarth_eq	Percentage of bare earth within green space
		Negative	PerSGrass_eq	Percentage of open grass within green space
		Negative	PerSOther_eq	Percentage of other vegetation e.g. shrubs within green space
			PerSTrees_eq	Percentage of tree canopy within green space
		Negative	AreaSRoads_w0sum	Area of roads/paths within green space
			AreaSSwim_w0sum	Area of swimming pools within green space
			AreaSWater_w0sum	Area of water within green space
6	Surrounding Trees n = 2		Can100TrAl_w0sum	Area of tree canopy surrounding green space (within 100 m doughnut buffer)
			CanPerTR_eq	Percentage of tree canopy to roads surrounding green space (within 100 m doughnut buffer)

Note: Access and topography qualities were combined as hillier terrain could provide access to more dramatic scenery and a long/thin green space shape (higher Ratio of Perimeter to perimeter standardised by area) could provide opportunities for a longer walk.

Note that original data in the “Safety” domain is for crimes. The domain was called “Safety” here as the qualities were scored negatively and inverted.

Qualities included in the amenities and environment scheme are shown in Supplementary Table S2.

Table S2. Scheme 2A: green space cluster domains and respective green space qualities.

No	Domain	Negative score	Quality	Description
1	Access/Topography * n = 8		PathLen_w0sum	Length of pathways within green space
			BikeLen_w0sum	Length of bikeways within green space
			TrainLR100_w0sum	Number of Railway Stations within and surrounding a green space (within 100 m buffer)
			Bus_100_w0sum	Number of Bus Stops within and surrounding a green space (within 100 m buffer)
			Ferry_100_w0sum	Number of ferry wharves within and surrounding a green space (within 100 m buffer)
			AreaSlope6_w0sum	Area of park which is greater than 6 degrees of Slope
			PerimeterRatioMN_w1mean	Ratio of Perimeter (P) to perimeter standardised by area (A)
			PerSlope6_eq	Percentage of park which is greater than 6 degrees of Slope
2	Amenities positive+ n = 5		Toilet_100_w0sum	Number of public toilet facilities within and surrounding a green space (within 100 m buffer)
			Cafe_100_w0sum	Number of cafes within and surrounding a green space (within 100 m buffer)
			Rest_100_w0sum	Number of restaurants within and surrounding a green space (within 100 m buffer)
			Superm_100_w0sum	Number of supermarkets/greengrocers within and surrounding a green space (within 100 m buffer)

Table S2. Cont.

No	Domain	Negative score	Quality	Description
2			parkrun_ind	Presence of parkrun event
3	Amenities negative+	Negative	Hotels_100_w0sum	Number of hotels/bars within and surrounding a green space (within 100 m buffer)
	n = 2	Negative	TA_100_w0sum	Number of takeaways within and surrounding a green space (within 100 m buffer)
4	Biodiversity*		Birds_Max	Number of bird species/species habitat likely to occur within green space
	n = 5		Flora_Max	Number of flora species/species habitat likely to occur within green space
			Mammals_Max	Number of mammal species/species habitat likely to occur within green space
			BVin_m2_w0sum	Area of land with biodiversity value within green space
			Shannon_Index_eq	Shannon biodiversity index
5	Safety*	Negative	AlcAssault_Max	Density of alcohol-related assaults
	n = 5	Negative	MalDamage_Max	Density of malicious damage
		Negative	NDAssault_Max	Density of non-domestic violence assaults
		Negative	Robbery_Max	Density of robberies
		Negative	StealPerso_Max	Density of steal from persons
6	Surrounding Trees*		Can100TrAl_w0sum	Area of tree canopy surrounding green space (within 100 m doughnut buffer)
	n = 2		CanPerTR_eq	Percentage of tree canopy to roads surrounding green space (within 100 m doughnut buffer)
7	Total green space area		Int_Area_sum	Intersect of network buffer with green space
8	Beaches/Coastline		Coast100_ind	Presence of coastline
	n = 2		Beach100_w0sum	Area of beach within and surrounding a green space (within 100 m buffer)

* = same as in Scheme 1.

+ = portion of a domain from Scheme 1 is the same.

Note that original data in the "Safety" domain is for crimes. The domain was called "Safety" here as the qualities were scored negatively and inverted.

Qualities included in Area of land cover and Percentage-based land cover schemes are shown in Supplementary Table S3. Note, the area of land cover scheme is only included in the Supplementary Material and not in the main text.

Table S3. Scheme 1: green space cluster domains and respective green space qualities.

No	Domain	Quality	Description
Scheme 2B Areas of land cover (n = 1 per domain)			
1	Earth	AreaSEarth_w0sum	Area of bare earth within green space
2	Grass	AreaSGrass_w0sum	Area of open grass within green space
3	Other (Shrub)	AreaSOther_w0sum	Area of other vegetation e.g. shrubs within green space
4	Trees	AreaSTrees_w0sum	Area of tree canopy within green space
5	Built up	AreaSBuilt_w0sum	Area of built up area within green space
6	Roads	AreaSRoads_w0sum	Area of roads/paths within green space
7	Swimming pools	AreaSSwim_w0sum	Area of swimming pools within green space
8	Water	AreaSWater_w0sum	Area of water within green space
Scheme 2C Percentages of Area of land cover (n = 1 per domain)			
1	Earth	PerSEarth_eq	Percentage of bare earth within green space
2	Grass	PerSGrass_eq	Percentage of open grass within green space
3	Other (Shrub)	PerSOther_eq	Percentage of other vegetation e.g. shrubs within green space
4	Trees	PerSTrees_eq	Percentage of tree canopy within green space
5	Built up	PerSBuilt_eq	Percentage of built up area within green space
6	Roads	PerSRoads_eq	Percentage of roads/paths within green space
7	Swimming pools	PerSSwim_eq	Percentage of swimming pools within green space
8	Water	PerSWater_eq	Percentage of water within green space

Table S4. Inter-correlation of General qualities (Spearman's rho), 1600 m. Highlighted values indicate $\text{Rho} \geq 0.80$.

	Quality	Selected	1	2	3	4
			Int_Area_sum	n_gs	Area_m2_sum	Perim_m_w0sum
1	Int_Area_sum (Scheme 2A)	Yes		0.44	0.53	0.77
2	n_gs		0.44		0.13	0.83
3	Area_m2_sum		0.53	0.13		0.26
4	Perim_m_w0sum		0.77	0.83	0.26	

Only one quality, Intersect of buffer with green space (Int_Area) was used as a single quality in domain 7, Total green space, Scheme 2A. The other three qualities were removed due to conceptual irrelevance.

Table S5. Inter-correlation of Accessibility and Topography qualities (Spearman's rho), 1600 m. Highlighted values indicate Rho ≥ 0.80 .

			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
			PathLen_w0sum	BikeLen_w0sum	TrOverPath_w0sum	TrOverBike_w0sum	Path6Over_w0sum	Bike6Over_w0sum	PathPerMSq_eq	BikePerMSq_eq	TrPerPath_eq	TrPerBike_eq	PathPer6Ov_eq	BikePer6Ov_eq	TrainLR100_w0sum	Bus_100_w0sum	Ferry_100_w0sum	Trans_100_eq	AreaSlope6_w0sum	PerSlope6_eq	MnRd100Len_w0sum	ShapeRatio_w1mean	PerimeterRatioMN_w1mean
Quality	Selected																						
1 PathLen_w0sum	Yes			0.74	0.90	0.70	0.78	0.64	0.83	0.54	0.71	0.51	0.62	0.46	0.21	0.56	0.18	0.56	0.42	-0.07	0.43	0.12	0.20
2 BikeLen_w0sum	Yes		0.74		0.64	0.87	0.53	0.81	0.49	0.85	0.41	0.70	0.32	0.64	0.15	0.41	0.14	0.41	0.36	-0.16	0.32	0.23	0.08
3 TrOverPath_w0sum			0.90	0.64		0.75	0.77	0.61	0.77	0.47	0.87	0.61	0.64	0.45	0.27	0.53	0.15	0.54	0.45	0.05	0.45	0.10	0.23
4 TrOverBike_w0sum			0.70	0.87	0.75		0.55	0.79	0.52	0.76	0.59	0.90	0.39	0.67	0.21	0.45	0.14	0.45	0.36	-0.05	0.38	0.13	0.19
5 Path6Over_w0sum			0.78	0.53	0.77	0.55		0.70	0.66	0.35	0.65	0.40	0.92	0.58	0.10	0.41	0.28	0.42	0.68	0.38	0.32	0.09	0.32
6 Bike6Over_w0sum			0.64	0.81	0.61	0.79	0.70		0.45	0.69	0.43	0.67	0.56	0.91	0.14	0.33	0.21	0.34	0.56	0.19	0.27	0.13	0.23
7 PathPerMSq_eq			0.83	0.49	0.77	0.52	0.66	0.45		0.54	0.85	0.53	0.68	0.44	0.24	0.37	0.21	0.39	0.12	-0.07	0.29	-0.17	0.25
8 BikePerMSq_eq			0.54	0.85	0.47	0.76	0.35	0.69	0.54		0.44	0.82	0.29	0.72	0.16	0.20	0.15	0.21	0.06	-0.19	0.17	-0.01	0.10
9 TrPerPath_eq			0.71	0.41	0.87	0.59	0.65	0.43	0.85	0.44		0.63	0.68	0.43	0.30	0.36	0.15	0.37	0.21	0.08	0.32	-0.15	0.26
10 TrPerBike_eq			0.51	0.70	0.61	0.90	0.40	0.67	0.53	0.82	0.63		0.37	0.71	0.23	0.29	0.14	0.30	0.14	-0.05	0.27	-0.09	0.21
11 PathPer6Ov_eq			0.62	0.32	0.64	0.39	0.92	0.56	0.68	0.29	0.68	0.37		0.57	0.08	0.26	0.30	0.27	0.52	0.46	0.19	-0.10	0.37
12 BikePer6Ov_eq			0.46	0.64	0.45	0.67	0.58	0.91	0.44	0.72	0.43	0.71	0.57		0.12	0.17	0.22	0.18	0.37	0.23	0.15	-0.06	0.27
13 TrainLR100_w0sum	Yes		0.21	0.15	0.27	0.21	0.10	0.14	0.24	0.16	0.30	0.23	0.08	0.12		0.31	0.01	0.35	-0.05	-0.17	0.33	-0.07	-0.14
14 Bus_100_w0sum	Yes		0.56	0.41	0.53	0.45	0.41	0.33	0.37	0.20	0.36	0.29	0.26	0.17	0.31		0.09	1.00	0.30	-0.12	0.62	-0.10	0.10
15 Ferry_100_w0sum	Yes		0.18	0.14	0.15	0.14	0.28	0.21	0.21	0.15	0.15	0.14	0.30	0.22	0.01	0.09		0.11	0.16	0.15	0.11	-0.10	0.14
16 Trans_100_eq			0.56	0.41	0.54	0.45	0.42	0.34	0.39	0.21	0.37	0.30	0.27	0.18	0.35	1.00	0.11		0.30	-0.12	0.62	-0.10	0.10
17 AreaSlope6_w0sum	Yes		0.42	0.36	0.45	0.36	0.68	0.56	0.12	0.06	0.21	0.14	0.52	0.37	-0.05	0.30	0.16	0.30		0.70	0.23	0.28	0.27
18 PerSlope6_eq	Yes		-0.07	-0.16	0.05	-0.05	0.38	0.19	-0.07	-0.19	0.08	-0.05	0.46	0.23	-0.17	-0.12	0.15	-0.12	0.70		-0.10	-0.05	0.33
19 MnRd100Len_w0sum			0.43	0.32	0.45	0.38	0.32	0.27	0.29	0.17	0.32	0.27	0.19	0.15	0.33	0.62	0.11	0.62	0.23	-0.10		-0.01	0.04
20 ShapeRatio_w1mean			0.12	0.23	0.10	0.13	0.09	0.13	-0.17	-0.01	-0.15	-0.09	-0.10	-0.06	-0.07	-0.10	-0.10	-0.10	0.28	-0.05	-0.01		-0.34
21 PerimeterRatioMN_w1mean	Yes		0.20	0.08	0.23	0.19	0.32	0.23	0.25	0.10	0.26	0.21	0.37	0.27	-0.14	0.10	0.14	0.10	0.27	0.33	0.04	-0.34	

Pathway length (PathLen_w0sum) and bikeway length (BikeLen_w0sum) were included. Ten other pathway/bikeway-related qualities were removed due to conceptual similarity, but many were also highly correlated.

Total number of transport stops/stations/wharves (Trans_100_eq) was removed due to high correlations.

Length of Main Roads outside GS (MnRd100Len_w0sum) was excluded due to conceptual irrelevance and Ratio of Area to Perimeter (ShapeRatio_w1mean) was excluded due to conceptual similarity with Ratio of Perimeter to perimeter standardised by area (PerimeterRatioMN_w1mean).

Table S6. Inter-correlation of amenities and activities qualities (Spearman's rho), 1600 m. Highlighted values indicate $Rho \geq 0.80$.

Variable	Selected	1	2	3	4	5	6	7	8
		Toilet_100_w0sum	Cafe_100_w0sum	Rest_100_w0sum	Superm_100_w0sum	parkrun_ind	TA_100_w0sum	Hotels_100_w0sum	RestTA_100_w0sum
1 Toilet_100_w0sum	Yes		0.66	0.72	0.55	0.23	0.63	0.47	0.72
2 Cafe_100_w0sum	Yes	0.66		0.76	0.63	0.21	0.72	0.61	0.78
3 Rest_100_w0sum	Yes	0.72	0.76		0.67	0.21	0.77	0.58	0.94
4 Superm_100_w0sum	Yes	0.55	0.63	0.67		0.13	0.70	0.52	0.72
5 parkrun_ind	Yes	0.23	0.21	0.21	0.13		0.19	0.15	0.21
6 TA_100_w0sum	Yes	0.63	0.72	0.77	0.70	0.19		0.56	0.92
7 Hotels_100_w0sum	Yes	0.47	0.61	0.58	0.52	0.15	0.56		0.59
8 RestTA_100_w0sum		0.72	0.78	0.94	0.72	0.21	0.92	0.59	

Number of restaurants/takeaways (RestTA_100_w0sum) was excluded due to high intercorrelations.

Table S7. Inter-correlation of Biodiversity qualities (Spearman's rho), 1600 m. Highlighted values indicate Rho ≥ 0.80 .

Quality	Selected	1	2	3	4	5	6	7	8	9	10	11	12	13	14
		Birds_Max	Flora_Max	Mammals_Max	Fishes_Max	Frogs_Max	Reptiles_Max	OtherAnima_Max	Nspecies_eq	BVin_m2_w0sum	BV100_m2_w0sum	PerBVin_eq	PerBV100_eq	Shannon_Index_eq	Simpson_Index_eq
1 Birds_Max	Yes		0.08	0.59	0.83	0.27	0.81	0.13	0.90	-0.15	0.01	-0.22	-0.06	0.31	-0.26
2 Flora_Max	Yes	0.08		0.27	0.06	0.17	0.18	0.24	0.37	0.09	0.12	0.12	0.18	0.48	0.54
3 Mammals_Max	Yes	0.59	0.27		0.66	0.31	0.60	0.30	0.75	-0.21	-0.18	-0.23	-0.20	0.63	0.39
4 Fishes_Max		0.83	0.06	0.66		0.30	0.89	0.21	0.85	-0.14	-0.02	-0.19	-0.07	0.63	0.08
5 Frogs_Max		0.27	0.17	0.31	0.30		0.35	0.09	0.38	-0.14	-0.06	-0.17	-0.12	0.45	0.26
6 Reptiles_Max		0.81	0.18	0.60	0.89	0.35		0.18	0.84	-0.15	-0.01	-0.20	-0.05	0.64	0.06
7 OtherAnima_Max		0.13	0.24	0.30	0.21	0.09	0.18		0.28	0.18	0.21	0.20	0.20	0.49	0.38
8 Nspecies_eq		0.90	0.37	0.75	0.85	0.38	0.84	0.28		-0.17	0.00	-0.21	-0.04	0.57	0.06
9 BVin_m2_w0sum	Yes	-0.15	0.09	-0.21	-0.14	-0.14	-0.15	0.18	-0.17		0.82	0.95	0.79	-0.04	0.02
10 BV100_m2_w0sum		0.01	0.12	-0.18	-0.02	-0.06	-0.01	0.21	0.00	0.82		0.78	0.93	-0.03	-0.08
11 PerBVin_eq		-0.22	0.12	-0.23	-0.19	-0.17	-0.20	0.20	-0.21	0.95	0.78		0.83	-0.04	0.06
12 PerBV100_eq		-0.06	0.18	-0.20	-0.07	-0.12	-0.05	0.20	-0.04	0.79	0.93	0.83		-0.03	-0.03
13 Shannon_Index_eq	Yes	0.31	0.48	0.63	0.63	0.45	0.64	0.49	0.57	-0.04	-0.03	-0.04	-0.03		0.76
14 Simpson_Index_eq		-0.26	0.54	0.39	0.08	0.26	0.06	0.38	0.06	0.02	-0.08	0.06	-0.03	0.76	

Numbers of species/habitat: Fish (Fishes_Max), Reptiles (Reptiles_Max), Total number of species (Nspecies_eq) were removed due to high inter-correlations. Frogs (Frogs_Max) and Other animals (OtherAnima_Max) (as well as Fish and Reptiles) had small absolute numbers and so were removed. For groups of animals rejected due to small number of species, on average, each mesh block had 2 species of frogs and 0.2 species of other animals. The most populous group, birds, had on average 31.7 different species per mesh block.

Area and Percentage of land with biodiversity value. Four indices were highly inter-correlated (minimum $\rho = 0.78$). We removed three of them, leaving Area of land with biodiversity value within GS (BVin_m2_w0sum).

Indices of biodiversity. The Simpson Index (Simpson_Index_eq) was removed as it was conceptually similar to the Shannon Index. These two indices were also close to the high intercorrelation threshold, with $\rho = 0.76$.

Table S8. Inter-correlation of safety qualities (Spearman's ρ), 1600 m. Highlighted values indicate $\rho \geq 0.80$.

Quality		1	2	3	4	5	6
		AlcAssault_Max	MalDamage_Max	NDAssault_Max	Robbery_Max	StealPerso_Max	Incivility_eq
1 AlcAssault_Max	Yes		0.65	0.79	0.64	0.70	0.87
2 MalDamage_Max	Yes	0.65		0.73	0.62	0.58	0.82
3 NDAssault_Max	Yes	0.79	0.73		0.73	0.74	0.91
4 Robbery_Max	Yes	0.64	0.62	0.73		0.65	0.84
5 StealPerso_Max	Yes	0.70	0.58	0.74	0.65		0.84
6 Incivility_eq		0.87	0.82	0.91	0.84	0.84	

Mean level of incivilities (Incivility_eq) was removed as it was highly correlated with each of the other safety qualities.

Table S9. Inter-correlation of Land cover qualities (Spearman's rho). Highlighted values indicate Rho ≥ 0.80 .

			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
			AreaSEarth_w0sum	AreaSGrass_w0sum	AreaSOther_w0sum	AreaSTrees_w0sum	AreaSRoads_w0sum	AreaSSwim_w0sum	AreaSWater_w0sum	AreaSBuilt_w0sum	AreaSBuid_w0sum	AreaSShad_w0sum	PerSEarth_eq	PerSGrass_eq	PerSOther_eq	PerSTrees_eq	PerSRoads_eq	PerSSwim_eq	PerSWater_eq	PerSBuilt_eq	PerSBuid_eq	PerSShad_eq	Coast100_ind	Beach100_w0sum
Variable	Selected																							
1 AreaSEarth_w0sum	Sch 1	Sch 2B		0.53	0.63	0.13	0.56	0.28	0.41	0.38	0.50	-0.09	0.79	0.07	0.10	-0.55	0.26	0.07	0.30	-0.02	0.16	-0.29	0.09	0.14
2 AreaSGrass_w0sum	Sch 1	Sch 2B	0.53		0.50	0.33	0.61	0.38	0.35	0.58	0.56	0.17	0.12	0.66	-0.25	-0.41	0.27	0.13	0.21	0.14	0.17	-0.05	0.01	0.04
3 AreaSOther_w0sum	Sch 1	Sch 2B	0.63	0.50		0.49	0.55	0.19	0.43	0.29	0.37	-0.04	0.20	-0.10	0.50	-0.20	0.15	-0.09	0.28	-0.24	-0.11	-0.28	0.04	0.04
4 AreaSTrees_w0sum	Sch 1	Sch 2B	0.13	0.33	0.49		0.25	0.37	0.37	0.41	0.36	0.53	-0.34	-0.26	-0.11	0.57	-0.12	0.16	0.25	0.03	0.01	0.35	0.18	0.14
5 AreaSRoads_w0sum	Sch 1	Sch 2B	0.56	0.61	0.55	0.25		0.32	0.43	0.58	0.60	-0.03	0.22	0.18	-0.04	-0.38	0.83	0.10	0.32	0.22	0.29	-0.22	0.18	0.13
6 AreaSSwim_w0sum	Sch 1	Sch 2B	0.28	0.38	0.19	0.37	0.32		0.31	0.58	0.56	0.37	0.04	0.09	-0.32	0.01	0.13	0.92	0.24	0.41	0.43	0.25	0.14	0.12
7 AreaSWater_w0sum	Sch 1	Sch 2B	0.41	0.35	0.43	0.37	0.43	0.31		0.45	0.38	0.15	0.14	-0.06	-0.03	-0.08	0.20	0.14	0.97	0.17	0.12	0.00	0.36	0.33
8 AreaSBuilt_w0sum		Sch 2B	0.38	0.58	0.29	0.41	0.58	0.58	0.45		0.83	0.43	0.05	0.18	-0.39	-0.13	0.35	0.41	0.34	0.78	0.63	0.27	0.27	0.24
9 AreaSBuid_w0sum			0.50	0.56	0.37	0.36	0.60	0.56	0.38	0.83		0.33	0.17	0.12	-0.32	-0.20	0.34	0.37	0.27	0.54	0.81	0.16	0.19	0.19
10 AreaSShad_w0sum			-0.09	0.17	-0.04	0.53	-0.03	0.37	0.15	0.43	0.33		-0.31	-0.05	-0.45	0.43	-0.21	0.30	0.10	0.36	0.27	0.94	0.15	0.07
11 PerSEarth_eq	Sch 1	Sch 2C	0.79	0.12	0.20	-0.34	0.22	0.04	0.14	0.05	0.17	-0.31		0.05	0.15	-0.65	0.20	0.01	0.13	-0.03	0.12	-0.37	0.00	0.09
12 PerSGrass_eq	Sch 1	Sch 2C	0.07	0.66	-0.10	-0.26	0.18	0.09	-0.06	0.18	0.12	-0.05	0.05		-0.32	-0.56	0.19	0.06	-0.09	0.14	0.08	-0.10	-0.19	-0.12
13 PerSOther_eq	Sch 1	Sch 2C	0.10	-0.25	0.50	-0.11	-0.04	-0.32	-0.03	-0.39	-0.32	-0.45	0.15	-0.32		-0.12	-0.05	-0.34	-0.02	-0.49	-0.42	-0.46	-0.15	-0.12
14 PerSTrees_eq	Sch 1	Sch 2C	-0.55	-0.41	-0.20	0.57	-0.38	0.01	-0.08	-0.13	-0.20	0.43	-0.65	-0.56	-0.12		-0.40	0.06	-0.06	-0.04	-0.14	0.50	0.12	0.04
15 PerSRoads_eq		Sch 2C	0.26	0.27	0.15	-0.12	0.83	0.13	0.20	0.35	0.34	-0.21	0.20	0.19	-0.05	-0.40		0.06	0.18	0.29	0.30	-0.27	0.14	0.08
16 PerSSwim_eq		Sch 2C	0.07	0.13	-0.09	0.16	0.10	0.92	0.14	0.41	0.37	0.30	0.01	0.06	-0.34	0.06	0.06		0.13	0.44	0.42	0.28	0.11	0.10
17 PerSWater_eq		Sch 2C	0.30	0.21	0.28	0.25	0.32	0.24	0.97	0.34	0.27	0.10	0.13	-0.09	-0.02	-0.06	0.18	0.13		0.16	0.10	0.00	0.36	0.33
18 PerSBuilt_eq		Sch 2C	-0.02	0.14	-0.24	0.03	0.22	0.41	0.17	0.78	0.54	0.36	-0.03	0.14	-0.49	-0.04	0.29	0.44	0.16		0.71	0.37	0.24	0.20
19 PerSBuid_eq			0.16	0.17	-0.11	0.01	0.29	0.43	0.12	0.63	0.81	0.27	0.12	0.08	-0.42	-0.14	0.30	0.42	0.10	0.71		0.25	0.15	0.14
20 PerSShad_eq			-0.29	-0.05	-0.28	0.35	-0.22	0.25	0.00	0.27	0.16	0.94	-0.37	-0.10	-0.46	0.50	-0.27	0.28	0.00	0.37	0.25		0.13	0.04
Beach/Coast																								
21 Coast100_ind	Sch 1	Sch 2A	0.09	0.01	0.04	0.18	0.18	0.14	0.36	0.27	0.19	0.15	0.00	-0.19	-0.15	0.12	0.14	0.11	0.36	0.24	0.15	0.13		0.67
22 Beach100_w0sum	Sch 1	Sch 2A	0.14	0.04	0.04	0.14	0.13	0.12	0.33	0.24	0.19	0.07	0.09	-0.12	-0.12	0.04	0.08	0.10	0.33	0.20	0.14	0.04		0.67

Shadows can vary with different times of day, different seasons or different weather patterns. As such Area and Percentage of Shadow (AreaSShad_w0sum, PerSShad_eq) qualities were excluded from Scheme 1 and Scheme 2A.

Area of Buildings (AreaSBUILD_w0sum) was highly correlated with Area of Built-up. Percentage of Buildings (PerSBUILD_eq) was highly correlated with Area of Buildings. As such AreaSBUILD_w0sum and PerSBUILD_eq qualities were excluded from Scheme 1 and Scheme 2A.

Table S10. Inter-correlation of surrounding trees qualities (Spearman's rho), 1600 m. Highlighted values indicate $Rho \geq 0.80$.

	Selected	21 Can100TrAl_w0sum	22 Can100TrS4_w0sum	23 Can100TrG4_w0sum	24 Can100TrPe_eq	25 Can100TS4P_eq	26 Can100TG4P_eq	27 CanPerTR_eq	28 CanPerTS4_eq	29 CanPerTG4_eq
21 Can100TrAl_w0sum	Yes		0.91	1.00	0.77	0.46	0.78	0.70	0.24	0.70
22 Can100TrS4_w0sum		0.91		0.89	0.57	0.56	0.55	0.46	0.33	0.45
23 Can100TrG4_w0sum		1.00	0.89		0.79	0.44	0.79	0.72	0.23	0.73
24 Can100TrPe_eq		0.77	0.57	0.79		0.59	1.00	0.94	0.39	0.94
25 Can100TS4P_eq		0.46	0.56	0.44	0.59		0.54	0.47	0.80	0.42
26 Can100TG4P_eq		0.78	0.55	0.79	1.00	0.54		0.95	0.35	0.95
27 CanPerTR_eq	Yes	0.70	0.46	0.72	0.94	0.47	0.95		0.45	1.00
28 CanPerTS4_eq		0.24	0.33	0.23	0.39	0.80	0.35	0.45		0.39
29 CanPerTG4_eq		0.70	0.45	0.73	0.94	0.42	0.95	1.00	0.39	

The various surrounding land use qualities (area/percentage of commercial, education, hospital/medical, industrial, other, parkland, primary production, residential, transport, and water) were conceptually irrelevant to forming clusters.

The surrounding tree canopy qualities that were excluded were conceptually similar to Area of tree canopy surrounding GS (Can100TrAl_w0sum) and Percentage of tree canopy to roads surrounding GS (CanPerTR_eq). Most also had high intercorrelations.

S2. Clustering methods and models

S2.1. Clustering models

Table S11. Statistics of the best performing clustering models.

Clustering Scheme	K	Buffer (m)					
		1600	800	400	1600	800	400
		Within STD			R-square		
Scheme 1	4	0.70	0.73	0.76	0.50	0.47	0.43
Scheme 2A	5	0.68	0.69	0.71	0.54	0.53	0.50
Scheme 2B	4	0.73	0.71	0.69	0.46	0.50	0.52
Scheme 2C	4	0.78	0.80	0.79	0.39	0.36	0.37

SAS Proc Fastclus was used for clustering. K = number of clusters in the model. Within STD = the pooled within-cluster standard deviation; R-Square = the R square for predicting the variable from the cluster, $R \text{ square} = 1 - \text{STD}^2$. Estimation of the cluster model was made on 500 randomisations of the position of observations, and the solution with the lowest within cluster STD was selected.

S2.2. Aligning clusters across different network buffers (scales)

As the SAS FASTCLUS program assigns a number to a cluster independently for a sample belonging to a different network buffer scale, we aligned numbering of clusters by: (1) minimal sum of squared deviations (Min SS) between domains means of clusters; (2) maximal percentage of equally numbered clusters (% equal) and; (3) maximal value of the

Spearman’s correlation coefficient (ρ) between two buffer scales. The main criterion was Min SS, which was consistent with the visual profiles of clusters on the radar graphs (e.g. see Figure 1–Figure 2).

S3. Maps

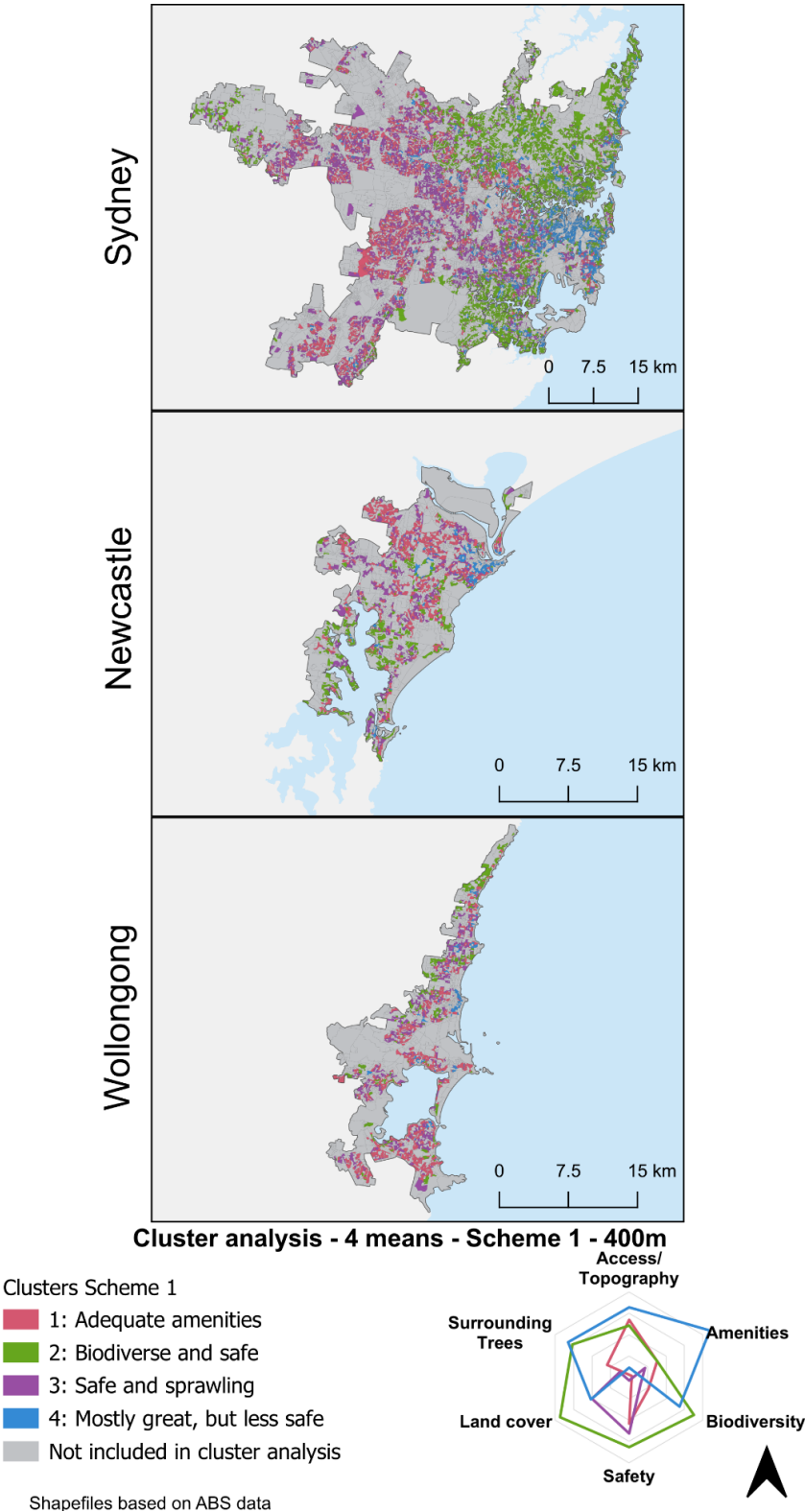


Figure S1. Cluster analysis—Scheme 1—400 m. Axis for radar graph is between –1.0–1.0.

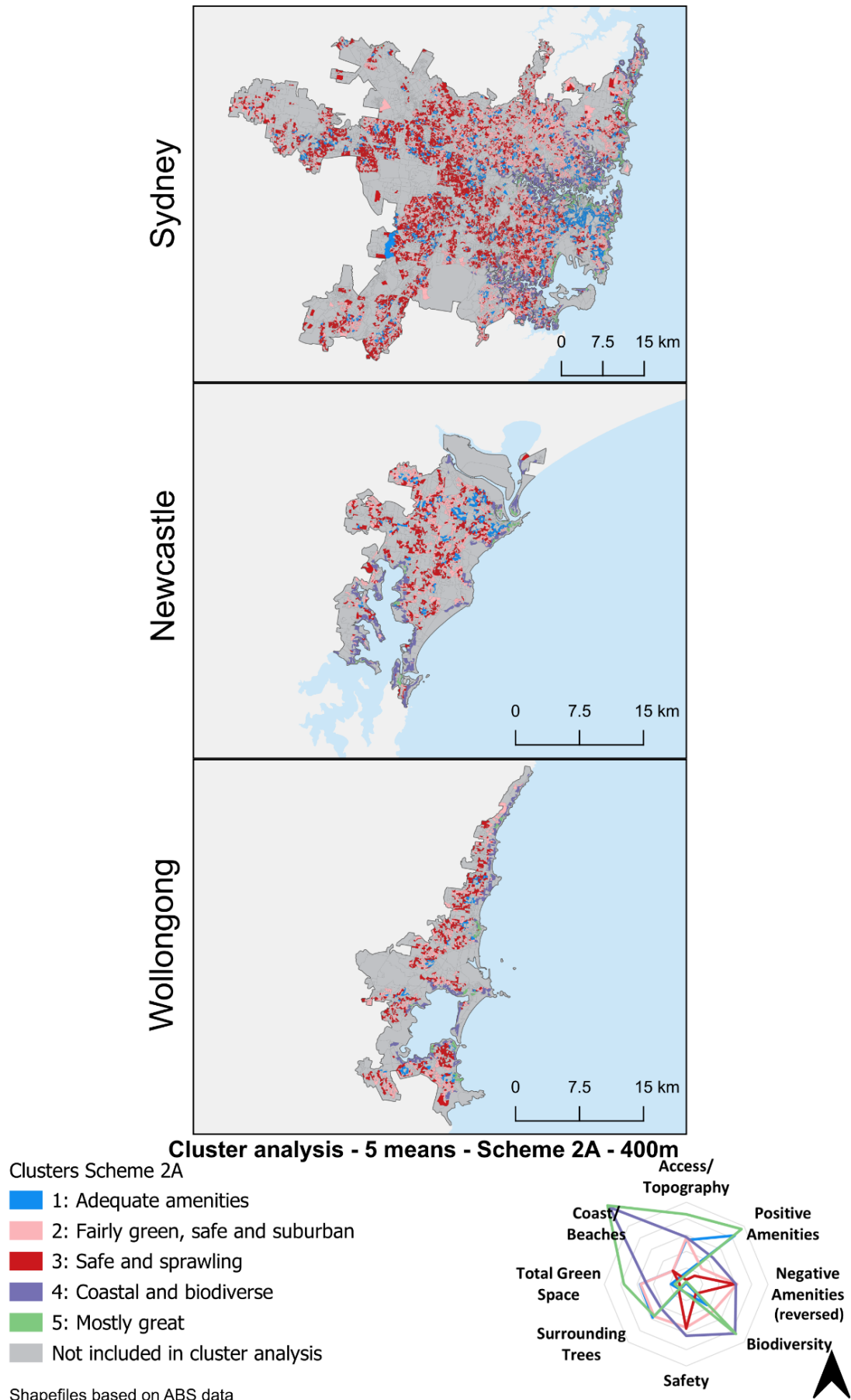


Figure S2. Cluster analysis—Scheme 2A—400 m. Axis for radar graph is between -1.0 – 1.5 .

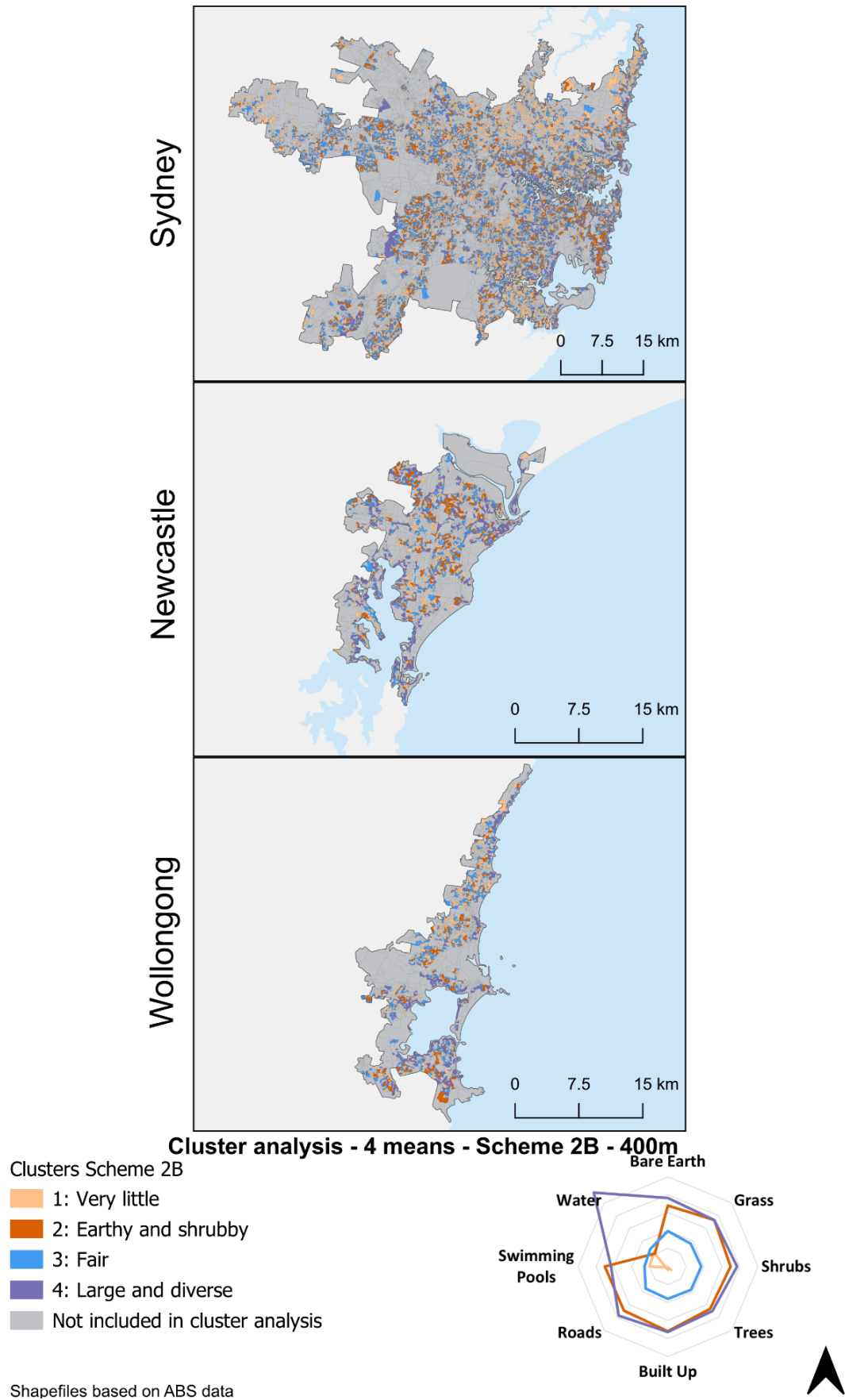


Figure S3. Cluster analysis—Scheme 2B—400 m. Axis for radar graph is between -1.0 – 1.5 . Note—‘water’ means water in a park that is not a swimming pool e.g. “streams, canals, ponds, lakes, reservoirs, estuaries, and bays” [44].

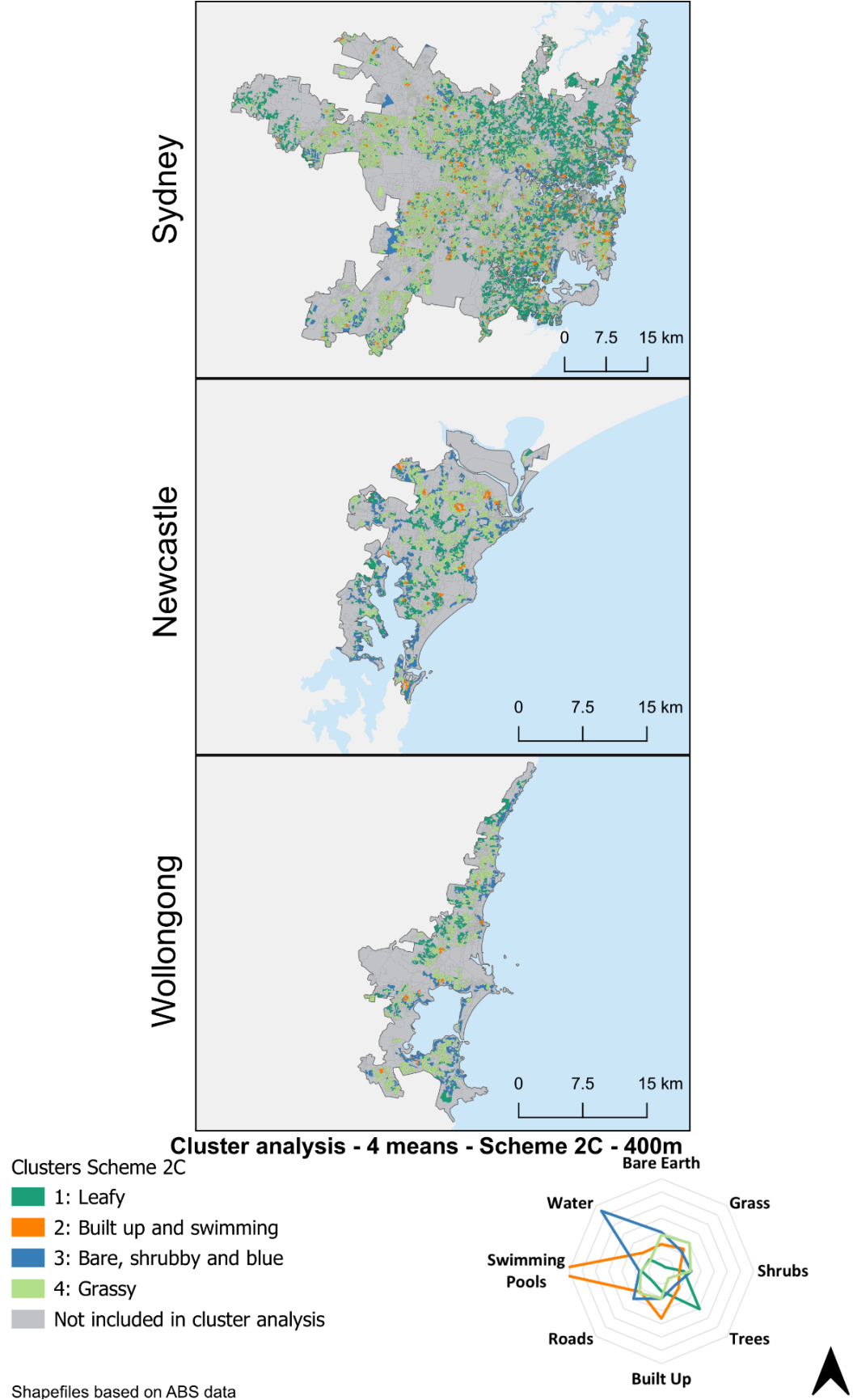


Figure S4. Cluster analysis—Scheme 2C—400 m. Axis for radar graph is between -1.0 – 2.5 .

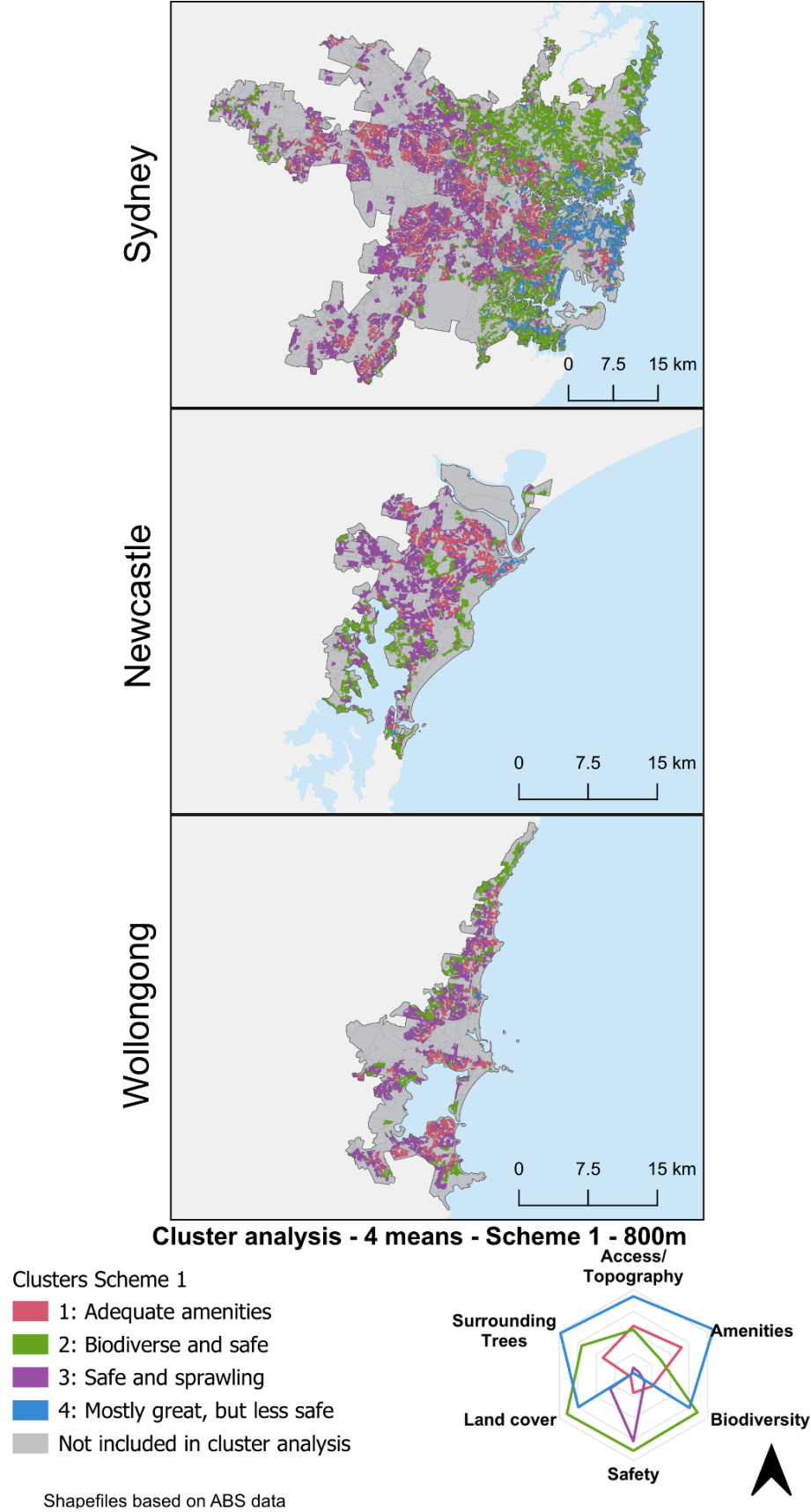


Figure S5. Cluster analysis—Scheme 1—800 m. Axis for radar graph is between -1.0 – 1.0 .

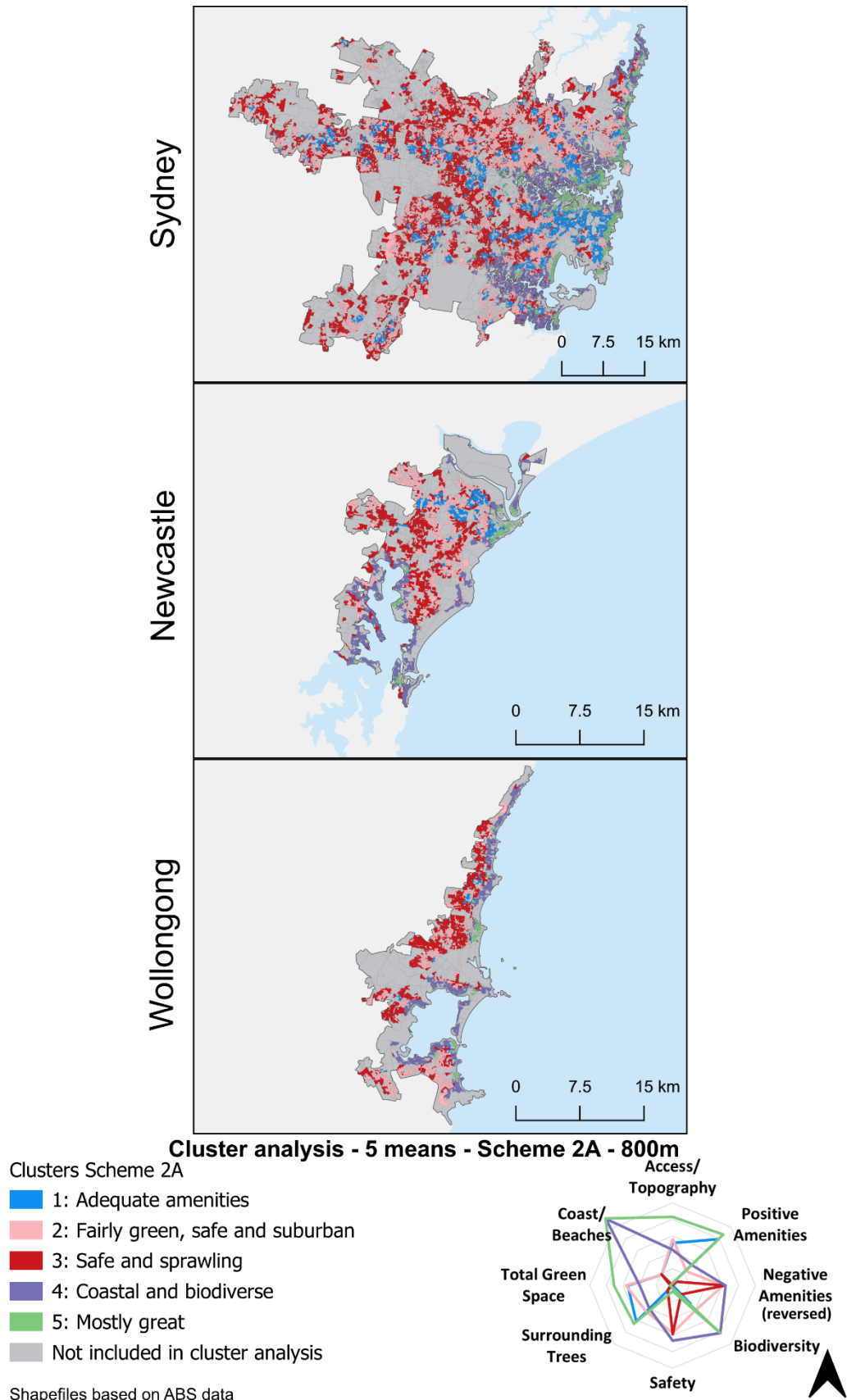


Figure S6. Cluster analysis—Scheme 2A—800 m. Axis for radar graph is between -1.0 – 1.5 .

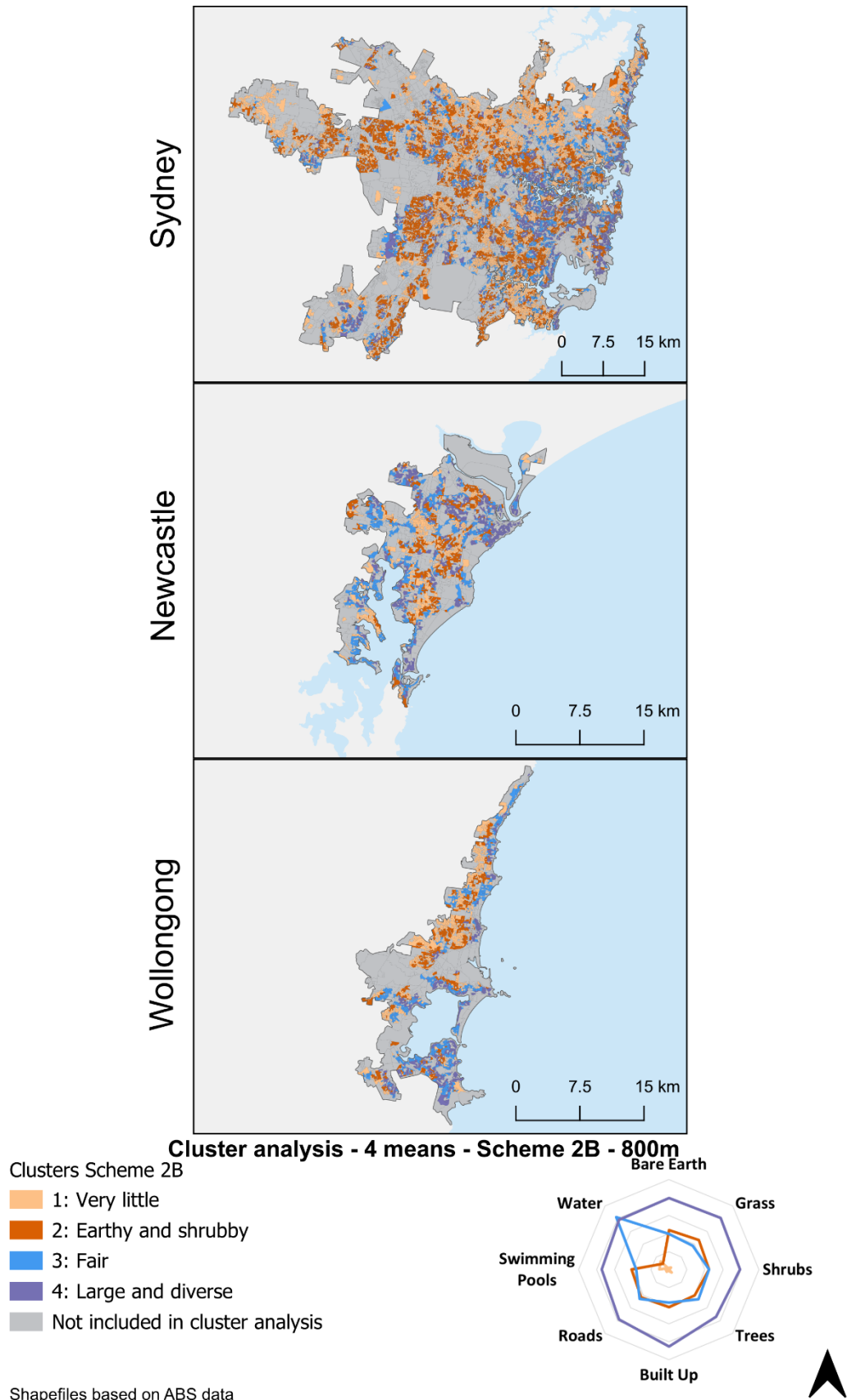


Figure S7. Cluster analysis—Scheme 2B—800 m. Axis for radar graph is between -1.0–1.5. Note—‘water’ means water in a park that is not a swimming pool e.g. “streams, canals, ponds, lakes, reservoirs, estuaries, and bays” ^[44].

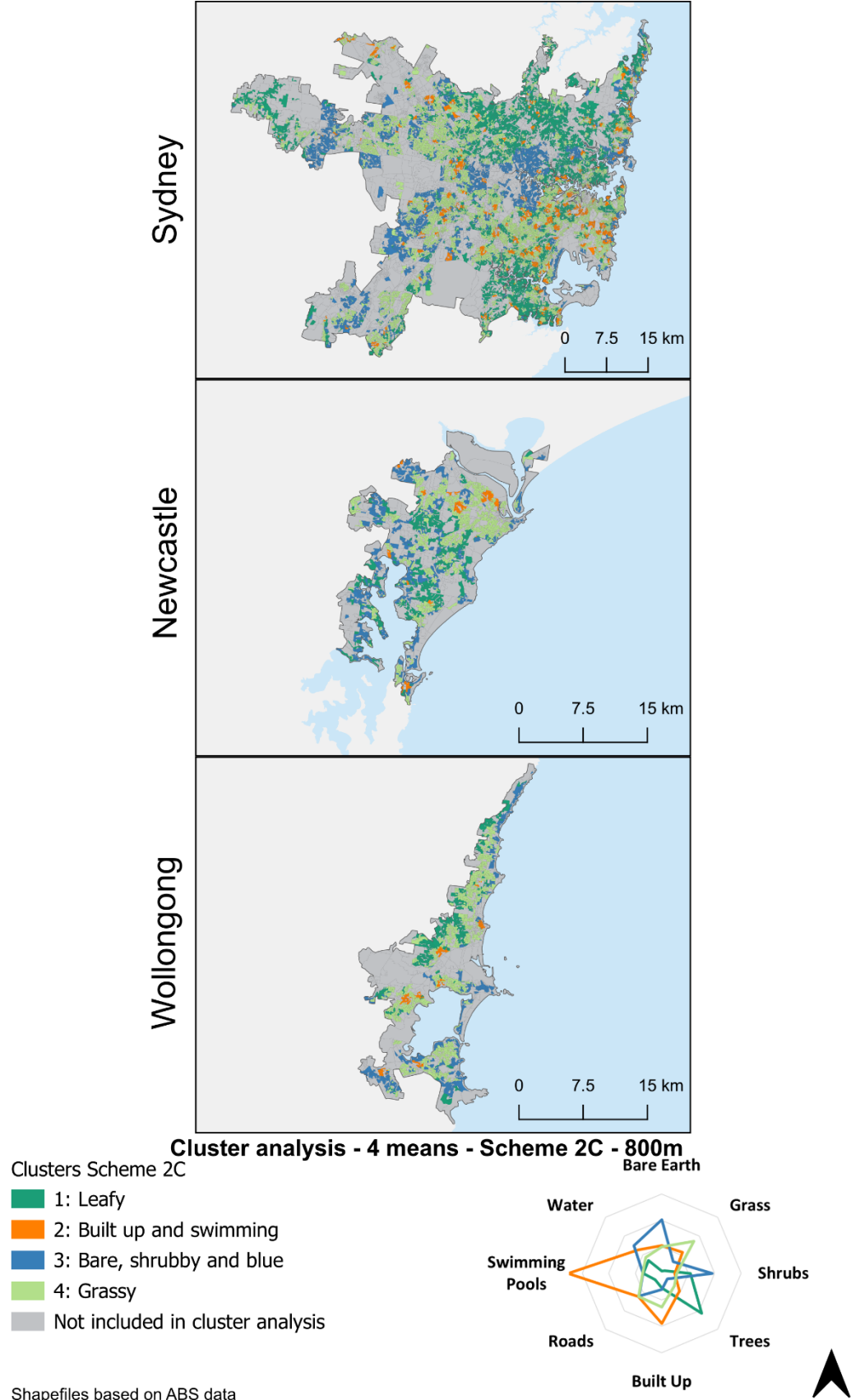
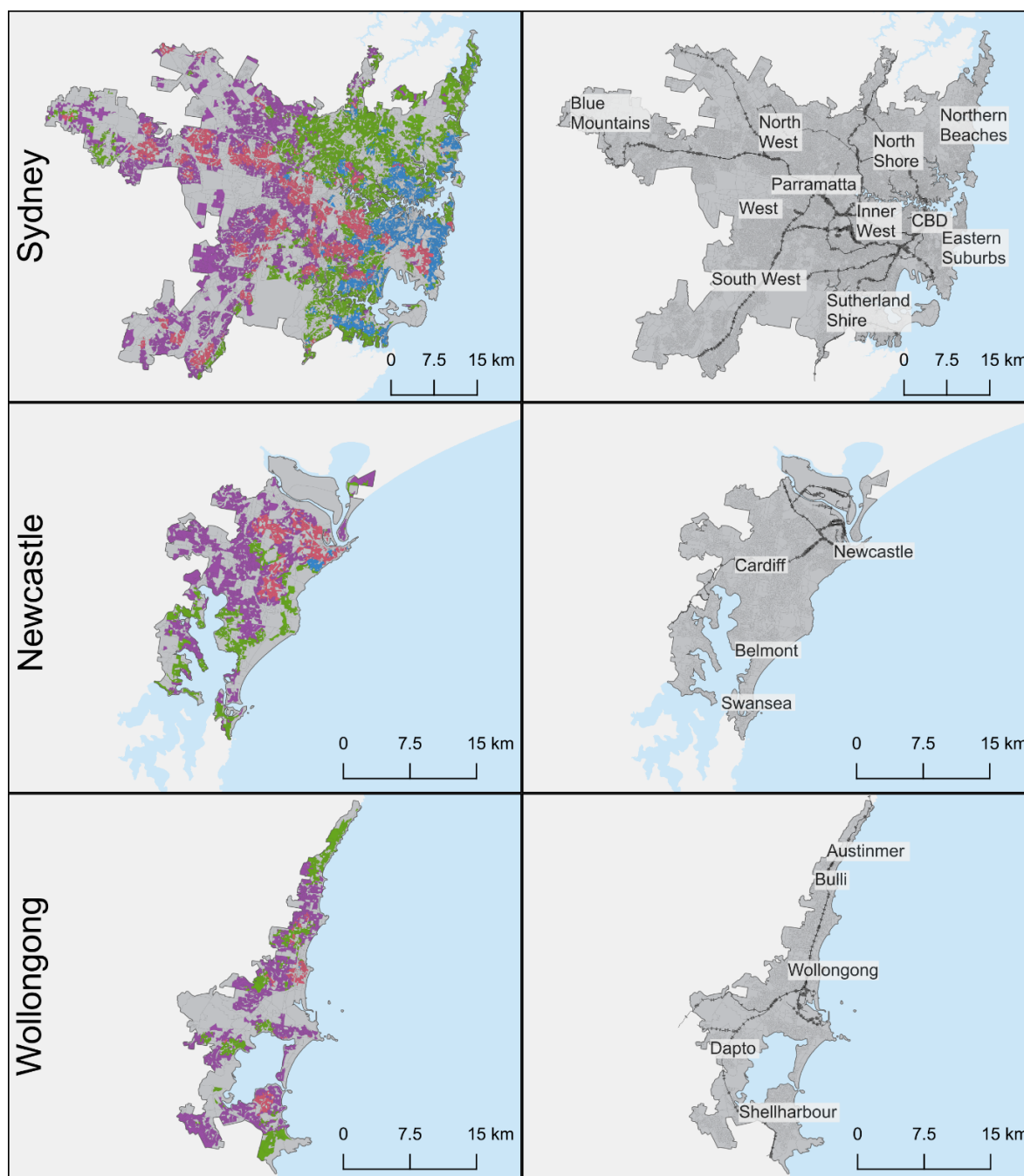


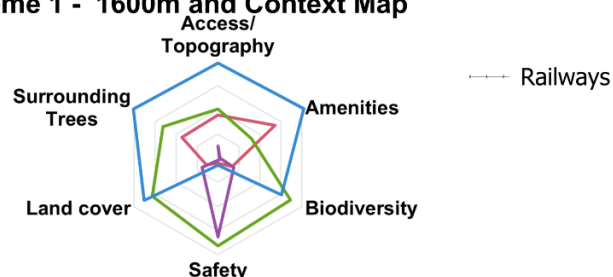
Figure S8. Cluster analysis—Scheme 2C—800 m. Axis for radar graph is between -1.0 – 2.5 .



Cluster analysis - 4 means - Scheme 1 - 1600m and Context Map

Clusters Scheme 1

- 1: Adequate amenities
- 2: Biodiverse and safe
- 3: Safe and sprawling
- 4: Mostly great, but less safe
- Not included in cluster analysis



Shapellies and Parramatta place location based on ABS data; railway lines from Geoscience Australia (https://digital.atlas.gov.au/datasets/9dd0b398e664306b03b69050433feb1_0/about); Newcastle and Wollongong place locations based on osm data (© OpenStreetMap contributors).

Figure S9. Cluster analysis—Scheme 1—1600 m and Context Map. 4 means: 1 = Adequate amenities; 2 = Biodiverse and safe; 3 = Safe and sprawling; 4 = Mostly great, but less safe. Axis for radar graph is between -1.0 – 1.0 . Mesh blocks that were not included in the cluster analysis did not have an intersect with a green space, were not residential, or did not have SEIFA data.

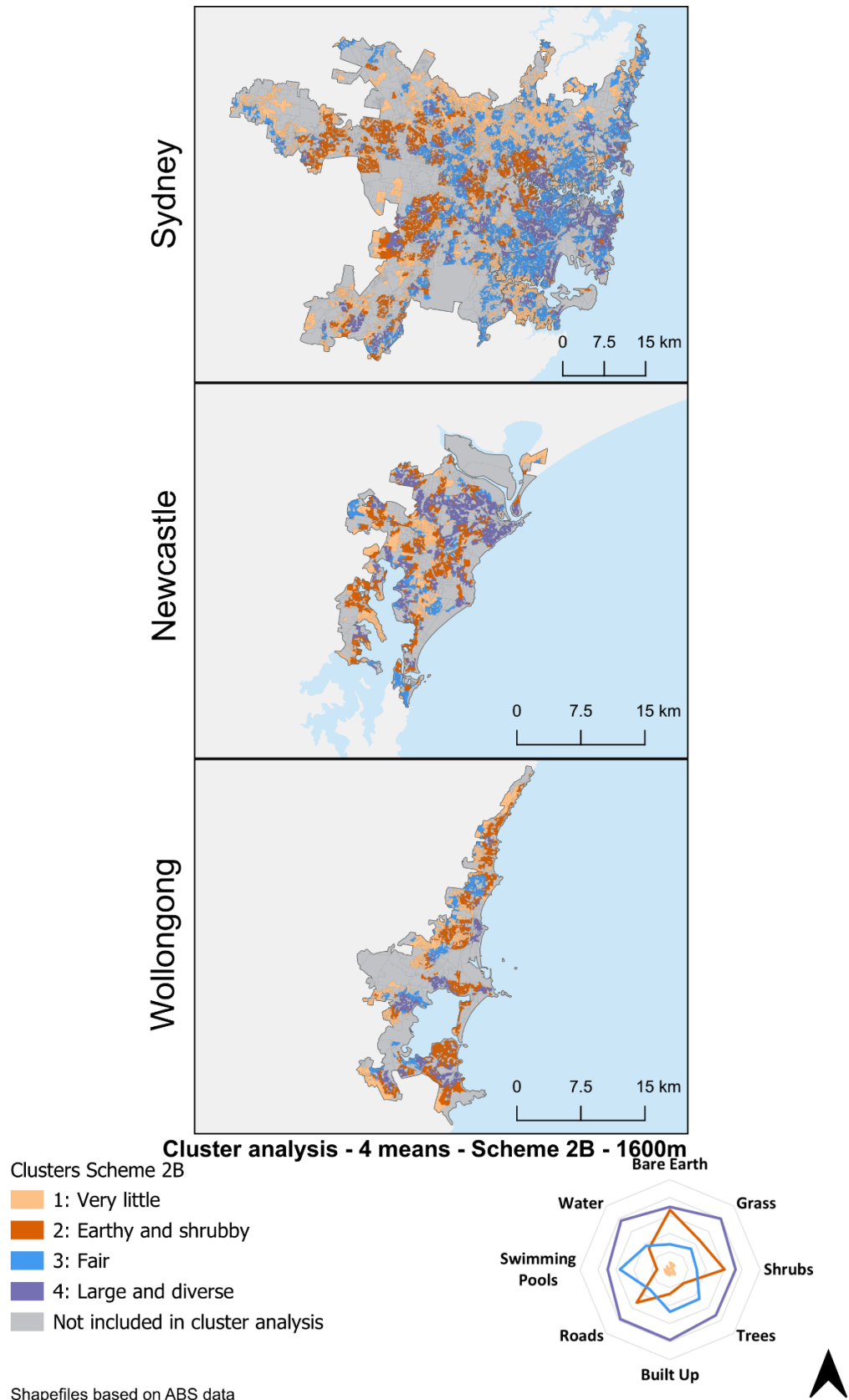
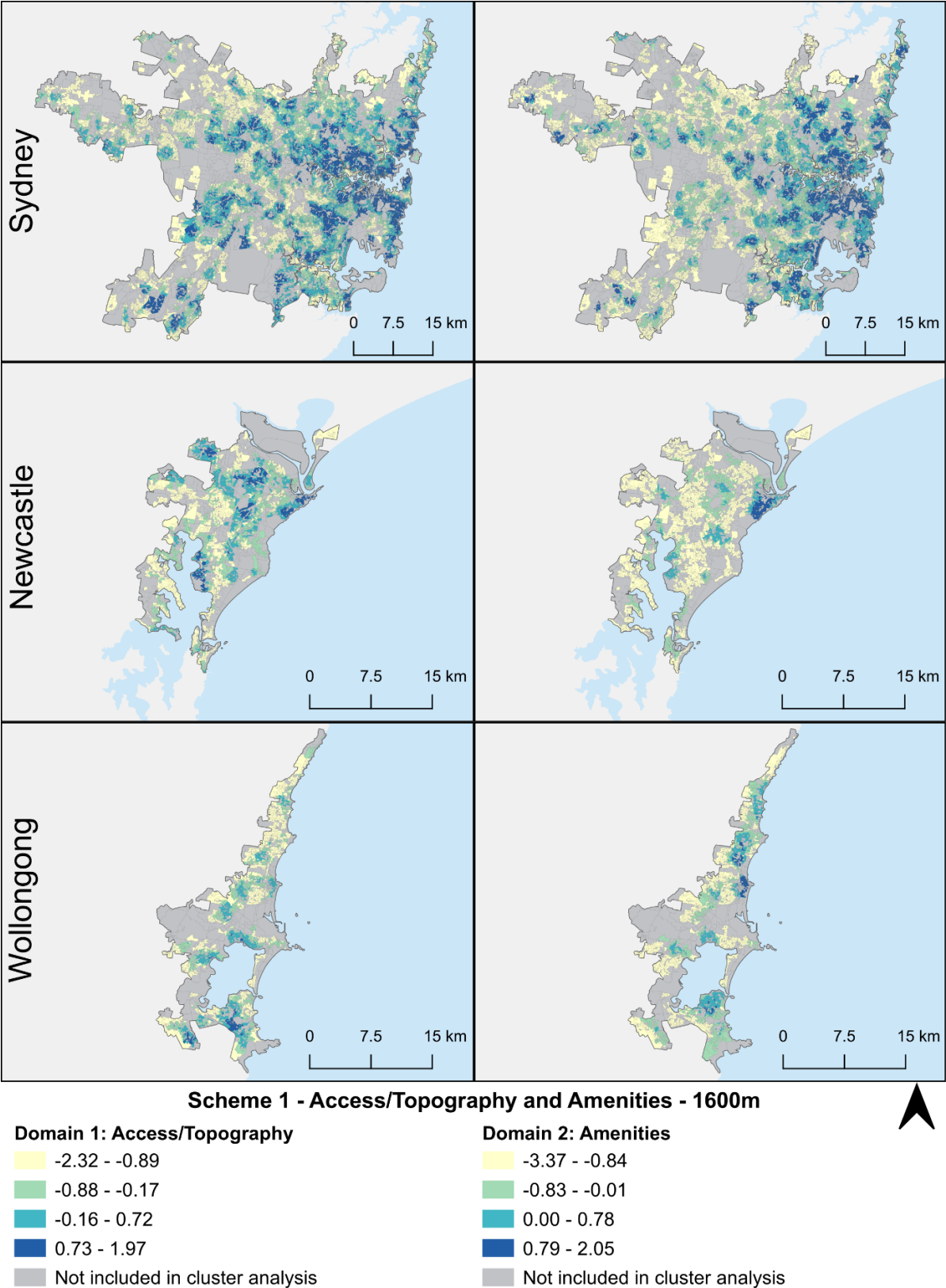


Figure S10. Cluster analysis—4 means—Scheme 2B—1600 m. Clusters: 1= Very little; 2 = Earthy and shrubby; 3 = Fair; 4 = Large and diverse. Axis for radar graph is between -1.0 – 1.5. ‘Water’ means water in a park that is not a swimming pool e.g. “streams, canals, ponds, lakes, reservoirs, estuaries, and bays” [44]. Mesh blocks that were not included in the cluster analysis did not have an intersect with a green space, were not residential, or did not have SEIFA data.



Shapefiles based on ABS data

Figure S11. Cluster analysis—1600 m—Scheme 1—Domains: access/topography and amenities. Values have been standardised.

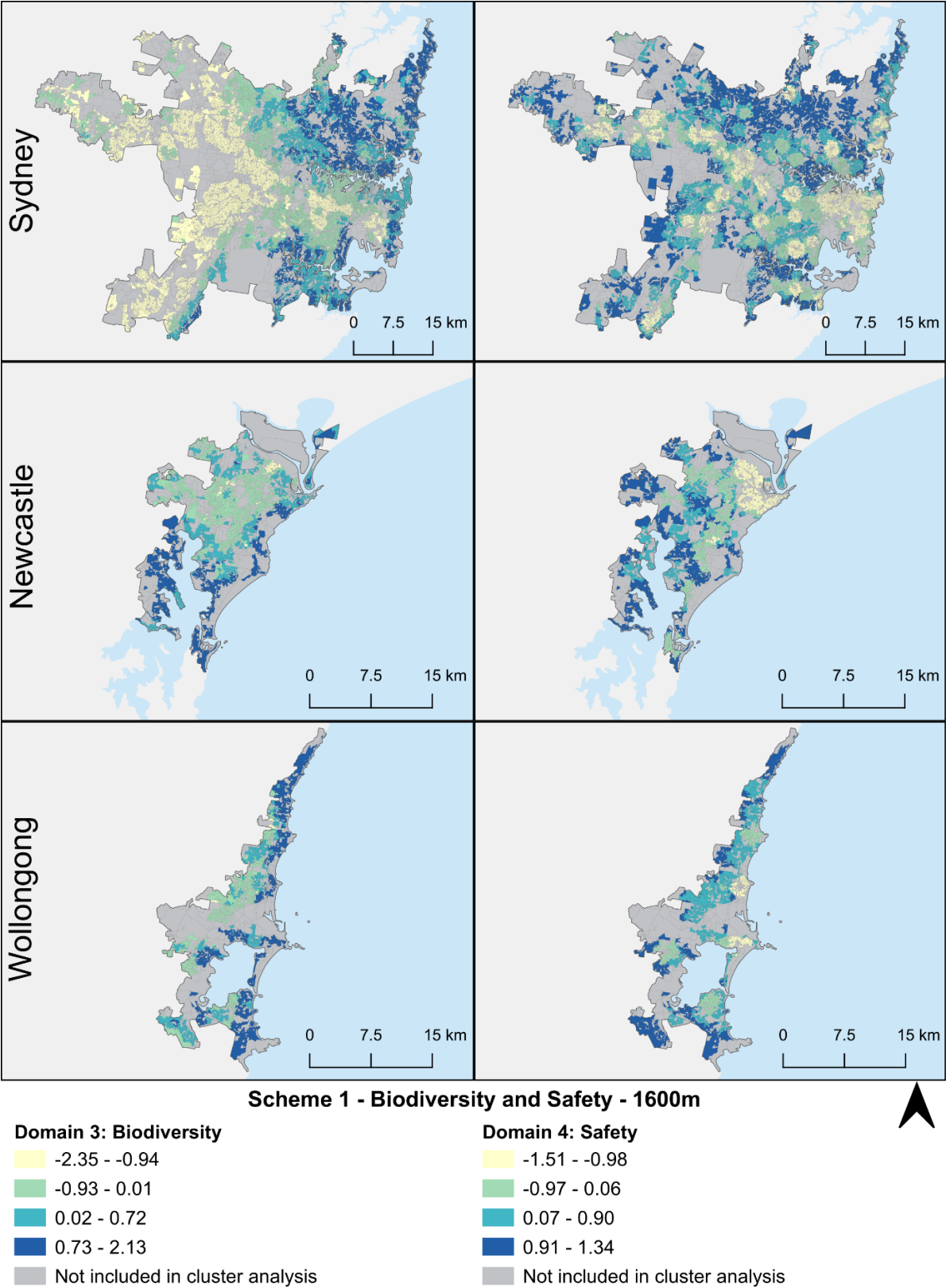
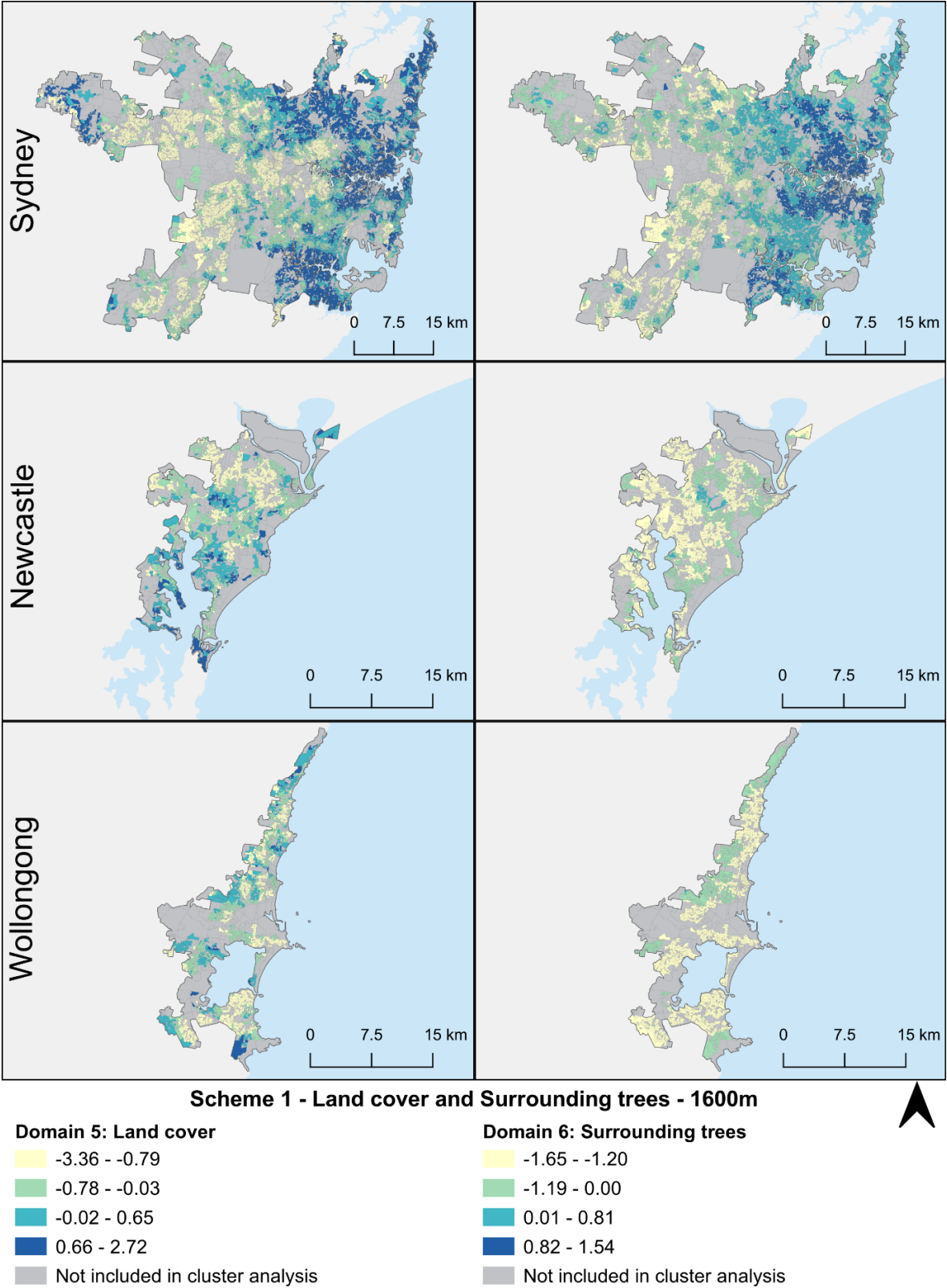


Figure S12. Cluster analysis—1600 m—Scheme 1—Domains: Biodiversity and Safety. Values have been standardised.



Shapefiles based on ABS data

Figure S13. Cluster analysis—1600 m—Scheme 1—Domains: land cover and surrounding trees. Values have been standardised.

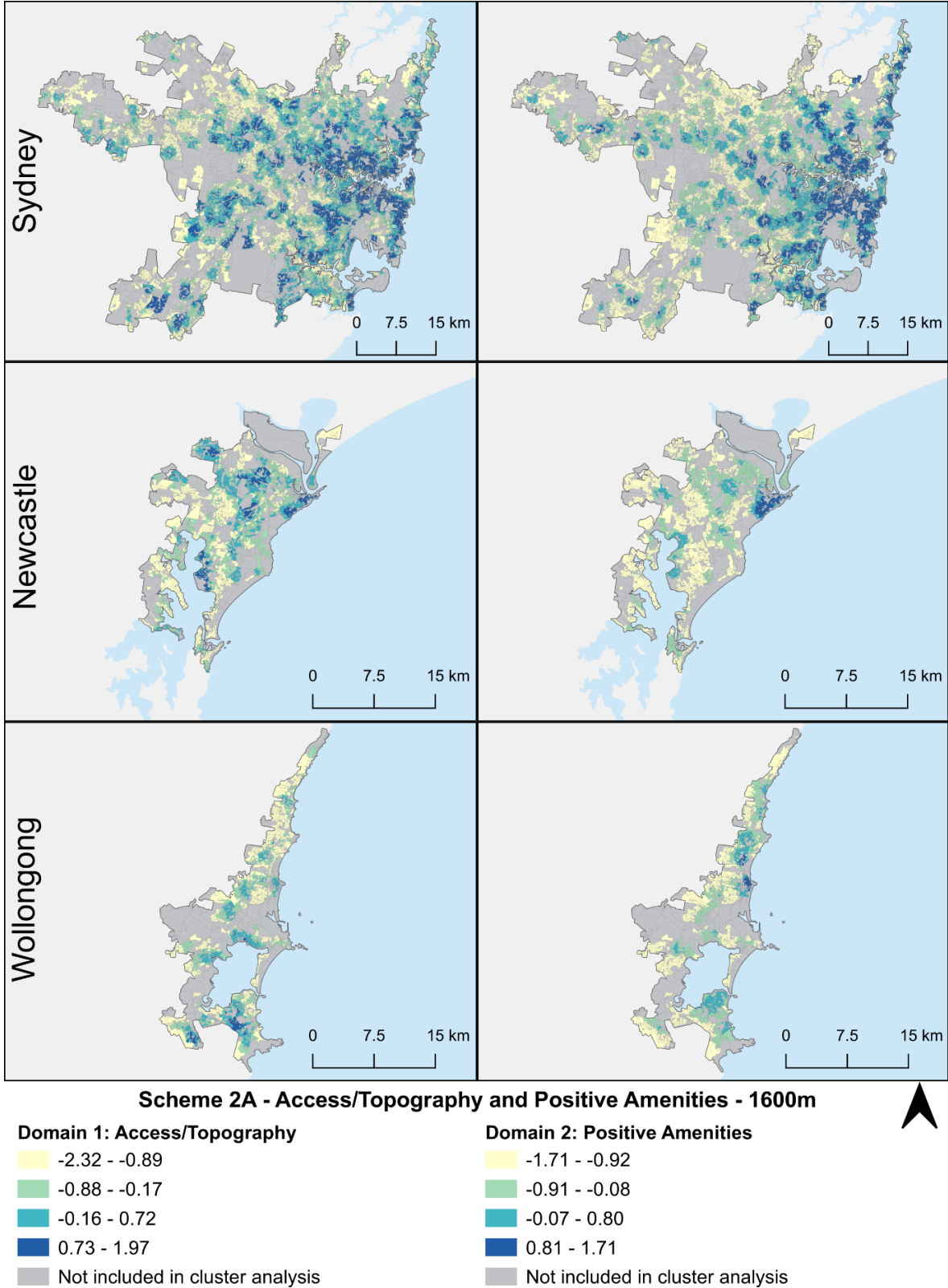
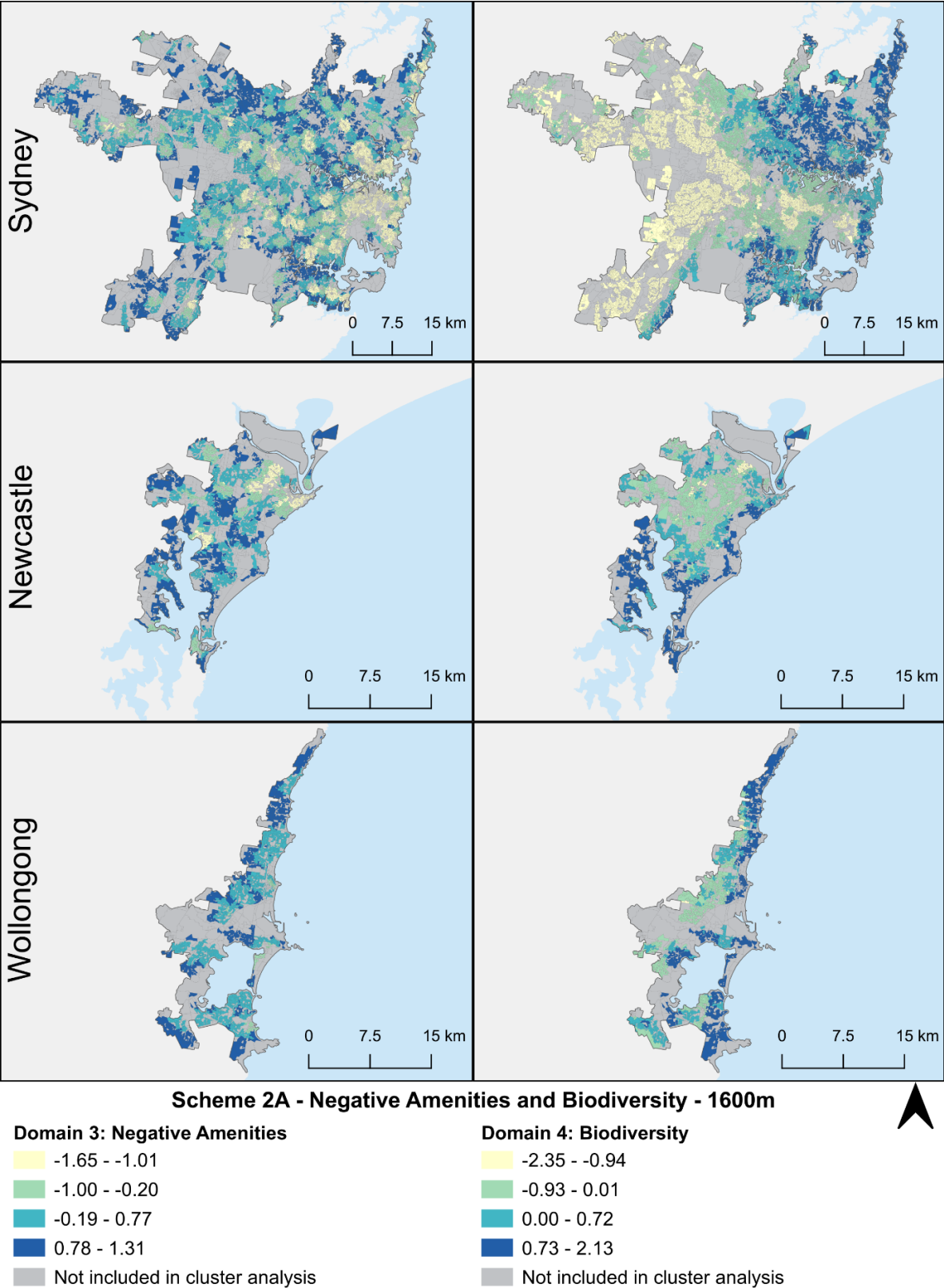


Figure S14. Cluster analysis—1600 m—Scheme 2A—Domains: access/topography and positive amenities. Values have been standardised.



Shapefiles based on ABS data

Figure S15. Cluster analysis—1600 m—Scheme 2A—Domains: negative amenities and biodiversity. Values have been standardised.

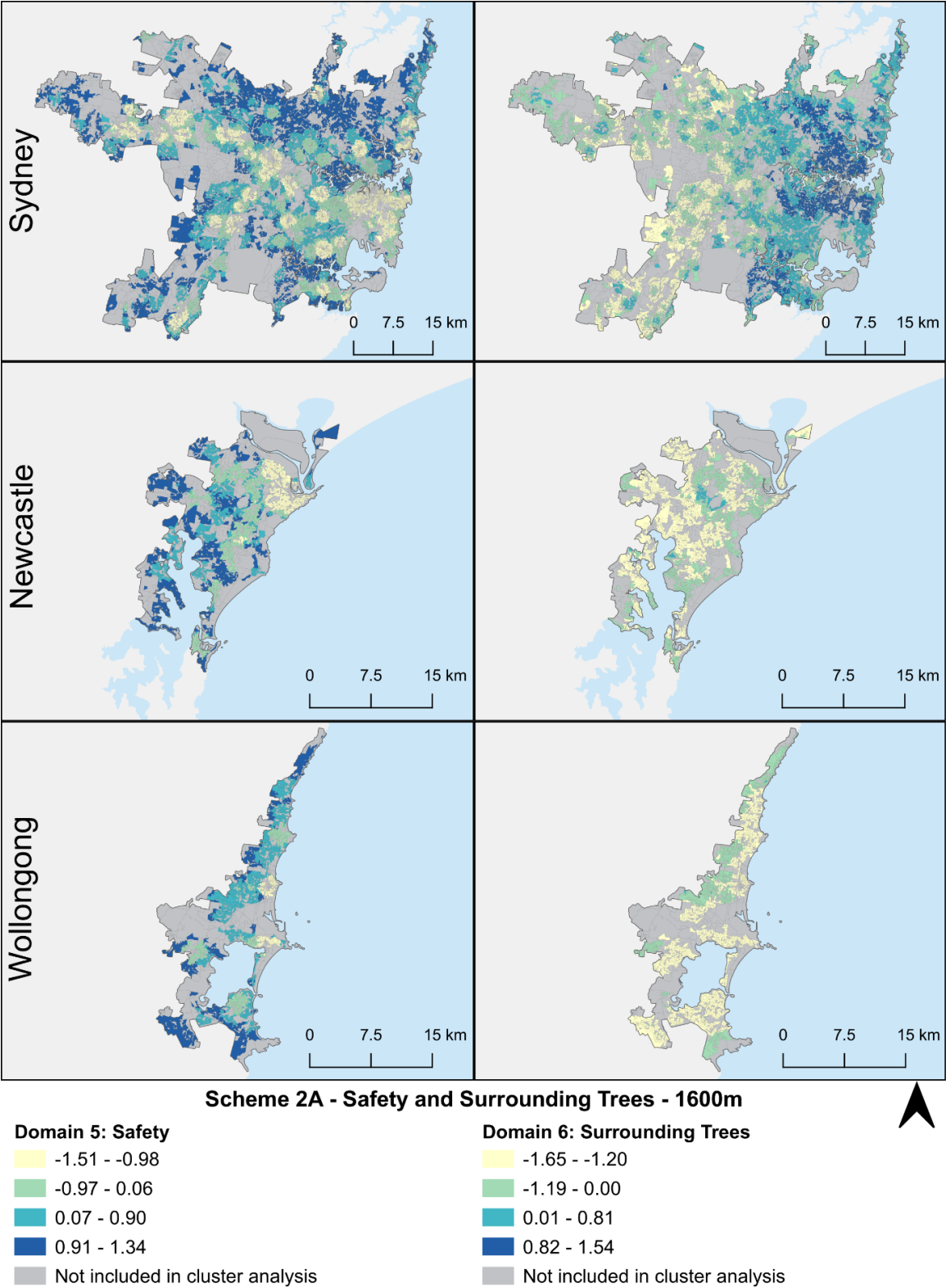


Figure S16. Cluster analysis—1600 m—Scheme 2A—Domains: safety and surrounding trees. Values have been standardised.

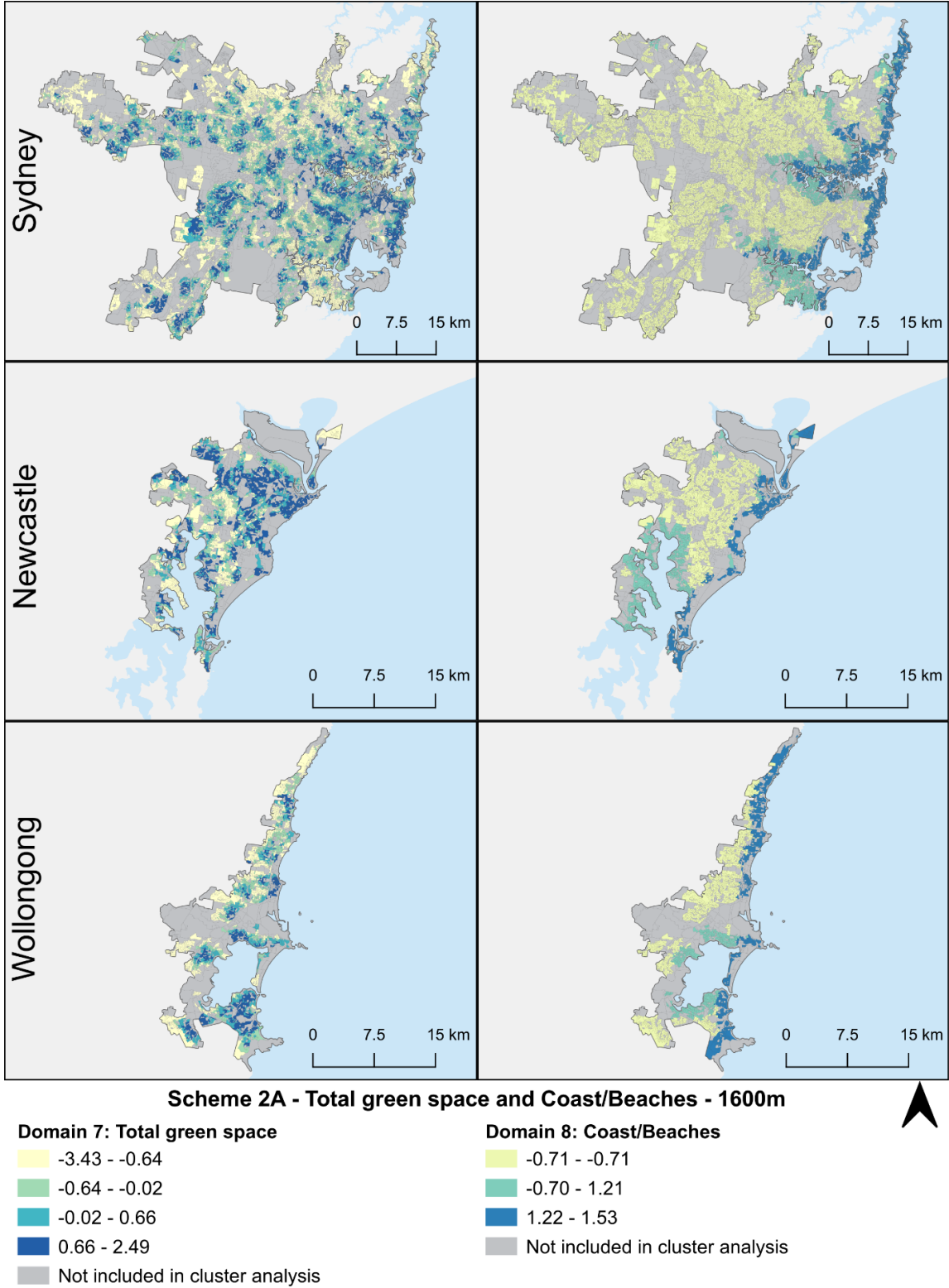
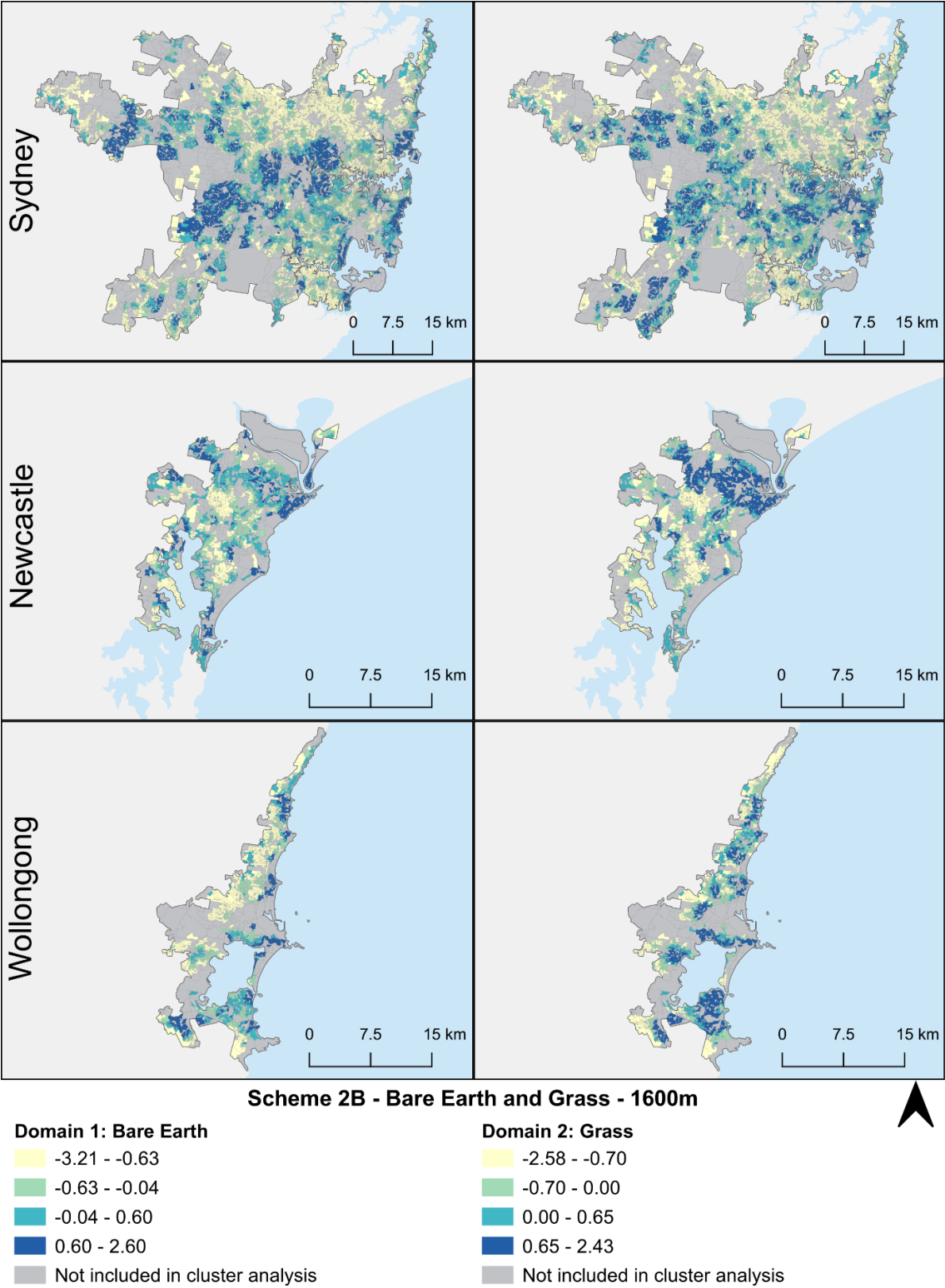
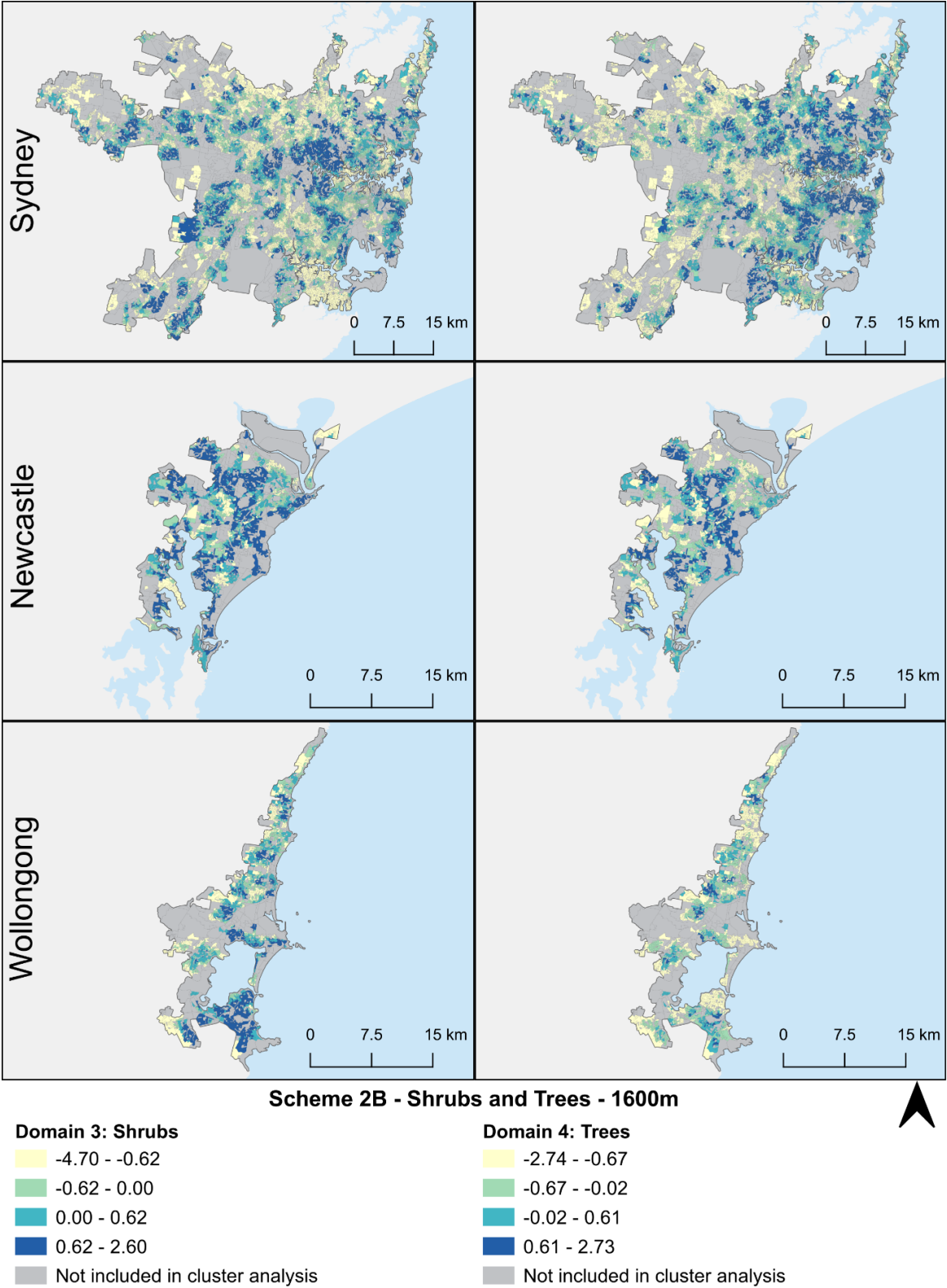


Figure S17. Cluster analysis—1600 m—Scheme 2A—Domains: total green space (intersect of network buffer with green space) and coast/beaches. Values have been standardised.



Shapefiles based on ABS data

Figure S18. Cluster analysis—1600 m—Scheme 2B—Domains: bare earth and grass. Values have been standardised.



Shapefiles based on ABS data

Figure S19. Cluster analysis—1600 m—Scheme 2B—Domains: shrubs and trees. Values have been standardised.

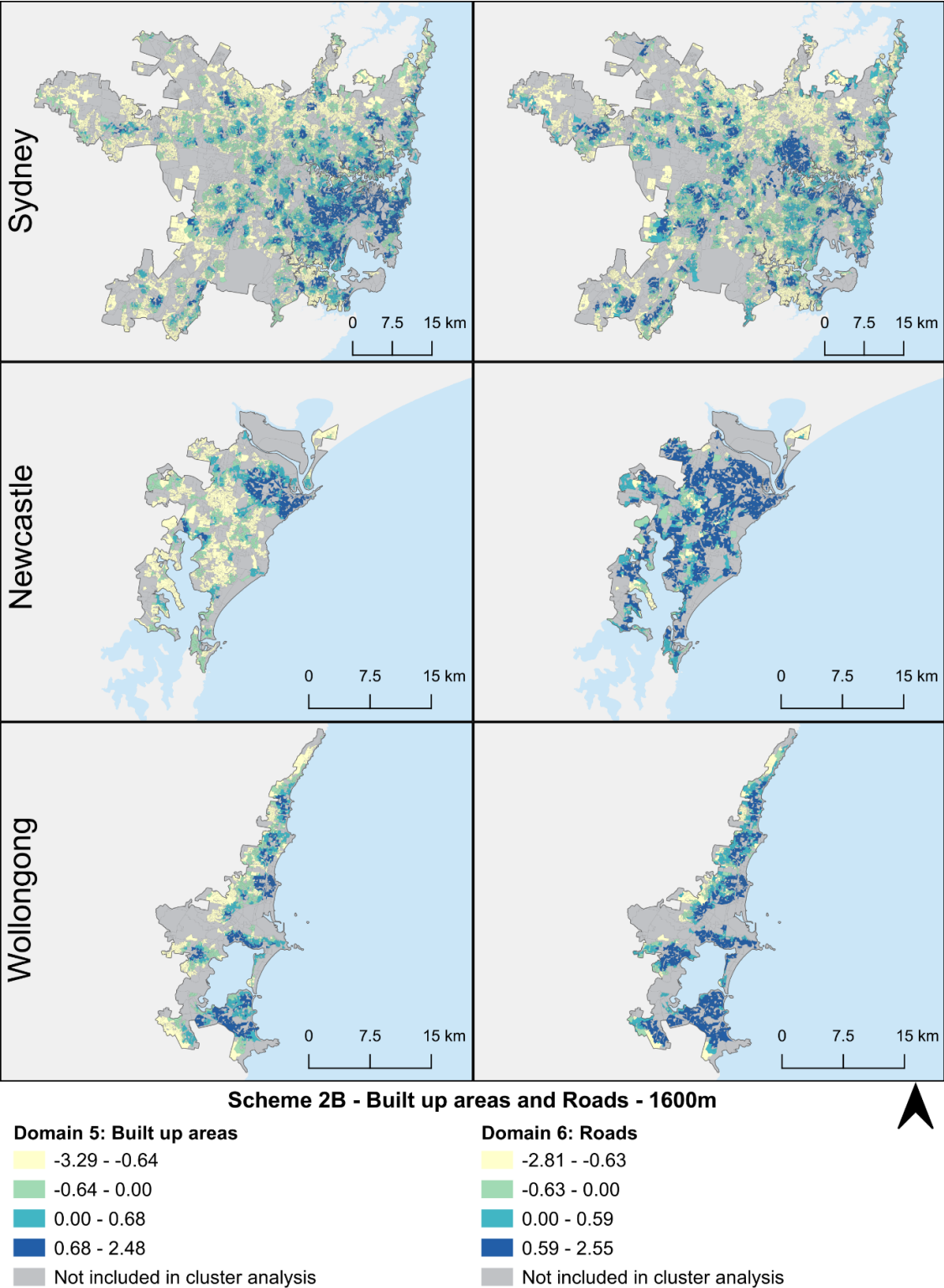


Figure S20. Cluster analysis—1600 m—Scheme 2B—Domains: built up areas and roads. Values have been standardised.

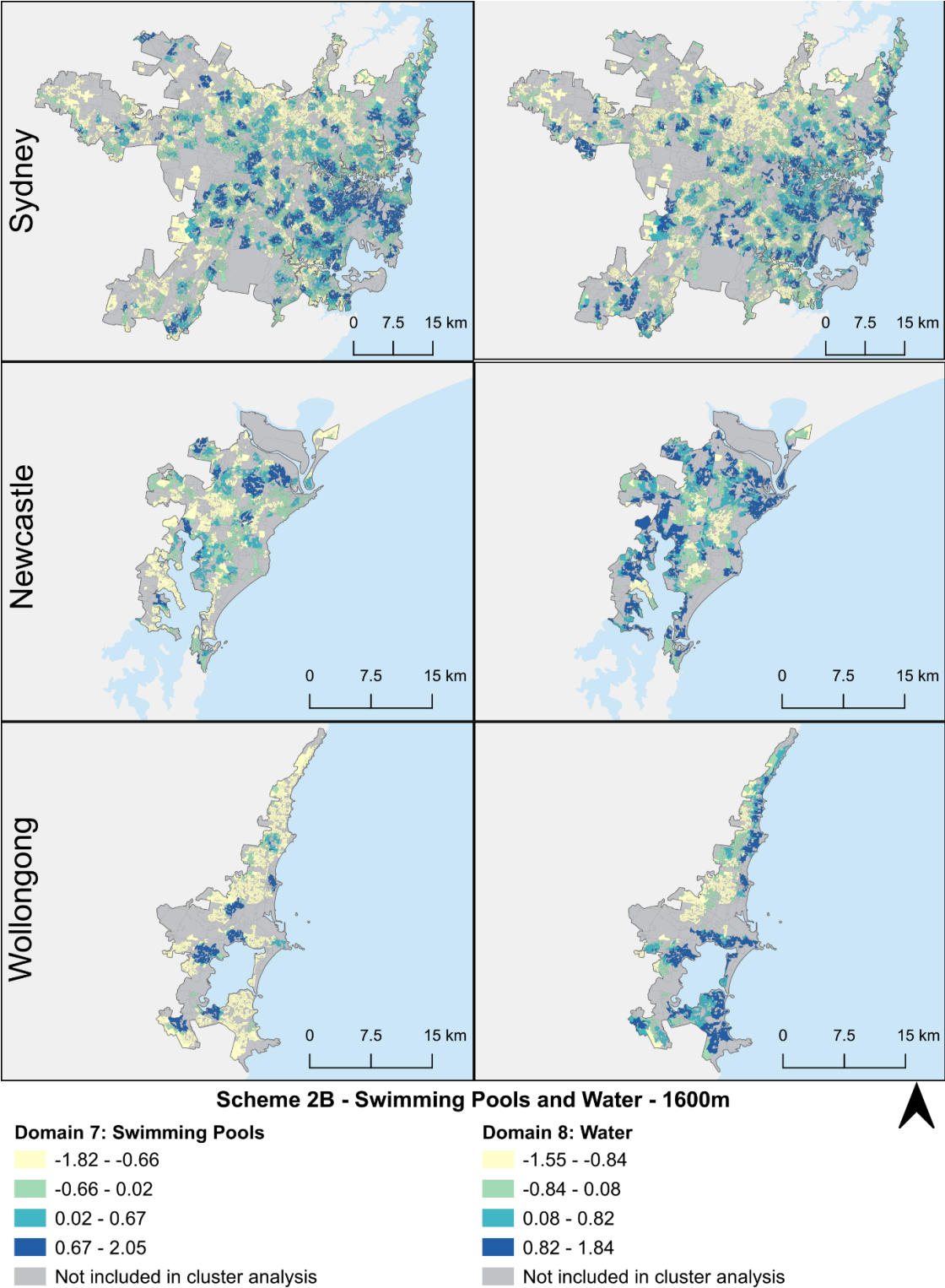


Figure S21. Cluster analysis—1600 m—Scheme 2B—Domains: swimming pools and water. Values have been standardised.

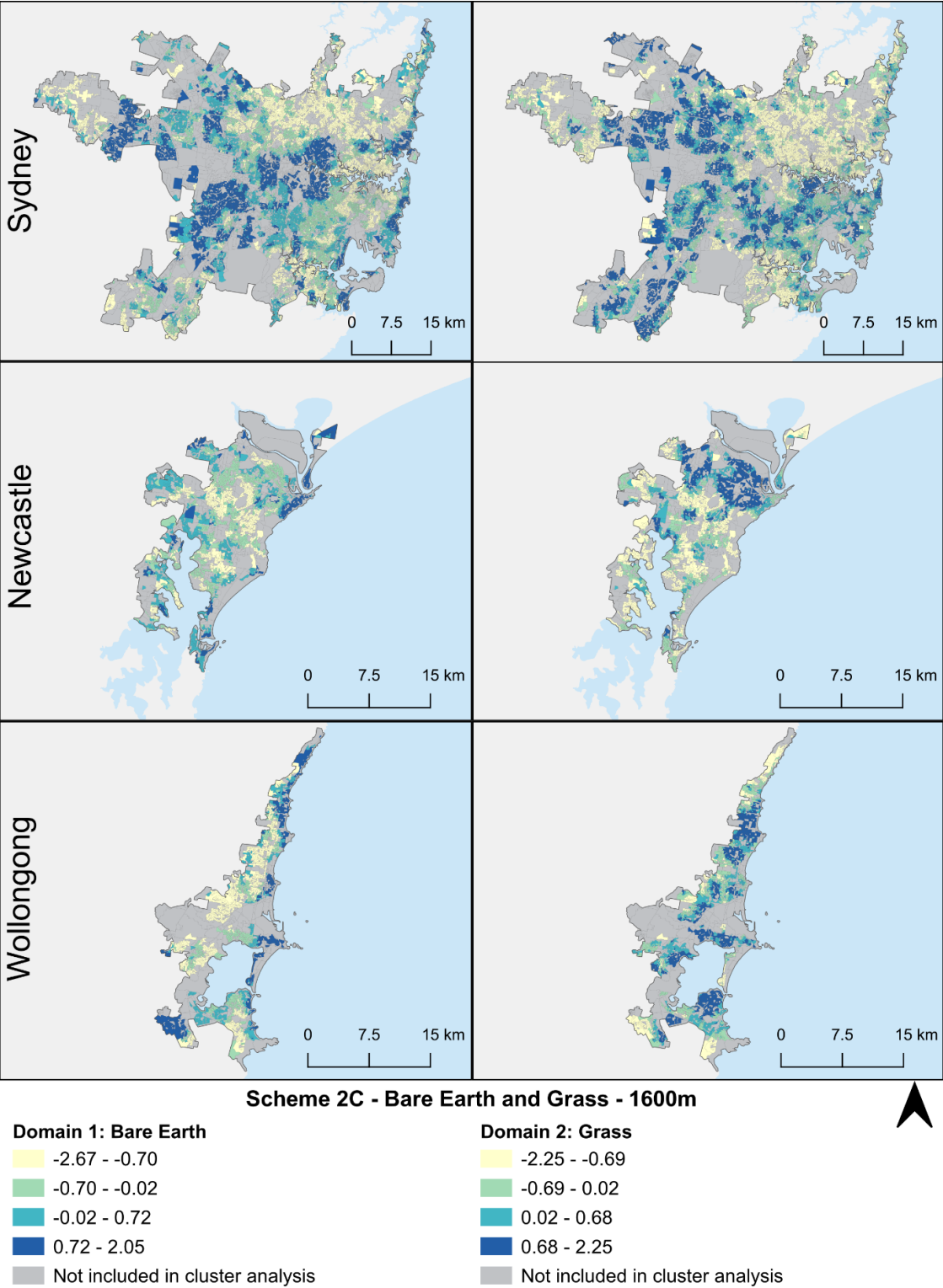
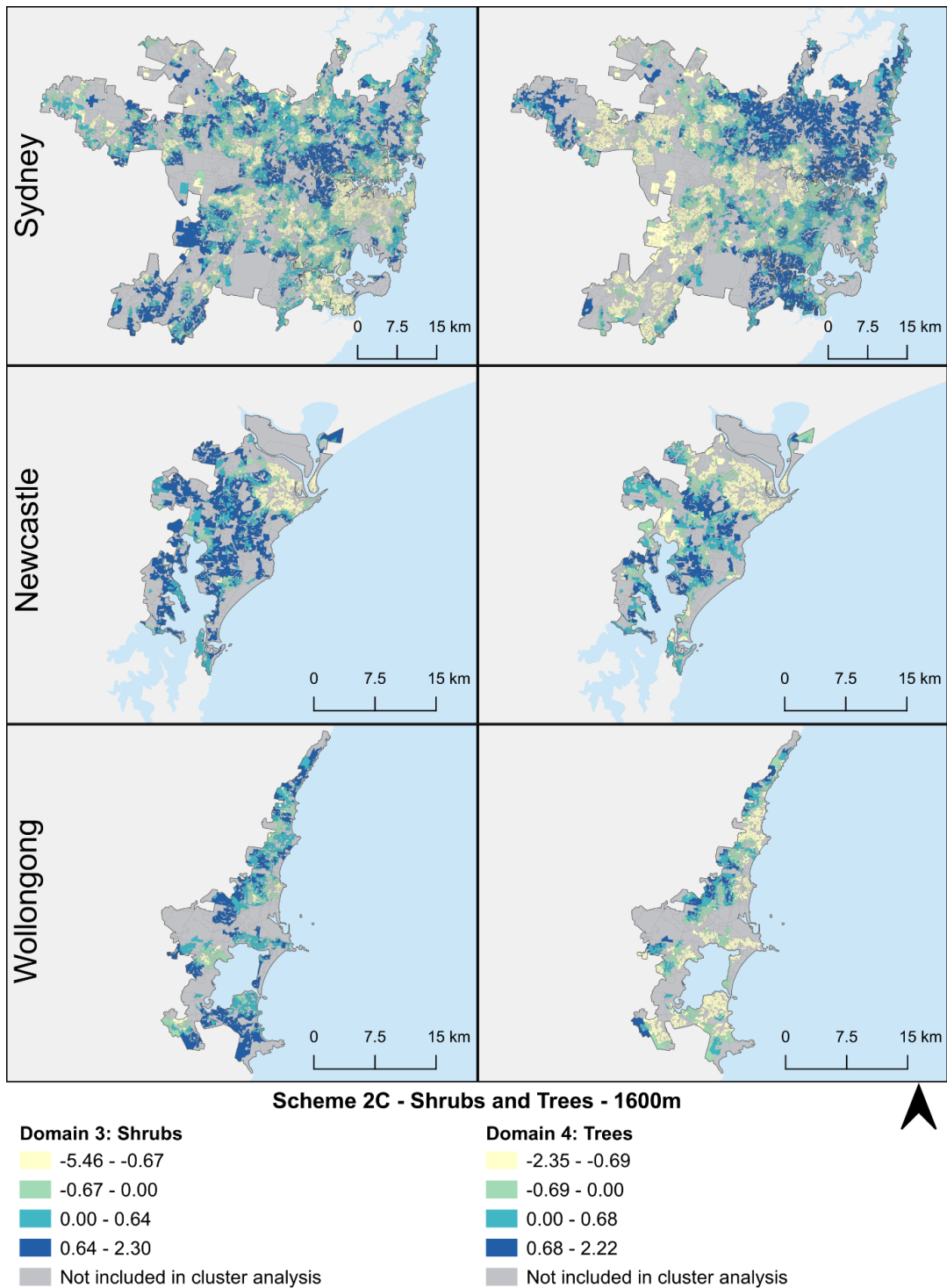
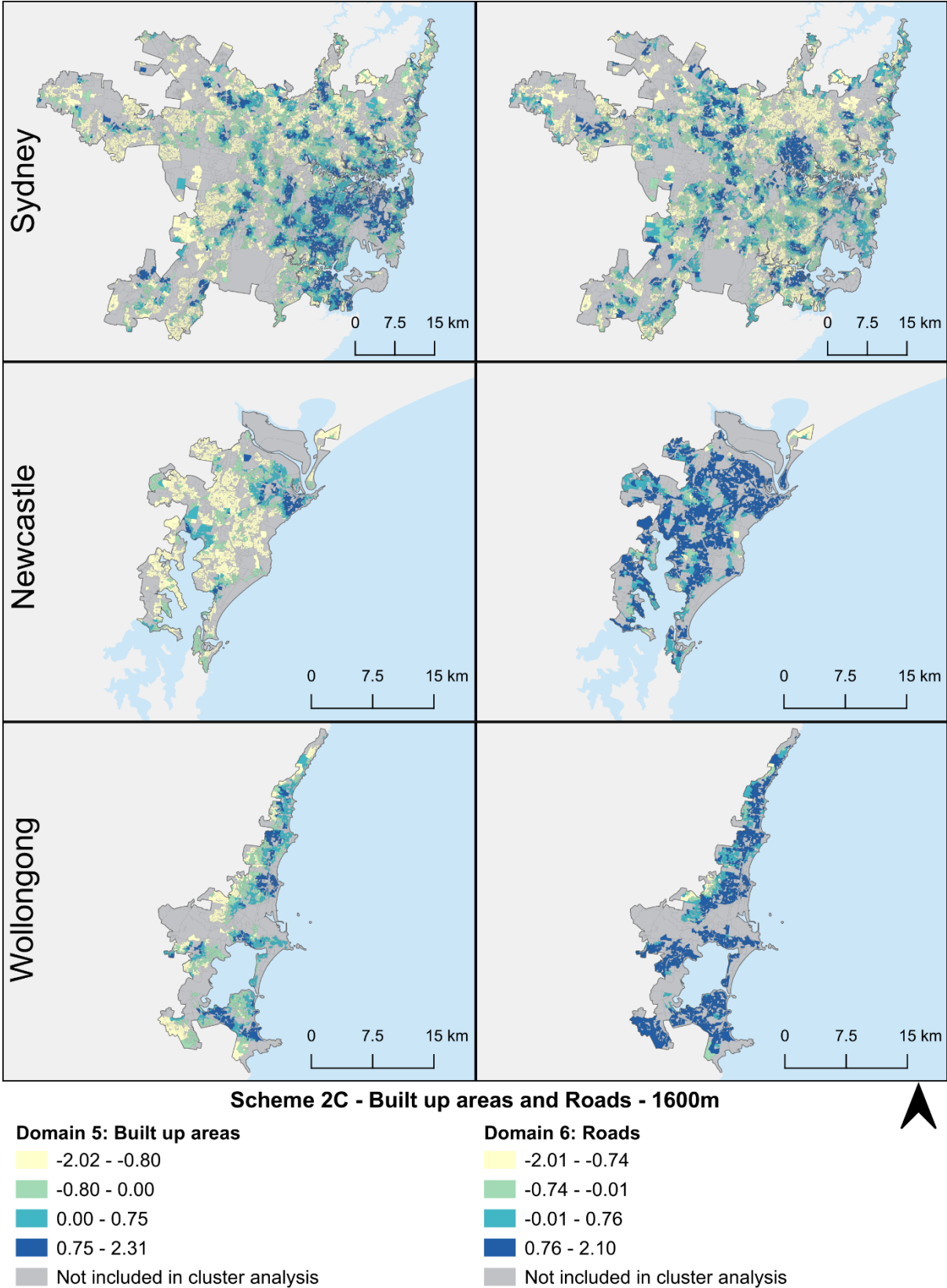


Figure S22. Cluster analysis—1600 m—Scheme 2C—Domains: bare earth and grass. Values have been standardised.



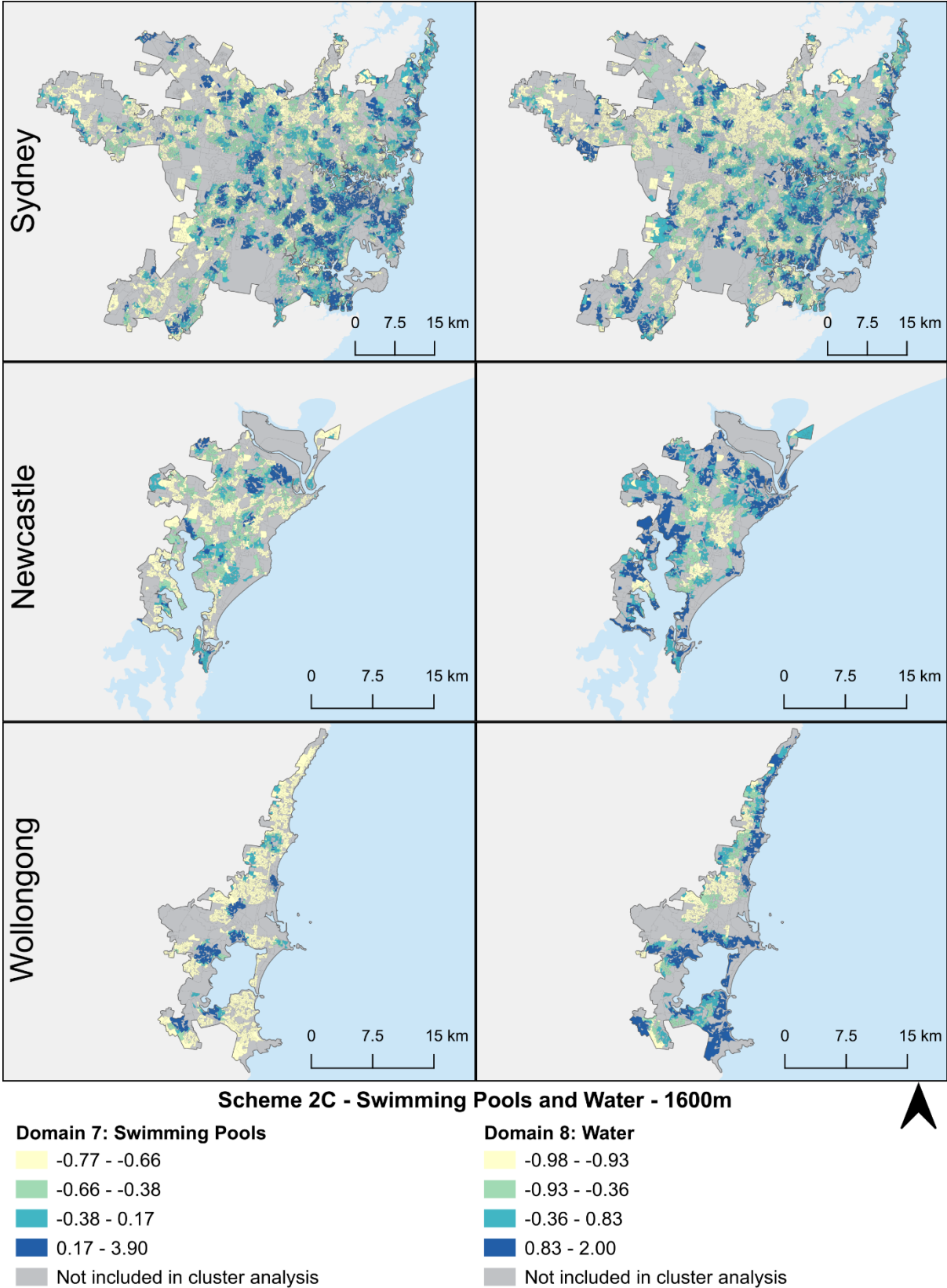
Shapefiles based on ABS data

Figure S23. Cluster analysis—1600 m—Scheme 2C—Domains: shrubs and trees. Values have been standardised.



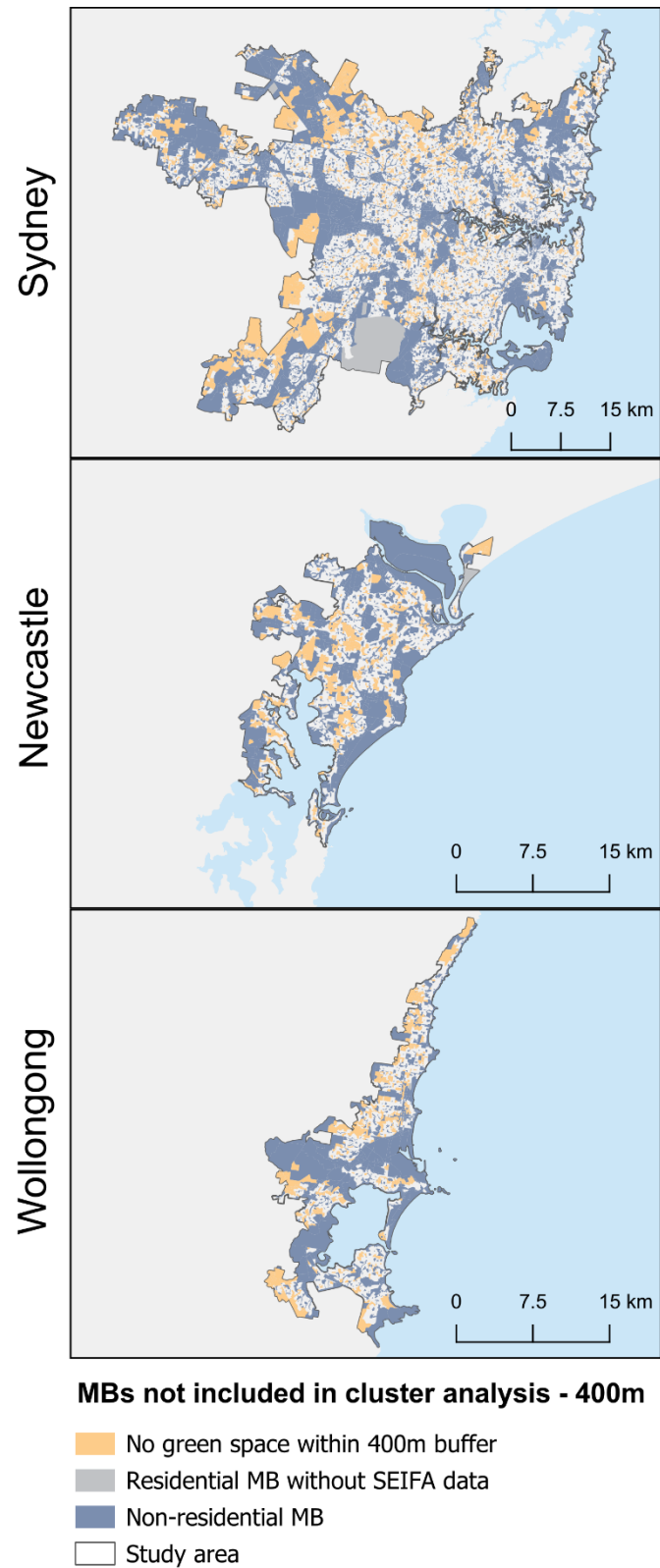
Shapefiles based on ABS data

Figure S24. Cluster analysis—1600 m—Scheme 2C—Domains: built up areas and roads. Values have been standardised.



Shapefiles based on ABS data

Figure S25. Cluster analysis—1600 m—Scheme 2C—Domains: swimming pools and water. Values have been standardised.



Shapefiles based on ABS data



Figure S26. MBs not included in cluster analysis—400 m.

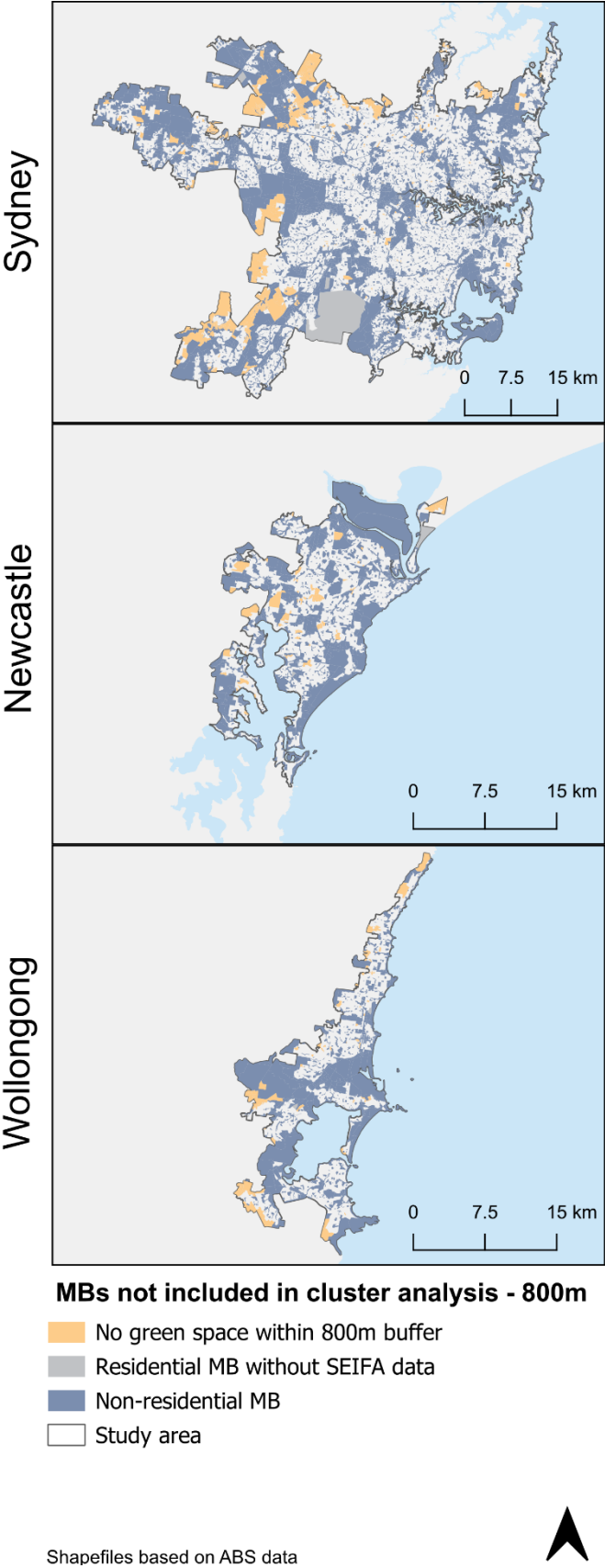


Figure S27. MBs not included in cluster analysis—800 m.

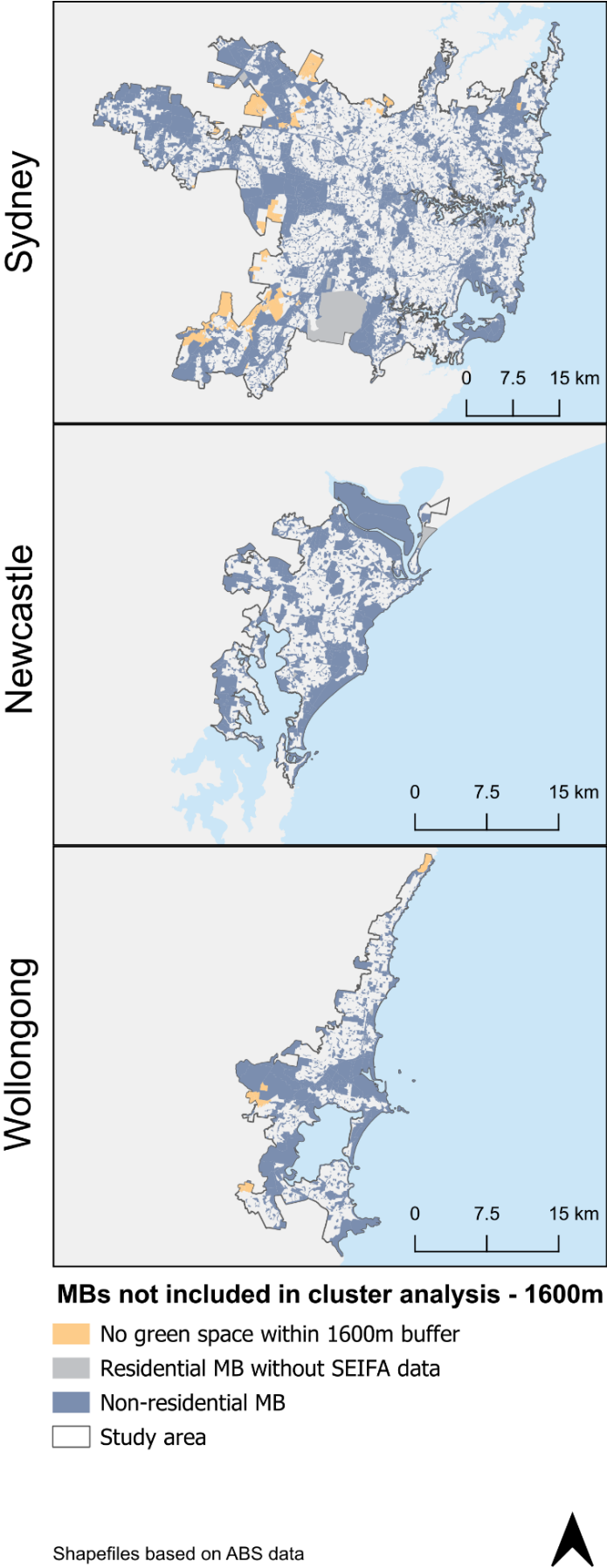


Figure S28. MBs not included in cluster analysis—1600 m.

S4. Quality check

The following two maps are example maps provided for the quality check (800 m scale).

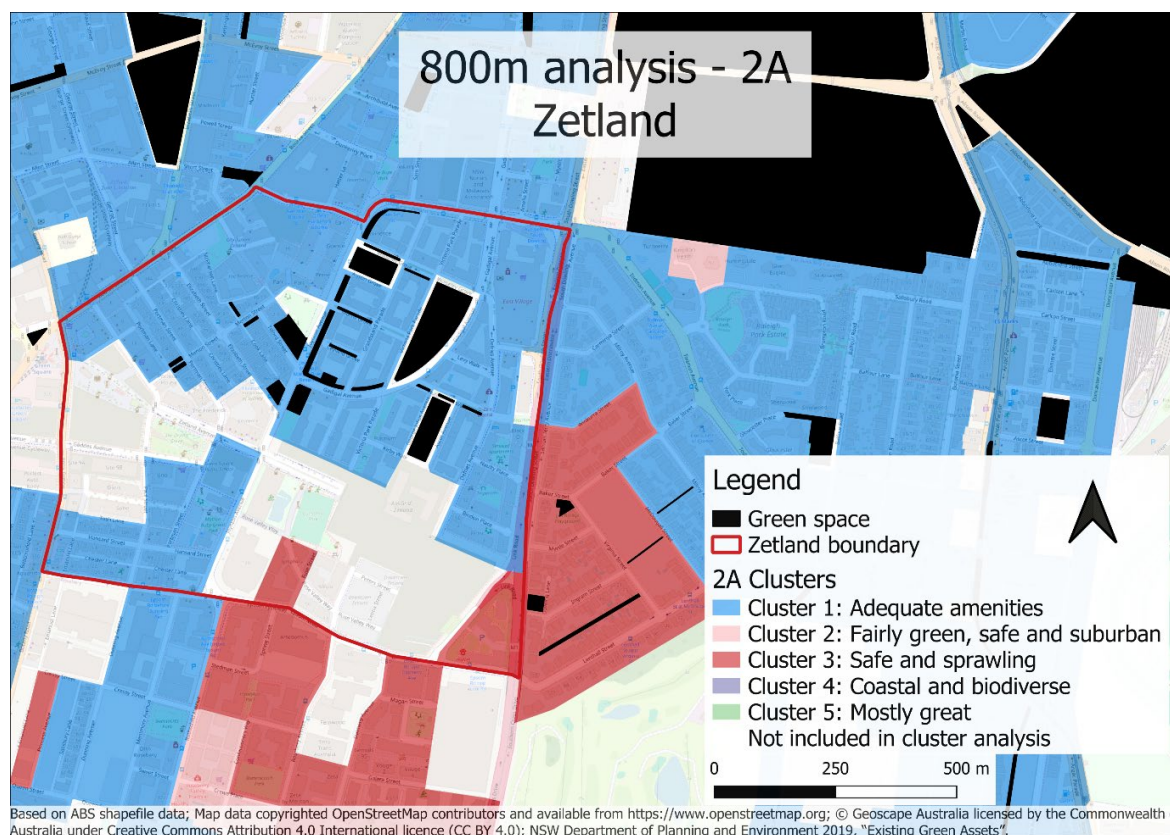


Figure S29. Example quality check map for Clustering Scheme 2A, 800 m scale.

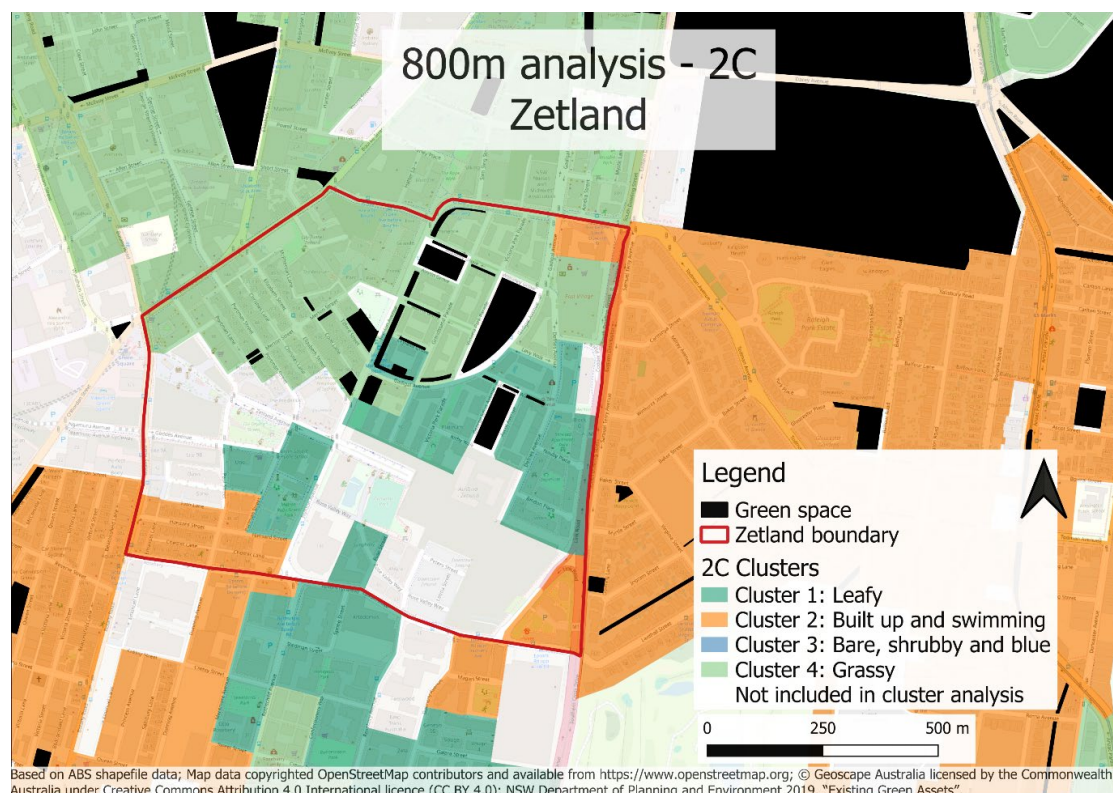


Figure S30. Example quality check map for Clustering Scheme 2C, 800 m scale.

The following Description of Clusters document was provided to team members assisting in the quality check. Minor formatting changes were made for the Supplementary data.

S4.1. Cluster descriptions

We are trying to see how well our clustering analyses data matches your lived experience. While the clustering won't be perfect, we're interested in whether it's good enough.

There are two different clustering methods that will need to be evaluated: 2A (Features of nearby parks) and 2C (percentage of land covers within nearby parks).

We divided up the study area into smaller areas called mesh blocks (see Figure S31). We measured 800 m and 1600 m road distances from the mesh blocks (see pale orange in Figure S31 for 1600 m around the example mesh block). **Notice the parks** that are located within the 1600m distance. The cluster colour results in the maps given to you (example Figure S32 for 2C land cover clusters) are **influenced by all of the parks that fall within either a 800 m road distance or 1600 m road distance** (as indicated in the title of your maps) for each mesh block. There is an 800 m analysis for both 2A and 2C and a 1600 m analysis for both 2A and 2C, giving you four maps.

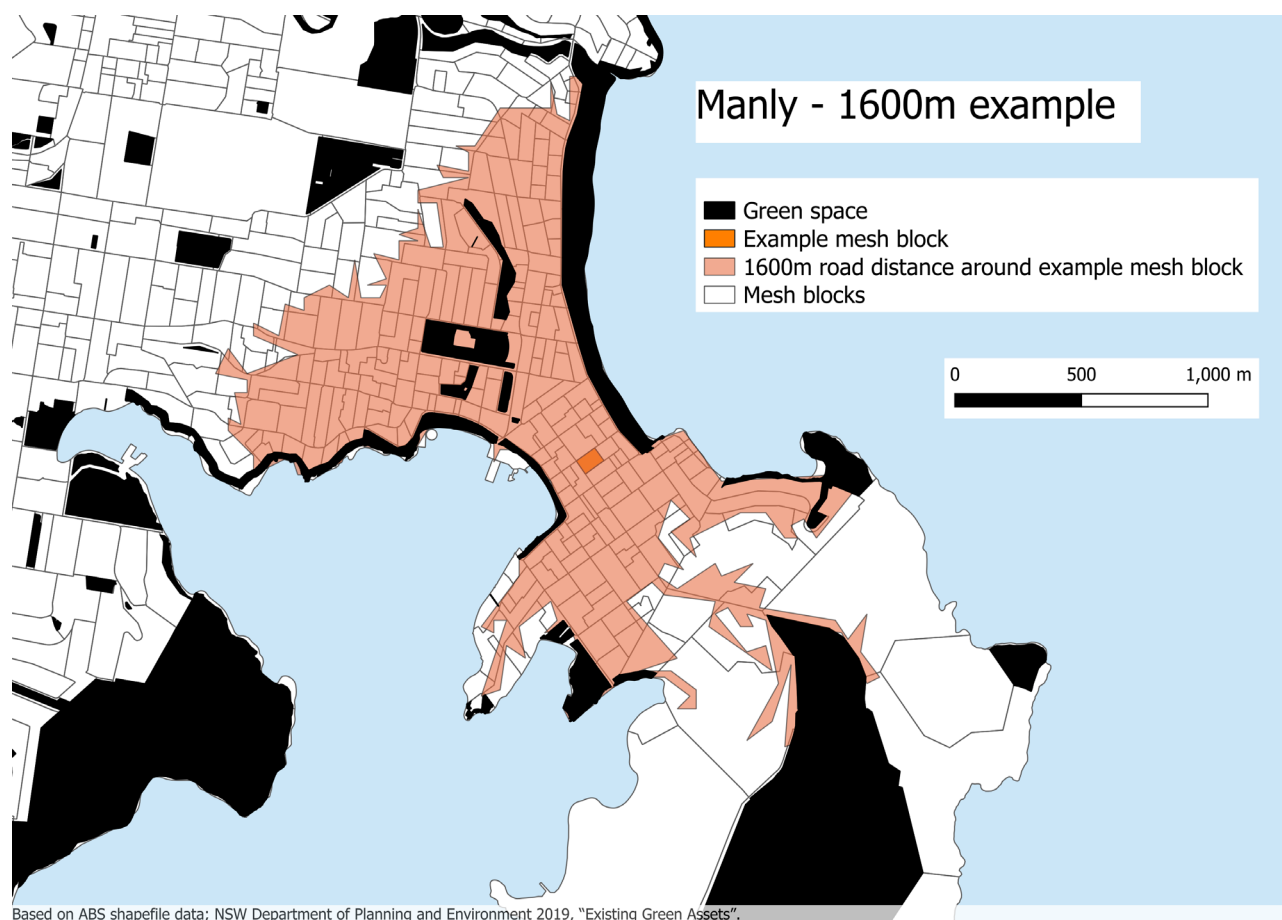


Figure S31. Manly—1600 m example.

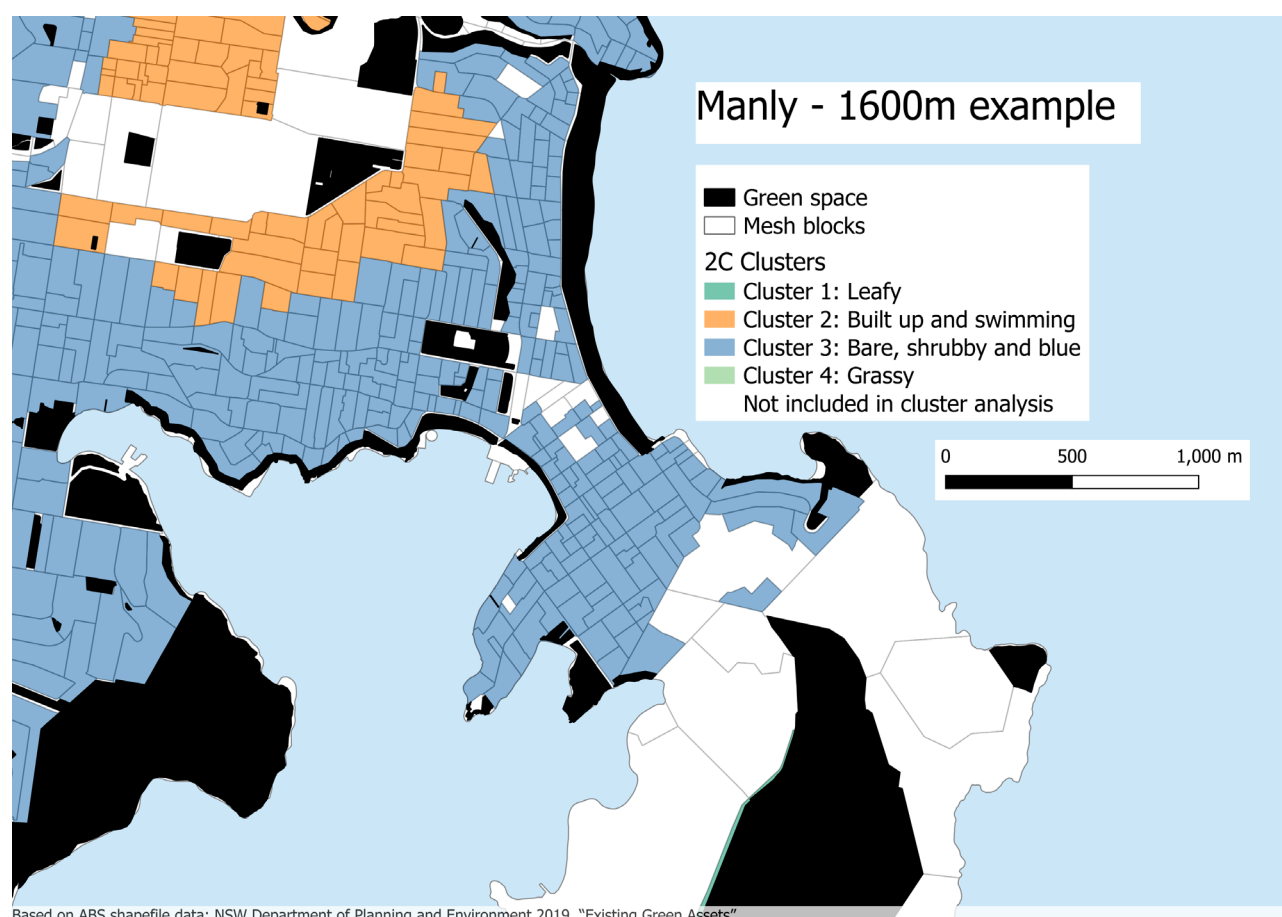


Figure S32. Manly—1600 m example with land cover clusters (2C).

Descriptions of the clusters are given below.

Use these descriptions for: 800 m, 2A

- **Cluster 1—Adequate amenities.** Access/topography is moderate (pathways/bikeways in parks, public transport near parks, and hilliness of parks). Amenities near parks are high (public toilets, cafes, restaurants, supermarkets/greengrocers, hotels/bars, takeaways and parkrun). Trees surrounding parks are moderate-high.
- **Cluster 2—Fairly green, safe and suburban.** Safety is moderate. Access/topography is moderate (pathways/bikeways in parks, public transport near parks, and hilliness of parks). Positive amenities near parks are low-moderate (public toilets, cafes, restaurants, supermarkets/greengrocers, and parkrun). Parks are not close to beaches/coastline. Size of green spaces is moderate. Trees surrounding parks are moderate.
- **Cluster 3—Safe and sprawling.** Safety is moderate. Access/topography is low (pathways/bikeways in parks, public transport near parks, and hilliness of parks). Positive amenities near parks are low (public toilets, cafes, restaurants, supermarkets/greengrocers, and parkrun). Biodiversity and trees surrounding parks are low. Parks are not close to beaches/coastline.
- **Cluster 4—Coastal and biodiverse.** Parks are close to beaches/coastline. Parks have high biodiversity. Safety is moderate-high.
- **Cluster 5—Mostly great.** Access/topography is high (pathways/bikeways in parks, public transport near parks, and hilliness of parks). Amenities near parks are high (public toilets, cafes, restaurants, supermarkets/greengrocers, hotels/bars, takeaways and parkrun). Parks are close to beaches/coastline. Parks have high biodiversity. Trees surrounding parks are moderate-high. Size of green spaces is moderate-high.

Use these descriptions for: 1600 m, 2A

- **Cluster 1—Adequate amenities.** Access/topography is low-moderate (pathways/bikeways in parks, public transport near parks, and hilliness of parks). Positive amenities near parks are moderate-high (public toilets, cafes, restaurants, supermarkets/greengrocers, and parkrun). Trees surrounding parks are moderate.
- **Cluster 2—Fairly green, safe and suburban.** Safety is moderate-high. Access/topography is moderate (pathways/bikeways in parks, public transport near parks, and hilliness of parks). Positive amenities near

parks are low-moderate (public toilets, cafes, restaurants, supermarkets/greengrocers, and parkrun). Parks are not close to beaches/coastline. Size of green spaces is moderate.

- **Cluster 3—Safe and sprawling.** Safety is moderate-high. Access/topography is low (pathways/bikeways in parks, public transport near parks, and hilliness of parks). Positive amenities near parks are low (public toilets, cafes, restaurants, supermarkets/greengrocers, and parkrun). Biodiversity and trees surrounding parks are low. Parks are not close to beaches/coastline.
- **Cluster 4—Coastal and biodiverse.** Parks are close to beaches/coastline. Parks have moderate-high biodiversity. Safety is moderate-high.
- **Cluster 5—Mostly great.** Access/topography is high (pathways/bikeways in parks, public transport near parks, and hilliness of parks). Amenities near parks are high (public toilets, cafes, restaurants, supermarkets/greengrocers, hotels/bars, takeaways and parkrun). Parks are close to beaches/coastline. Trees surrounding parks are high. Biodiversity is moderate-high. Size of green spaces is moderate-high.

Use these descriptions for: 800m, 2C

- **Cluster 1—Leafy.** Tree cover within parks is high. Shrubs cover within parks is moderate.
- **Cluster 2—Built up and swimming.** Swimming pools within parks is high. Built areas (excluding buildings/roads/paths) within parks is moderate-high.
- **Cluster 3—Bare, shrubby and blue.** Bare earth within parks is high. Shrubs cover within parks is moderate-high. Roads within parks is moderate. Water within parks is moderate.
- **Cluster 4—Grassy.** Grass within parks is moderate-high. Tree cover is low-moderate. Roads within parks is moderate. Built areas (excluding buildings/roads/paths) within parks is moderate. Bare earth within parks is moderate.

Use these descriptions for: 1600m, 2C

- **Cluster 1—Leafy.** Tree cover within parks is high. Shrubs cover within parks is moderate.
- **Cluster 2—Built up and swimming.** Built areas (excluding buildings/roads/paths) within parks is high. Swimming pools within parks is moderate-high.
- **Cluster 3—Bare, shrubby and blue.** Bare earth within parks is high. Shrubs cover within parks is moderate-high. Water within parks is moderate-high. Roads within parks is moderate-high.
- **Cluster 4—Grassy.** Grass within parks is moderate-high. Tree cover is low.

S5. Cluster results

Table S12. Closeness of cluster designations across different buffer scales.

Scheme	Comparison of buffers	For min SS			Overall		
		Min SS	<i>rho</i>	% equals	Min SS	Max <i>rho</i>	Max % equals
Scheme 1 K = 4	1600 v 800	0.6	0.51	69.7	0.6	0.51	69.7
	1600 v 400	3.8	0.23^	51.5	3.8	0.29	51.5
	800 v 400	1.7	0.38	63.5	1.7	0.38	63.5
Scheme 2A K = 5	1600 v 800	3.2	0.38^	57.5	3.2	0.44	57.5
	1600 v 400	8.0	0.14^	40.8	8.0	0.37	40.8
	800 v 400	1.6	0.59	62.8	1.6	0.59	62.8
Scheme 2B K = 4	1600 v 800	4.0	0.50	41.7^	4.0	0.50	43.5
	1600 v 400	7.8	0.20^	34.1	7.8	0.29	34.1
	800 v 400	6.6	0.41^	40.5^	6.6	0.54	41.7
Scheme 2C K = 4	1600 v 800	4.1	0.43^	57.9	4.1	0.46	57.9
	1600 v 400	10.9	0.43	46.8	10.9	0.43	46.8
	800 v 400	6.2	0.46	57.8	6.2	0.46	57.8

SS is the sum of squared deviations of domains means between two buffer scales. Minimum SS is the main criterion for the alignment of the clusters across buffers. Initial numbering is done for the 1600 m buffer by visual inspection of maps. Minimum SS is found over all possible combination of cluster numberings, which is 24 for Schemes 1, 2B and 2C, and 120 for Scheme 2A. *Rho* is the Spearman correlation coefficient between clusters. % equal is the percentage of clusters designated to the same category. K = number of clusters in a scheme. Note, that in terms of the maximum % equals and especially the maximum *Rho*, the best combination does not always coincide with the one selected by minimum SS (see right part of the table). ^ = index is lower than maximum value overall.

S6. Radar graphs

Note, all axis ranges in this section are from -1.0 to 1.0.

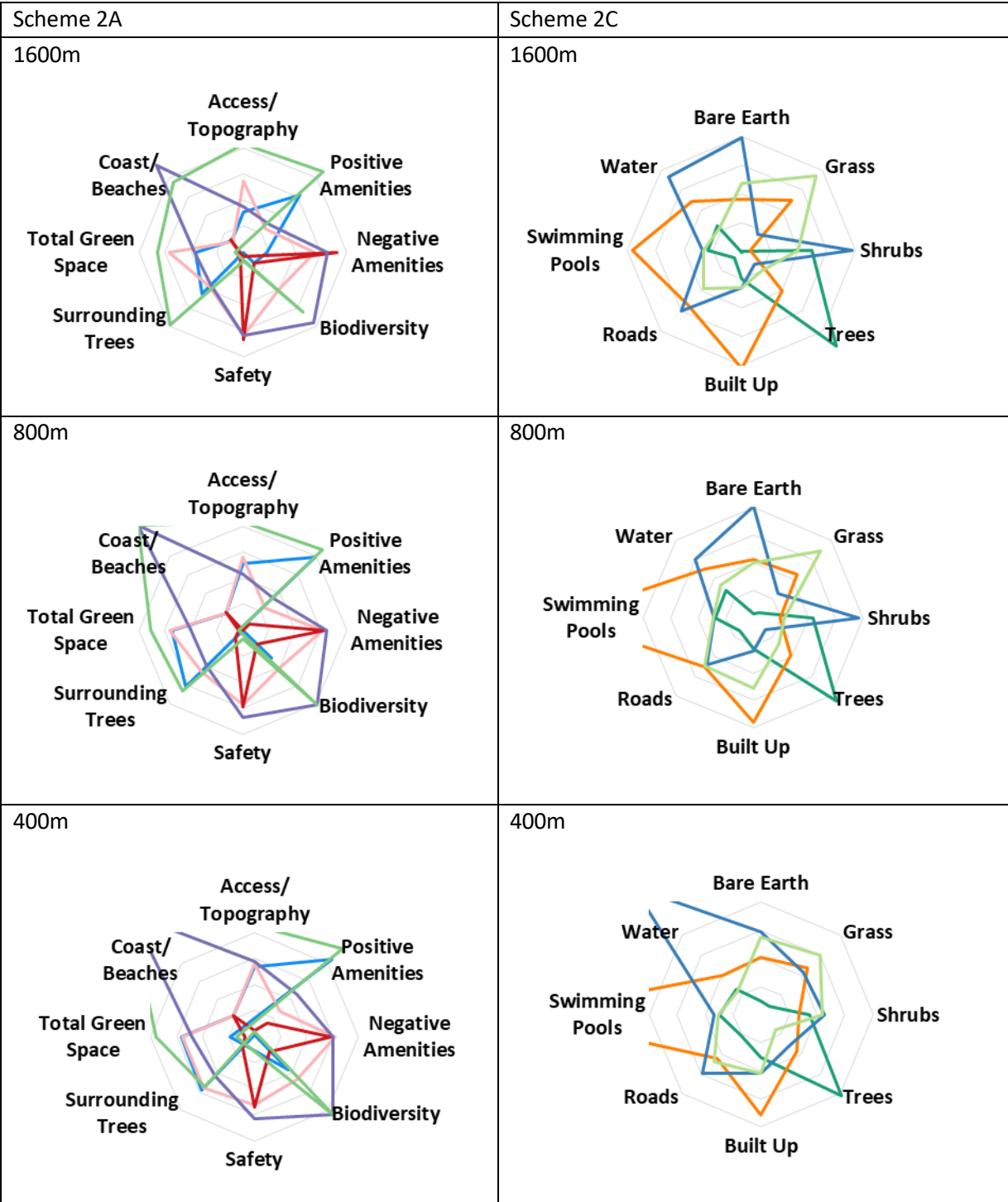


Figure S33. Radar graphs for amenities and environment scheme and percentage-based land cover scheme.



Figure S34. Radar graphs for Schemes 1 and 2B.

S7. Quality check results

Table S13. Two-tailed one-sample student test to assess non-randomness of quality check exercise.

Index	Scheme 2A 800 m	Scheme 2A 1600 m	Scheme 2C 800 m	Scheme 2C 1600 m
N	17	17	17	17
Mean	3.35	3.06	3.24	2.94
SE	0.17	0.18	0.18	0.18
Random answering score (Mean)	2.5	2.5	2.5	2.5
One sample two-tailed t-test				
t-student	5.010	3.082	4.029	2.433
p-value, with 5 decimal places	0.00013	0.00714	0.00097	0.02706
p-value, by thresholds	< 0.001	< 0.01	< 0.001	< 0.05

S8. Elbow plots

Plots are for the 1600 m buffer, obtained using the seed of the final model. RSQ = R-squared, measuring the explained variance of data. RSQ-Change = value of R-squared relative to the previous K, absolute and relative to the previous K R-square.

The elbow tip indicates the point where a further K-increase gives substantially smaller gains.

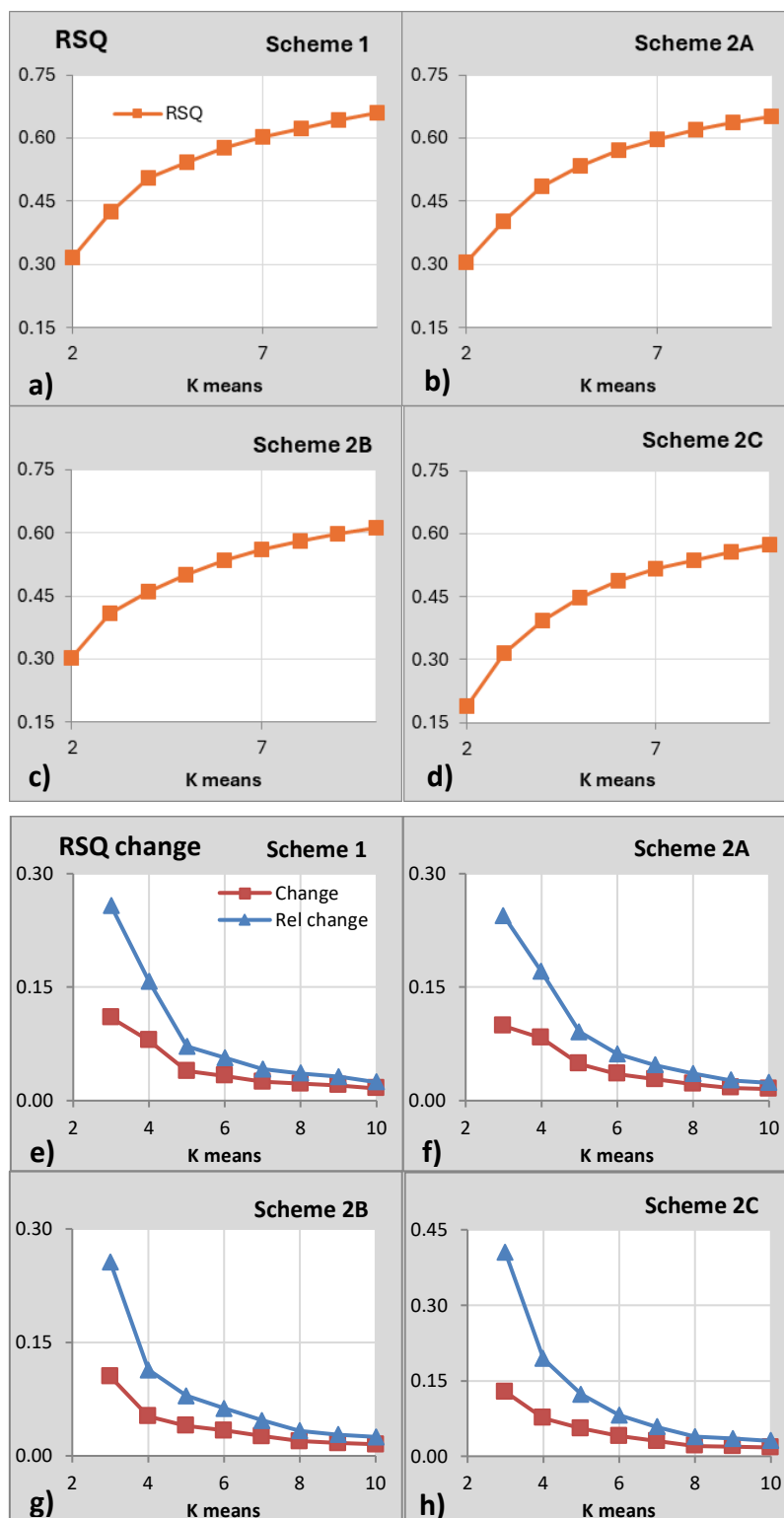


Figure S35. Elbow method for determining optimal number of clusters based on the variance explained. (a)–(d) are R-squared; (e)–(h) are the changes.