

Chapter 5

Minimal Constraints Scenario



Anti-Development Protest Signs at Hastings

No sensible decision can be made any longer without taking into account not only the world as it is but also the world as it will be.

Isaac Asimov

CHAPTER 5 MINIMAL CONSTRAINT SCENARIO

The minimal constraint scenario emulated continued urban growth throughout the region with few spatial restrictions to development. While many local government authorities have various environment and development controls they tend to be “pro-development” in an effort to increase local employment and income (Doyle & Kellow 1995).

The landscape futures scenario set presented in this chapter were derived by modeling the ‘business-as-usual’ parameters for future population growth (i.e. minimal constraints on development) based on past and current policies and trends (see also Chapters 3 and 4).

Restrictions to building at a local government level are usually based on the suitability of the type of development for the desired location rather than a restriction on any new development for that location and an alternative development may be approved. The classification of ‘urban’ area encompasses this development regardless of its actual structural form. While restrictions might vary between local government areas and at different times, this scenario forms a generalised ‘current trend’ urban development scenario through application of few constraints to development. Policy trends include incremental land release and urban development with large areas of commercial space (e.g. shopping centres).

5.1 CONSTRAINTS

The constraints to building in this scenario mirror those that existed at the time of modeling and did not allow for future changes within the constraint parameter. Constraints on urban development were:

- land used by major roads (Figure 5.1);
- areas where the slope greater than 25% (Figure 5.2); and
- the area managed by the National Parks and Wildlife Service and State Forests (Figure 5.3);

The primary development restrictions of roads are the Pacific Highway and two major inland highways (Figure 5.1). Existing roads within populated areas are also excluded by already being classified as urban area. Slope was calculated from the Digital Elevation Model produced as part of the Historical Land Use Cover Model (see Chapter 2). The areas excluded are predominately located in the Border Ranges near the Queensland border, around Mount Warning near Murwillumbah and West of Grafton, where little growth is expected (Figure 5.2). Additionally a large portion of the high slope areas are also part of the National Parks estate, due to the legacy of National Parks being derived from areas of low agricultural or economic use (Scott et al 2001, Mendel & Kirkpatrick 2002; Pressey *et al.* 2002) (Figure 5.3).

In addition to the constraints mentioned, areas determined to be urban, water or beach in the 2004 Land Use Land Cover (LULC) model (see Chapter 3) were removed as possible buildable areas.

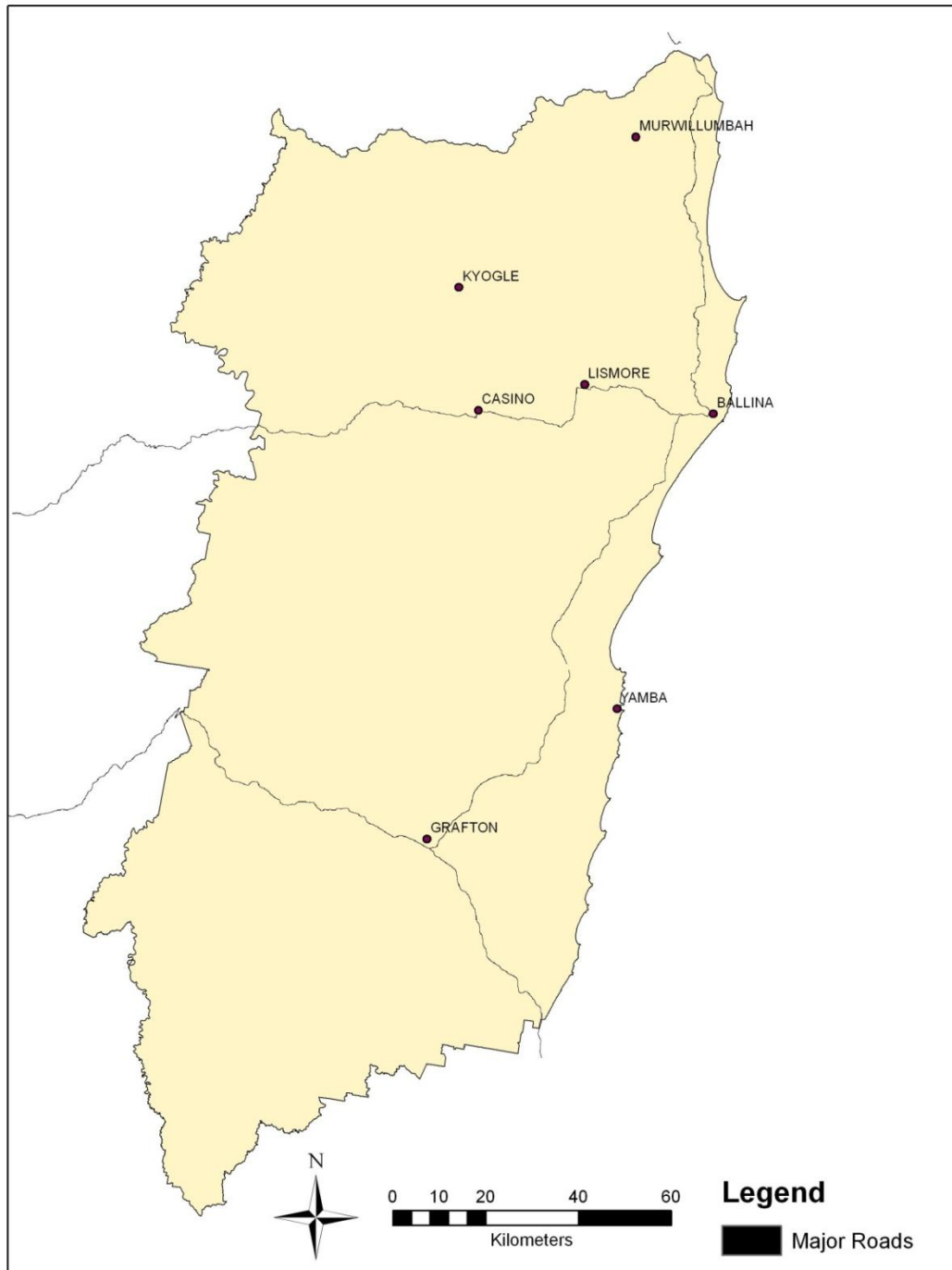


FIGURE 5.1: MAJOR ROADS CONSTRAINT

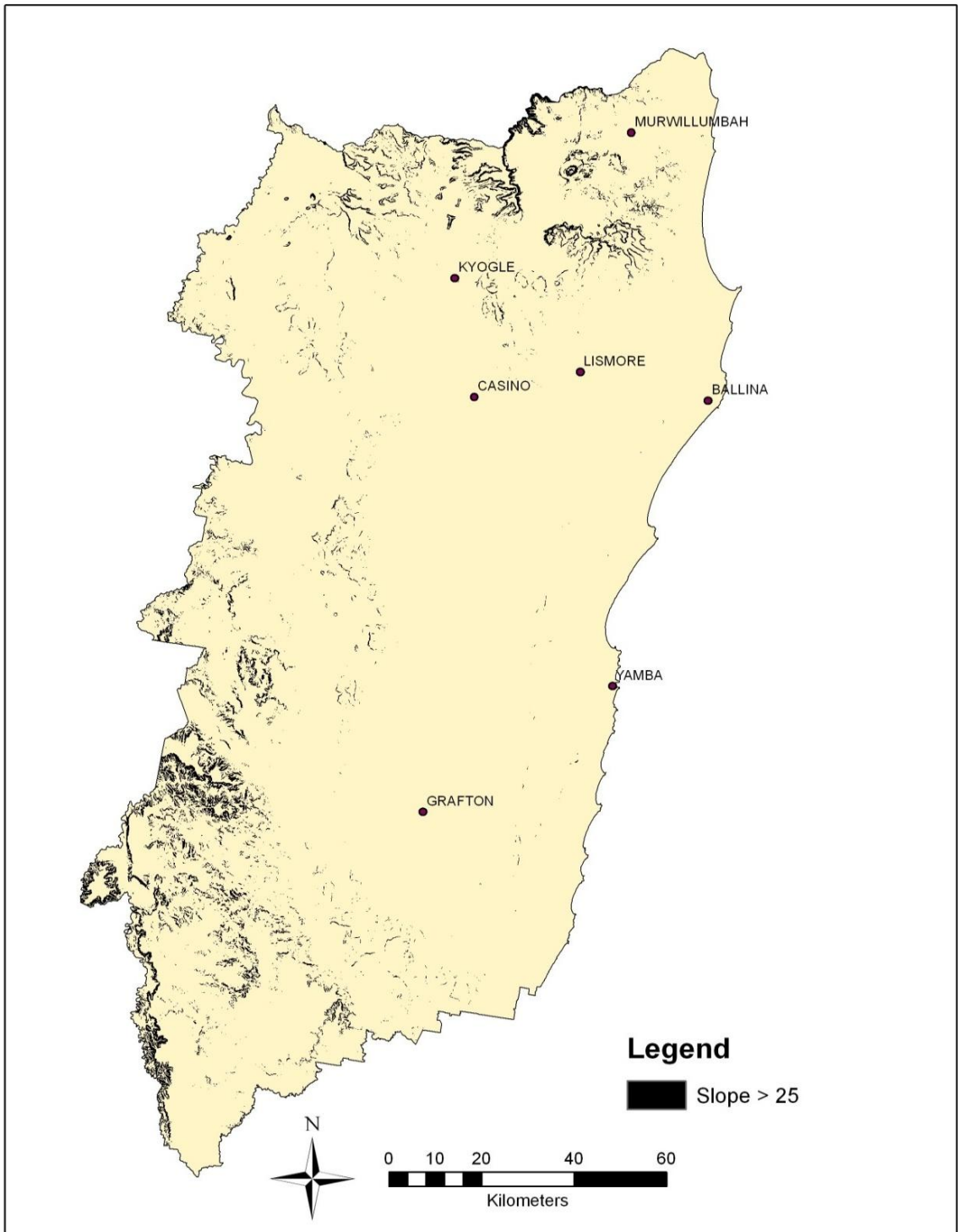


FIGURE 5.2: AREAS WITH A SLOPE GREATER THAN 25%

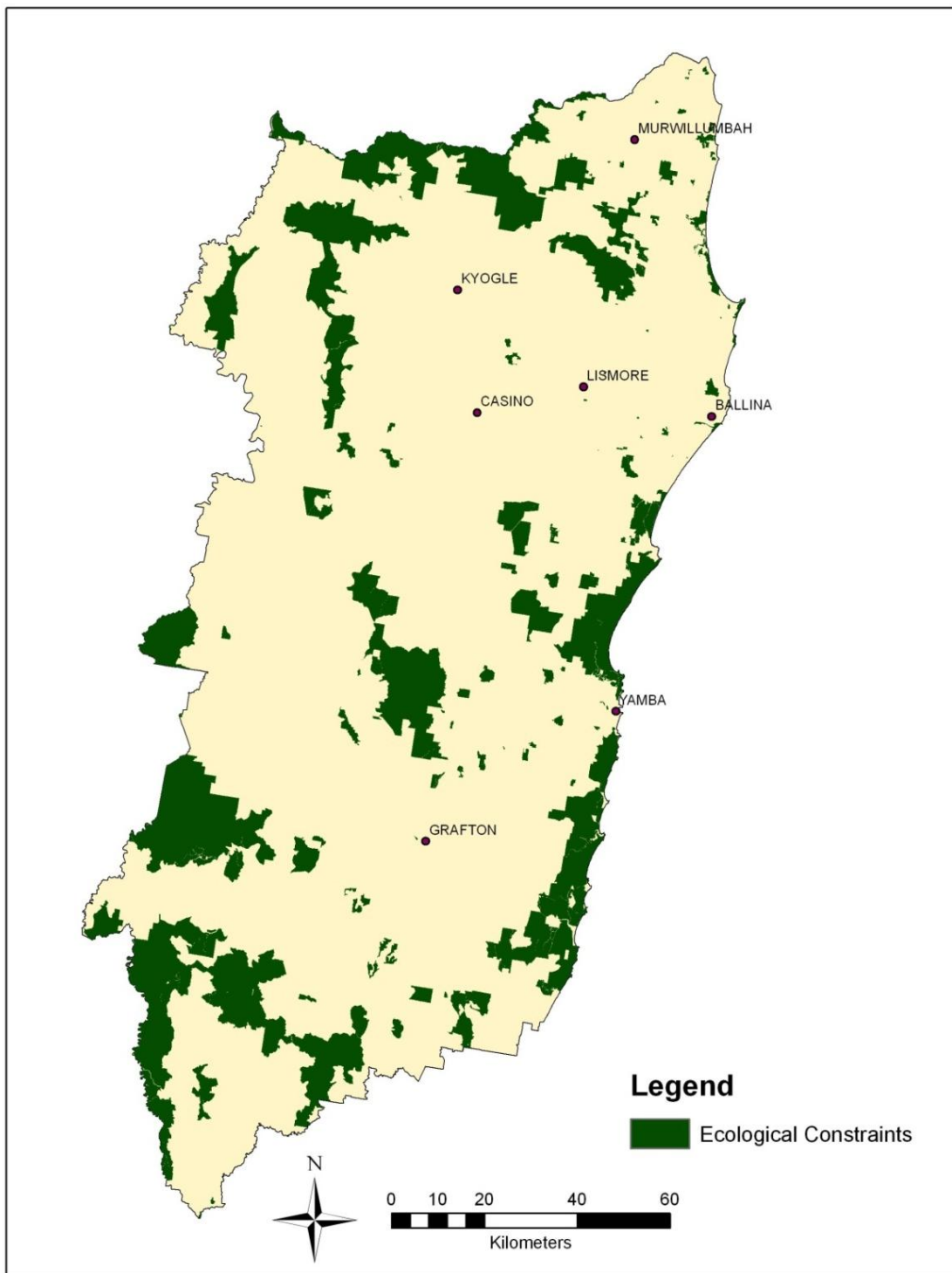


FIGURE 5.3: STATE FORESTS AND THE NATIONAL PARKS AND WILDLIFE ESTATE

5.1.1 BUILDABLE AREA

The buildable area for the scenario was derived by using a raster mask of the region and subtracting the constraints or 'not buildable' areas. A raster was produced comprising two states in which cells were either 'no data' i.e. not buildable or value '1' and hence buildable and is shown in Figure 5.4. The placement algorithm (see Appendix 2) used the raster to determine placement of new urban areas.

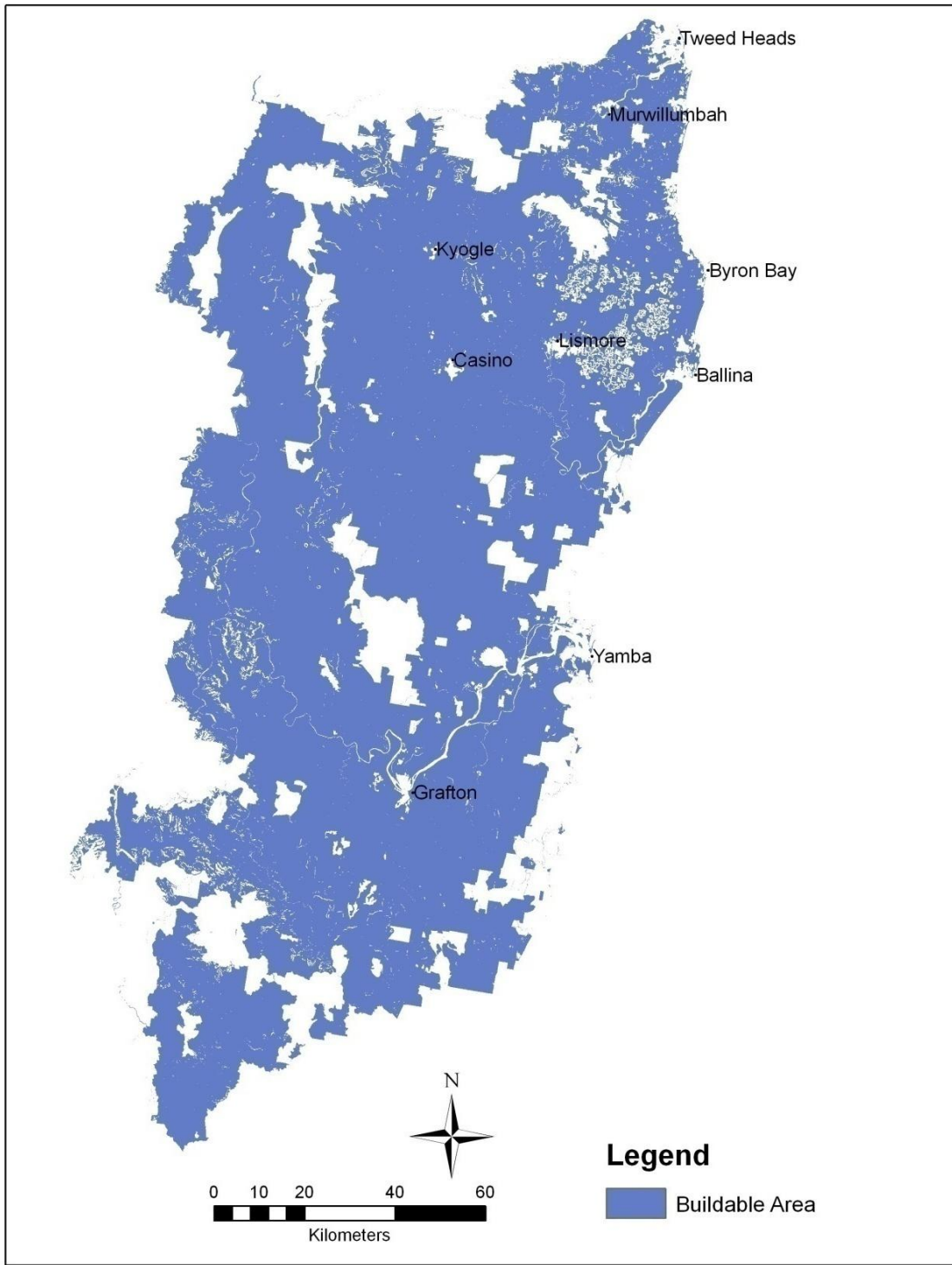


FIGURE 5.4: BUILDABLE AREA MINIMAL CONSTRAINTS SCENARIO

5.2 POPULATION 403839 SCENARIO RESULTS

The population trend estimates for each zone, up to the total regional projected population for the study area of 403839, are provided in Table 5.1. The cells listed within the table are the 25 x 25 metre raster cells utilised by the LULC Model and the placement algorithm.

TABLE 5.1: POPULATION 403839

Zone	Current (2004)			Population 403839			
	Number of urban cells	Number of People	Number of Cells / Person	Estimated Population	Estimated Cells / person	Estimated Cells Required	Number of Cells to be added
1	3818	5705	0.67	6186	1.36	8387	4569
2	20783	19677	1.06	23348	1.63	37973	17190
3	36325	25742	1.41	31400	2.40	75391	39066
4	149438	144387	1.03	246550	1.79	440649	291211
5	45071	46833	0.96	60729	1.75	106533	61462
6	35765	22114	1.62	35626	2.70	96282	60517
Sum		264458		403839		765215	474015

The estimated number of cells required for each zone was calculated by multiplying the estimated population by the estimated cells per person and hence shows the combined effect of increasing population and decreasing density. Subtracting the number of cells in 2004 within a zone from the estimated number of cells, the number of new urban cells for the placement algorithm was derived.

These new urban cells were then compared by change analysis with the 2004 Land Use Land Cover Model to demonstrate qualitatively (map visualisation) and quantitatively (analysis of aerial changes to LULC classes) the landscape changes that the increased urban area, under

those constraints, would likely impose on the (Figures 5.5 and 5.6, Table 5.2).

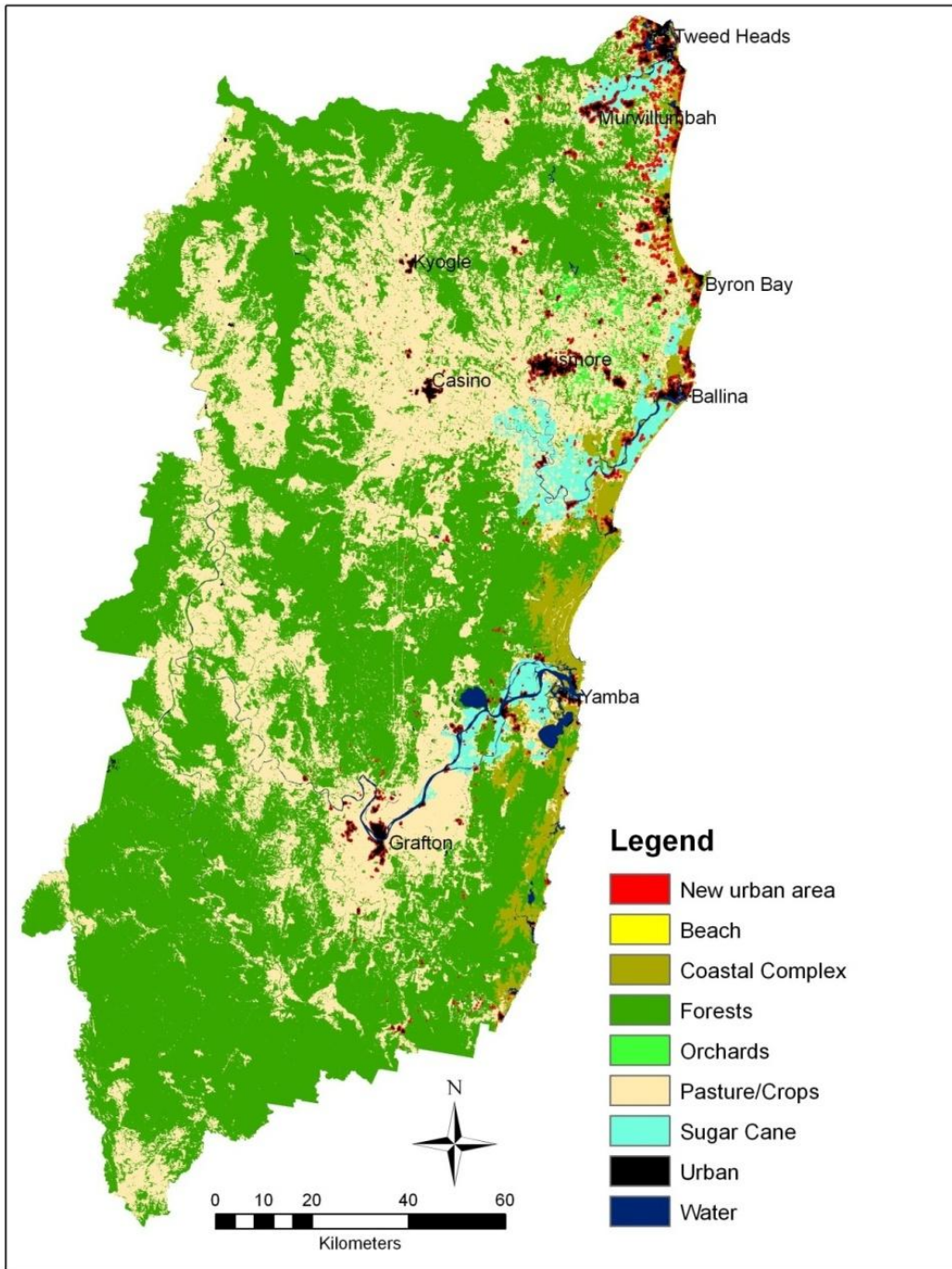


FIGURE 5.5: REGIONAL LULC CHANGE WITH POPULATION 403839

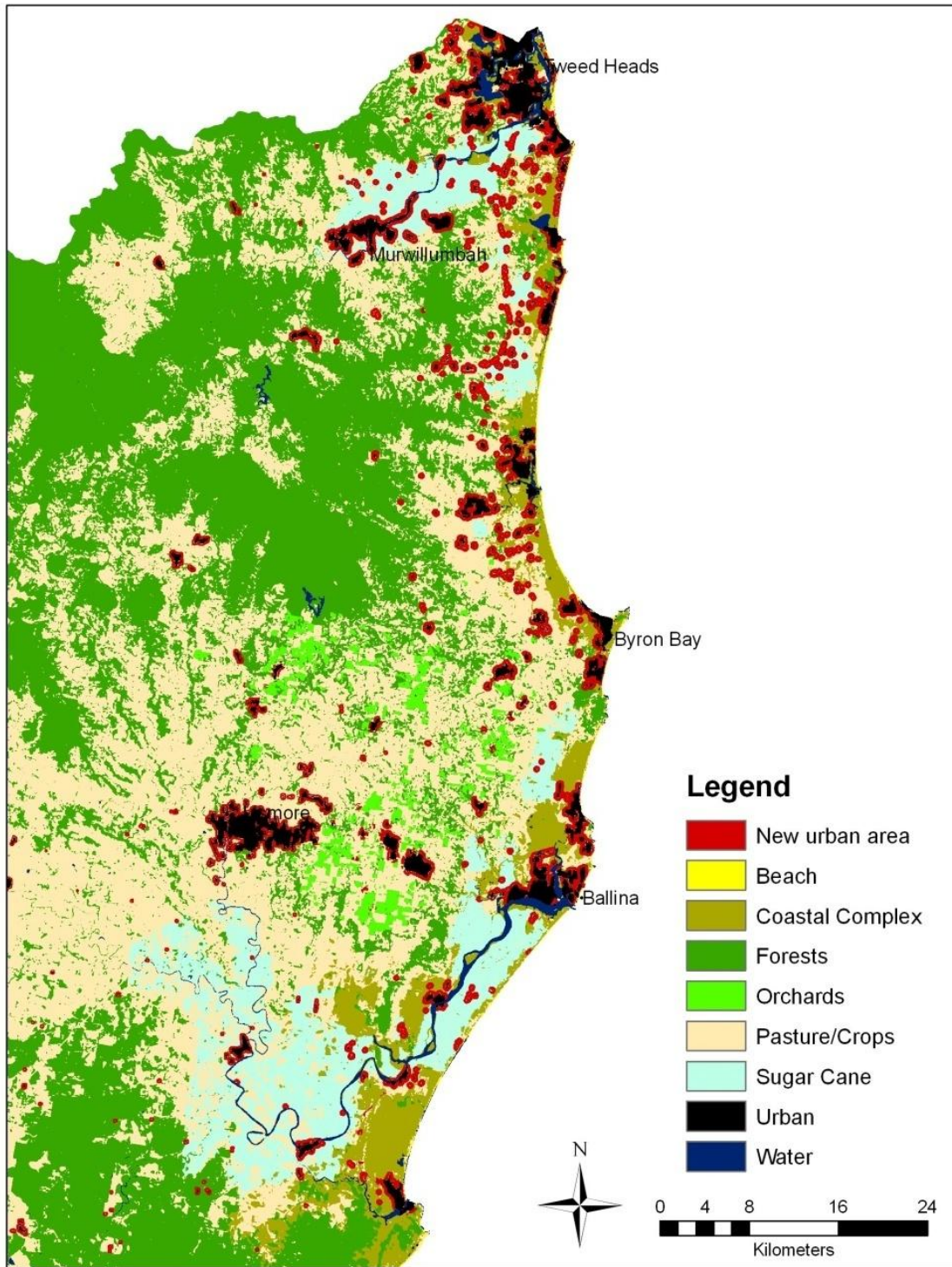


FIGURE 5.6: REGIONAL LULC CHANGE WITH POPULATION 403839, FAR NORTH COAST PORTION

As expected from population growth trends, Figure 5.5 shows the strong growth in the north coast area, particularly around Tweed Heads, Byron Bay and Ballina. Significant growth has also occurred around Lismore and there has been an increase in urban sprawl along the length of the Pacific Highway throughout the region. While the highway itself was excluded it already had a number of communities at various points along its length and new development spread from these communities.

The new urban area was merged then compared with the 2004 LULC model and the resultant land use / land cover maps were tabulated to show the change in area both as a percentage and total hectares (ha) for each LULC class (Table 5.2).

TABLE 5.2: LAND USE CHANGE FOR POPULATION 403839

Land Use / Population	2004	403839		
	Total ha	Total ha	Difference (ha)	% change
Coastal Complex	67563	63368	-4195	-6.18%
Forests	1205414	1200575	-4840	-0.4%
Pasture/Crops	713725	697393	-16332	-2.29%
Orchards	8730	8540	-190	-2.18%
Sugar Cane	56069	52285	-3783	-6.75%
Urban	20148	49488	29340	245.63%

The amount of urban space more than doubled in area. About half of this gain was through the loss of pasture and cropland with the remaining areas of urbanisation coming from conversion of 4-5000 each of sugar cane, forests and coastal complex. A breakdown of the spatial impact, by ecosystem type, is provided in Table 5.3.

TABLE 5.3: CHANGE IN VEGETATION TYPES FOR POPULATION 403839

ECOSYSTEM	JANIS STATUS	2004 (ha)	Population 403839		
			Total (ha)	Change	% Change
unclassified		151111	146025	-509	3.37%
Baileys Stringybark		31076	30947	-13	0.42%
Banksia	Rare	1336	1251	-86	6.41%
Casuarina Woodland	Rare	21	15	-6	29.38%
Clarence Lowland Needlebark Stringybark		10322	10281	-41	0.00%
Lowlands Grey Box	Vulnerable	14455	14440	-15	0.40%
Coast Cypress Pine	Rare	67	64	-3	0.10%
Coast Range Bloodwood-Mahogany		5177	5160	-17	4.22%
Clarence Lowlands Spotted Gum		128339	128141	-198	0.32%
Coast Range Spotted Gum-Blackbutt	Rare	625	625	-0.8	0.15%
Coastal Sands Blackbutt		2821	2803	-17	0.62%
Dry Foothills Blackbutt-Turpentine		2704	2697	-7	0.25%
Dry Foothills Spotted Gum		73800	73797	-3	0.00%
Dry Grassy Blackbutt-Tallowwood		5353	5327	-26	0.48%
Dry Grassy Tallowwood-Grey Gum		2168	2150	-17	0.77%
Dry Heathy Blackbutt-Bloodwood		42039	41847	-192	0.46%
Dry Heathy Sandstone Blackbutt		16634	16592	-42	0.25%
Escarpment Redgum		15211	15208	-3	0.02%
Escarpment Scribbly Gum-Apple		3583	3583	-0.3	0.01%
Wet Bangalow-Brushbox	Vulnerable	8312	8275	-37	0.44%
Foothill Grey Gum-Ironbark-Spotted Gum		39837	39755	-82	0.21%
Foothills Grey Gum-Spotted Gum		5947	5928	-19	0.32%
Gorge Ironbark-Grey Gum		22685	22684	-0.6	0.00%
Heath	Vulnerable	8138	8035	-104	1.28%
Heathy Scribbly Gum	-	7235	7198	-36	0.50%
Herbfield and Fjaeldmark	Rare	25	23	-3	10.22%
High Elevation Open Spotted Gum		42550	42542	-9	0.02%
Ironbark		5467	5458	-9	0.16%
Lowland Red Gum		43876	43570	-306	0.70%
Lowlands Scribbly Gum	Vulnerable	3204	3154	-49	1.54%
Lowlands Spotted Gum-Box		15578	15568	-9	0.06%
Coastal Mallee	Vulnerable	1240	1220	-20	1.62%
Mangrove	Rare	395	375	-20	5.17%
Moist Foothills Spotted Gum		30780	30776	-4	0.01%
Northern Moist Blackbutt		8700	8683	-17	0.19%
Natural Grassland	Rare	270	269	-0.9	0.32%
Needlebark Stringybark-Large Fruited Blackbutt		9547	9501	-46	0.48%

Northern Open Grassy Blackbutt		18876	18808	-68	0.36%
Northern Ranges Dry Tallowwood		19608	19606	-2	0.01%
Open Coastal Brushbox		3440	3422	-18	0.54%
Open Shrubby Brushbox-Tallowwood		9663	9662	-0.7	0.01%
Paperbark	Vulnerable	22405	21898	-507	2.26%
Red Bloodwood	Rare	207	207	-0.1	0.06%
Red Mahogany		12510	1249	-2	0.15%
Richmond Range Spotted Gum		16415	16410	-5	0.03%
Richmond Range Spotted Gum-Box		171970	17197	-0.2	0.00%
River Oak	Vulnerable	824	821	-3	0.39%
Rough-barked Apples	Vulnerable	1396	1396	-0.5	0.04%
Saltbush	Rare	9	9	-0.5	5.30%
Sandstone Spotted Gum-Blackbutt		3870	3864	-6	0.15%
Sherwood Needlebark Stringybark		8249	8220	-29	0.35%
South Coast Tallowwood-Blue Gum		2569	2568	-0.8	0.03%
Stringybark-Apple		5044	5044	-0.5	0.01%
Swamp	Endangered	11569	11138	-432	3.73%
Swamp Mahogany	Rare	351	323	-27	7.79%
Swamp Oak	Rare	1946	1828	-118	6.07%
Tallowwood		3563	3562	-0.9	0.03%
Turpentine		2470	2429	-41	1.66%
Wattle		783	773	-10	1.25%
Wet Bloodwood-Tallowwood		25677	25648	-29	0.11%
Wet Coastal Tallowwood-Brushbox		1526	1518	-9	0.56%
Wet Flooded Gum-Tallowwood		5399	5350	-49	0.90%
Forestry Plantations		10325	10309	-16	0.15%
Improved Pasture and Cropland		507	5065	-0.7	0.14%
Rainforest	Endangered	111641	111448	-193	0.17%
Scrub	Vulnerable	4202	4119	-84	1.99%
Cleared-Partially Cleared		3118	3103	-15	0.48%
Camphor Laurel		6150	5933	-226	3.67%

The largest area of land cover conversion was the unclassified native vegetation class, encompassing approximately half of the new urban area. In addition, 507 hectares of vulnerable paperbark, 432 hectares of endangered 'swamp' and 306 hectares of lowland red gum were converted to urban. The paperbark and swamp form part of 171 hectares of land that is listed by the state government as endangered, rare, or

vulnerable. This area also includes 30% of the available Casuarina woodlands, 10% of the herbfield and fjaeldmark, and 8% of the available swamp mahogany ecosystems.

5.3 POPULATION 558911 SCENARIO RESULTS

This section provides the LULC change scenario for a regional population increase of 558911, based on the trend population projections for each zone. Table 5.4 summarises the number of cells added for each zone. In comparison to the previous populations listed in Table 5.3, zone 1 increased by 17 cells for this new population level, whereas zone 4 increased by approximately 150000 cells.

TABLE 5.4: POPULATION 558911

Zone	Current			Population 558911			
	Number of urban cells	Number of People	Number of Cells / Person	Estimated Population	Estimated Cells / person	Estimated Cells Required	Number of Cells to be added
1	3818	5705	0.67	6199	1.36	8404	4586
2	20783	19677	1.06	23945	1.63	38945	18162
3	36325	25742	1.41	32612	2.40	78303	41978
4	149438	144387	1.03	382186	1.79	683066	533628
5	45071	46833	0.96	65065	1.75	114139	69068
6	35765	22114	1.62	48902	2.70	132164	96399
Sum		264458		558911		1055021	763821

The results of the placement algorithm of these new urban areas are mapped on the 2004 Land Use Land Cover Model in Figures 5.7 and 5.8.

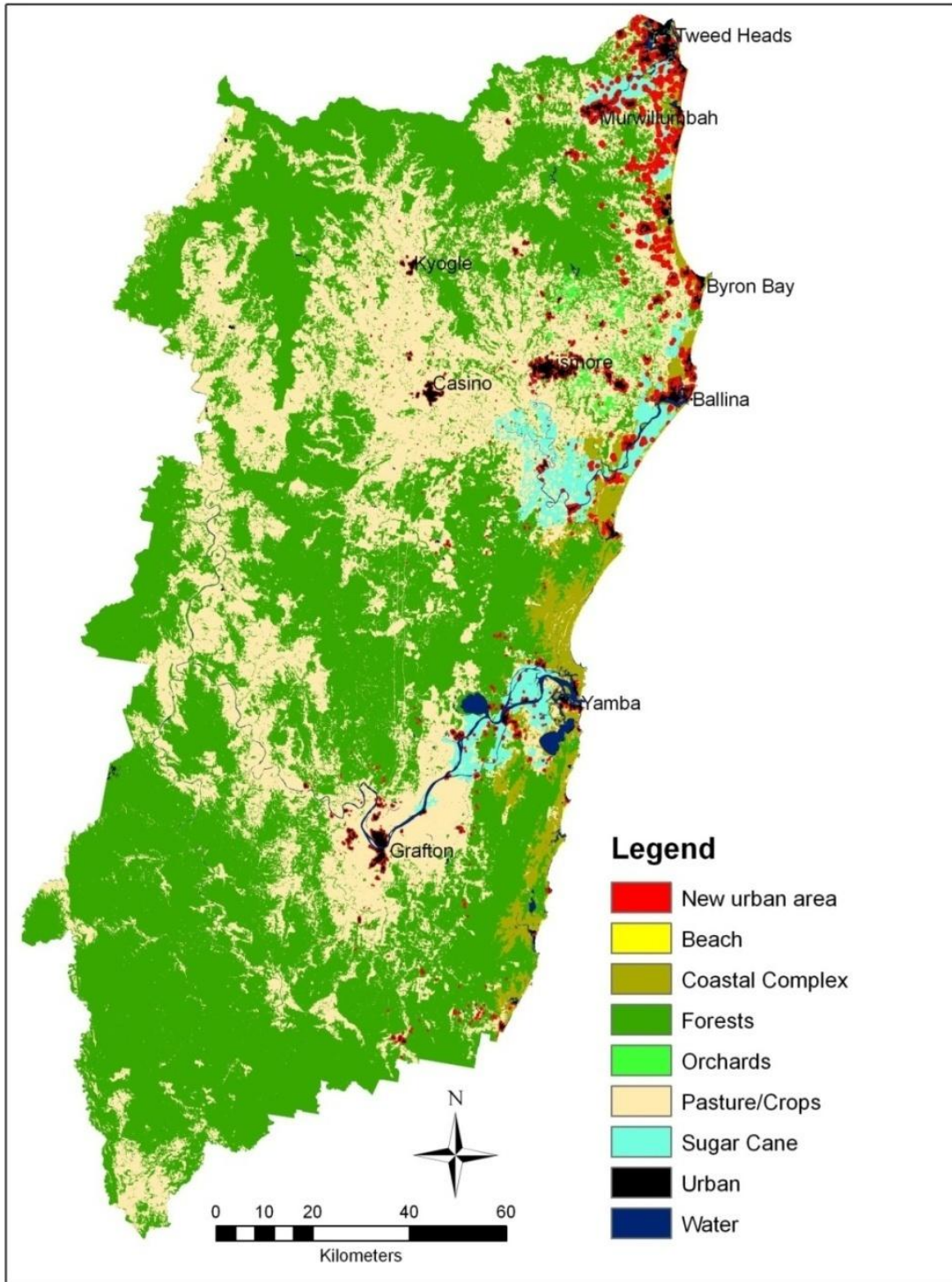


FIGURE 5.7: REGIONAL LULC CHANGE WITH POPULATION 558911

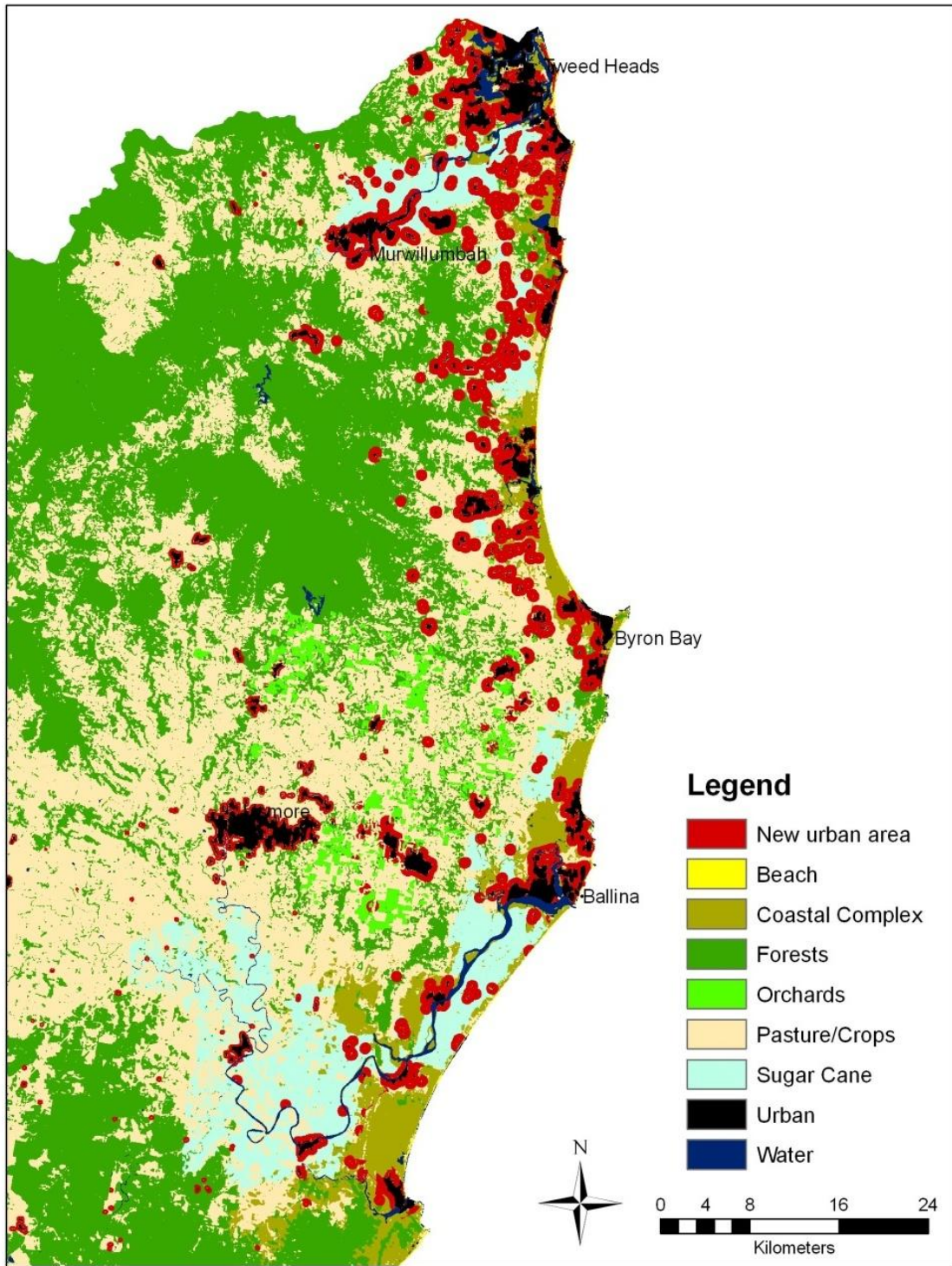


FIGURE 5.8: REGIONAL LULC CHANGE WITH POPULATION 558911, FAR NORTH COAST PORTION

The most noticeable change was in the areas of urban growth between Tweed Heads and Byron Bay, particularly along the length of the Pacific Highway again. Communities south of Ballina also realised modest growth, as did the area between Ballina and Lismore.

In the southern areas, the city of Maclean, east of Yamba grew but most other growth was dispersed between Yamba and Grafton. A number of areas around Grafton also became larger, where notably, growth can be attributed to decreasing population density more than increasing population levels.

Table 5.5 shows the resultant changes in land use.

TABLE 5.5: LAND USE CHANGE FOR POPULATION 558911

Land Use / Population	2004		558911	
	Total ha	Total ha	Difference (ha)	% change
Coastal Complex	67563	60299	-7263	-10.75%
Forests	1205414	1197452	-7962	-0.66%
Pasture/Crops	713725	689387	-24338	-3.41%
Orchards	8730	8324	-405	-4.63%
Sugar Cane	56069	48515	-7553	-3.47%
Urban	20148	67670	47522	335.87%

In this instance the amount of urban space more than trebled in area, through a paralleled loss of just over half of the available pasture and cropland with the remainder being the conversion of areas of sugar cane, forests and coastal complex. Some 24338 hectares of pasture / cropland became urbanised as did 7553 hectares (13.5%) of sugar cane.

Depending on the spatial distribution of this change there is the possibility

for this loss to have a negative impact upon the viability of local sugarmills, employment, agricultural service industries and finally local economies and communities.

In this scenario some 15000 hectares of native vegetation were lost when compared to the 2004 LULC. A breakdown of the change in area of ecosystem types is provided in Table 5.6

TABLE 5.6: CHANGE IN VEGETATION TYPES FOR POPULATION 558911

ECOSYSTEM	JANIS STATUS	2004 (ha)	Population 558911		
			Total (ha)	Change (ha)	Change %
unclassified		151111	1432744	-78366	5.19%
Baileys Stringybark		31076	308493.1	-2270	0.73%
Banksia	Rare	1336	11645	-1718	12.85%
Casuarina Woodland	Rare	21	106.25	-104	49.55%
Central Mid Elevation Sydney Blue Gum		3278	32774.38	-8	0.02%
Clarence Lowland Needlebark Stringybark		10322	102412.5	-805	0.78%
Lowlands Grey Box	Vulnerable	14455	144353.1	-192	0.13%
Coast Cypress Pine	Rare	67	627.5	-39	5.82%
Coast Range Bloodwood-Mahogany		5177	51423.75	-346	0.67%
Clarence Lowlands Spotted Gum		128339	1280028	-3362	0.26%
Coast Range Spotted Gum-Blackbutt	Rare	625	6241.25	-13	0.20%
Coastal Flooded Gum		8039	80380	-5	0.01%
Coastal Sands Blackbutt		2821	27937.5	-270	0.96%
Dry Foothills Blackbutt-Turpentine		2704	26905	-134	0.49%
Dry Foothills Spotted Gum		73800	737961.3	-37	0.00%
Dry Grassy Blackbutt-Tallowwood		5353	53070.63	-454	0.85%
Dry Grassy Tallowwood-Grey Gum		2167	21336.25	-336	1.55%
Dry Heathy Blackbutt-Bloodwood		42039	416990.6	-3398	0.81%
Dry Heathy Sandstone Blackbutt		16634	165662.5	-678	0.41%
Escarpment Redgum		15211	152073.1	-32	0.02%
Escarpment Scribbly Gum-Apple		3583	35827.5	-5	0.01%
Wet Bangalow-Brushbox	Vulnerable	8312	82360	-757	0.91%
Foothill Grey Gum-Ironbark-Spotted Gum		39837	396793.1	-1573	0.39%
Foothills Grey Gum-Spotted Gum		5947	59111.25	-363	0.61%
Gorge Ironbark-Grey Gum		22685	226840	-10	0.00%

Heath	Vulnerable	8138	7947	-192	2.35%
Heathy Scribbly Gum		7235	7166	-68	0.94%
Herbfield and Fjaeldmark	Rare	25	21	-4	17.21%
High Elevation Open Spotted Gum		42550	42532	-19	0.04%
Ironbark		5467	5456	-11	0.21%
Lowland Red Gum		43876	43291	-585	1.33%
Lowlands Scribbly Gum	Vulnerable	3204	3102	-101	3.17%
Lowlands Spotted Gum-Box		15578	15564	-14	0.09%
Coastal Mallee	Vulnerable	1240	1207	-33	2.69%
Mangrove	Rare	395	350	-46	11.57%
Moist Foothills Spotted Gum		30780	30774	-6	0.02%
Northern Moist Blackbutt		8700	8657	-43	0.49%
Natural Grassland	Rare	270	269	-1	0.49%
Needlebark Stringybark-Large Fruited Blackbutt		9547	9464	-84	0.87%
Northern Open Grassy Blackbutt		18876	18750	-126	0.67%
Northern Ranges Dry Tallowwood		19608	19603	-5	0.03%
Open Coastal Brushbox		3440	3411	-29	0.84%
Open Shrubby Brushbox-Tallowwood		9663	9662	-0.7	0.01%
Paperbark	Vulnerable	22405	21369	-1036	4.62%
Red Bloodwood	Rare	207	207	-0.3	0.15%
Red Mahogany		1251	1248	-2	0.19%
Richmond Range Spotted Gum		16415	16409	-6	0.04%
Richmond Range Spotted Gum-Box		17197	17197	-0.4	0.00%
River Oak	Vulnerable	824	820	-4	0.49%
Rough-barked Apples	Vulnerable	1396	1396	-0.5	0.04%
Saltbush	Rare	9	8	-1	13.25%
Sandstone Spotted Gum-Blackbutt		3870	3861	-9	0.23%
Sherwood Needlebark Stringybark		8249	8186	-62	0.76%
South Coast Tallowwood-Blue Gum		2569	2568	-1	0.05%
Stringybark-Apple		5044	5043	-0.8	0.02%
Swamp	Endangered	11569	10759	-810	7.01%
Swamp Mahogany	Rare	351	290	-61	17.42%
Swamp Oak	Rare	1946	1690	-256	13.14%
Tallowwood		3563	3561	-2	0.04%
Turpentine		2470	2376	-94	3.79%
Very Wet New England Blackbutt-Tallowwood		434	434	-0.1	0.01%
Wattle		783	761	-23	2.89%
Wet Bloodwood-Tallowwood		25677	25612	-65	0.25%
Wet Coastal Tallowwood-Brushbox		1526	1508	-18	1.20%
Wet Flooded Gum-Tallowwood		5399	52942.5	-104	1.93%
Forestry Plantations		10325	10280	-44	0.43%
Improved Pasture and Cropland		507	507	-0.7	0.14%
Rainforest	Endangered	111641	111276	-365	0.33%

Scrub	Vulnerable	4202	4039	-164	3.90%
Cleared-Partially Cleared		3118	3095	-23	0.75%
Camphor Laurel		6159	5758	-401	6.51%

The primary vegetation types affected were paperbark, swamp and lowland red gum. 401 Hectares of camphor laurel were urbanised, however as this is a non native and considered a weed species, it might be interpreted as a benefit of landcover conversion to urban development. However, 3357 hectares of rare, endangered or vulnerable native vegetation were lost, including almost 50% of the Casuarina woodlands, 17% of the swamp mahogany and the herbfield and fjaeldmark, as well as approximately 13% of the swamp oak, saltbush and banksias.

5.4 POPULATION 727657 SCENARIO RESULTS

Expanding the population to 727657 achieved the allocation of cells in Table 5.7

TABLE 5.7: POPULATION 727657

Zone	Current			Population 727657		Estimated Cells Required	Number of Cells to be added
	Number of urban cells	Number of People	Number of Cells / Person	Estimated Population	Estimated Cells / person		
1	3818	5705	0.67	6288	1.36	8524	4706
2	20783	19677	1.06	25316	1.63	41174	20391
3	36325	25742	1.41	35074	2.40	84214	47889
4	149438	144387	1.03	525599	1.79	939381	789943
5	45071	46833	0.96	72028	1.75	126354	81283
6	35765	22114	1.62	63351	2.70	171214	135449
Sum		264458		727657		1370862	1079662

Over 75% of the total population allocation was located in zone 4, with the population reaching in excess of 500000 people. Zone 6 highlights the amount of space used by the trend for lower density development as it is estimated to contain 88% of the population of zone 5, however the less dense settlement pattern resulted in has 166% more cells allocated to new urban areas.

The merging and comparison of this population settlement allocation with the 2004 LULC model produced the changes shown in Figures 5.9 and 5.10.

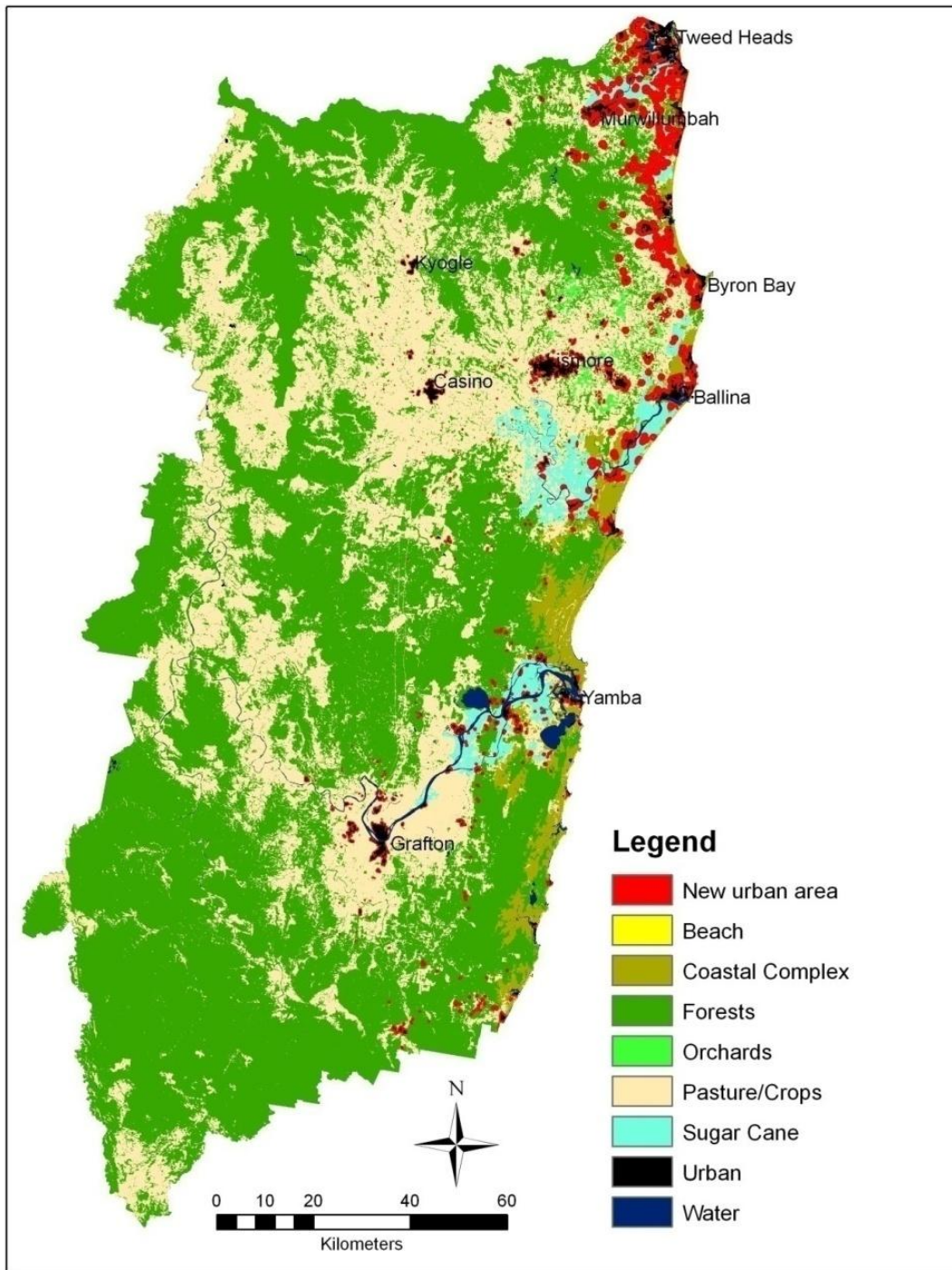


FIGURE 5.9: REGIONAL LULC CHANGE WITH POPULATION 727657

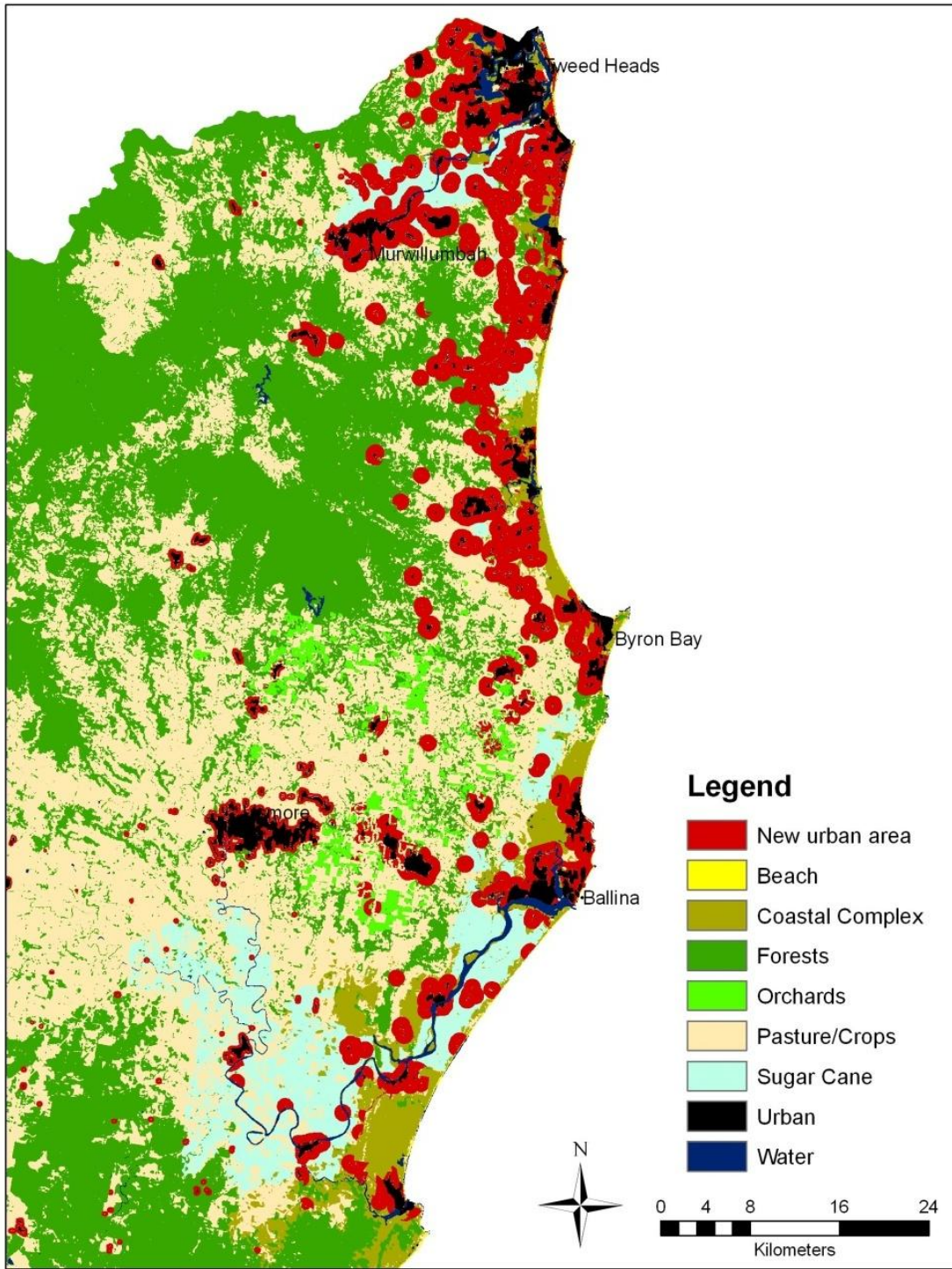


FIGURE 5.10: REGIONAL LULC CHANGE WITH POPULATION 727657, FAR NORTH COAST PORTION

The disproportionate settlement pattern of the future population projection within the region became more obvious on the mapped visualisation, with the all of the available buildable area around Tweed Heads through to Murwillimbah being entirely filled with development (Figures 5.9 and 5.10). A thick band extending inland approximately 10-15 kilometres follows the coast to Byron Bay. Ballina more than doubled in size. To the immediate south, the towns of Wardell, Woodburn, and Evans Head have also grown extensively.

Growth through the southern areas of the region was less and has again been sporadic, primarily occurring on the plains in and around the Maclean area. Growth within the inland areas was minimal. This is consistent with the past-present-future population and settlement trend calculations (Chapter 4).

Overall change in land use throughout the region is presented in Table 5.8

TABLE 5.8: LAND USE CHANGE FOR POPULATION 727657

Land Use / Population	2004		727657	
	Total ha	Total ha	Difference (ha)	% Change
Coastal Complex	67563	57634	-9929	-14.7%
Forests	1205414	1193523	-11891	-1%
Pasture/Crops	713725	681001	-32724	-4.58%
Orchards	8730	7962	-768	-8.8%
Sugar Cane	56069	44195	-11873	-1.18%
Urban	201477	87333	67185	433.46%

Agricultural pasture and crop land was again the most affected landscape type in terms of total area, losing over 30000 hectares to urban

development. The loss of 21% of the area of sugar cane fields could have social and economic impacts on a number of communities within the region.

Environmental impacts have increased in terms of the areas of ecosystems impacted. More than 20000 hectares of native vegetation including 15% of the coastal complex type were affected. A breakdown of the change in area of ecosystem type is provided in Table 5.9

TABLE 5.9: CHANGE IN VEGETATION TYPES FOR POPULATION 727657

ECOSYSTEM	JANIS STATUS	2004 (ha)	Population 727657		
			Total (ha)	Change (ha)	% Change
unclassified		151111	140443	-10668	7.06%
Baileys Stringybark		31076	30752	-324	1.04%
Banksia	Rare	1336	1094	-243	18.17%
Casuarina Woodland	Rare	21	5	-16	74.78%
Central Mid Elevation Sydney Blue Gum		3278	3277	-1	0.03%
Clarence Lowland Needlebark Stringybark		10322	10202	-120	1.16%
Lowlands Grey Box	Vulnerable	14455	14429	-26	0.18%
Coast Cypress Pine	Rare	67	63	-4	5.82%
Coast Range Bloodwood-Mahogany		5177	5124	-53	1.02%
Clarence Lowlands Spotted Gum		128339	127839	-500	0.39%
Coast Range Spotted Gum-Blackbutt	Rare	625	623	-3	0.44%
Coastal Flooded Gum		8039	8035	-4	0.04%
Coastal Sands Blackbutt		2821	2784	-37	1.31%
Dry Foothills Blackbutt-Turpentine		2704	2684	-20	0.73%
Dry Foothills Spotted Gum		73800	73793	-7	0.01%
Dry Grassy Blackbutt-Tallowwood		5353	5284	-69	1.28%
Dry Grassy Tallowwood-Grey Gum		2167	2117	-51	2.34%
Dry Heathy Blackbutt-Bloodwood		42039	41523	-516	1.23%
Dry Heathy Sandstone Blackbutt		16634	16537	-97	0.58%
Escarpment Redgum		15211	15207	-3	0.02%
Escarpment Scribbly Gum-Apple		3583	3582	-1	0.03%
Wet Bangalow-Brushbox	Vulnerable	8312	8175	-137	1.65%
Foothill Grey Gum-Ironbark-Spotted Gum		39837	39591	-246	0.62%
Foothills Grey Gum-Spotted Gum		5947	5894	-54	0.90%

Gorge Ironbark-Grey Gum		22685	22684	-1	0.01%
Heath	Vulnerable	8138	7852	-286	3.52%
Heathy Scribbly Gum		7235	7130	-105	1.45%
Herbfield and Fjaeldmark	Rare	25	20	-5	21.20%
High Elevation Open Spotted Gum		42550	42524	-26	0.06%
Ironbark		5467	5451	-16	0.29%
Lowland Red Gum		43876	43003	-874	1.99%
Lowlands Scribbly Gum	Vulnerable	3204	3044	-159	4.97%
Lowlands Spotted Gum-Box		15578	15557	-21	0.13%
Coastal Mallee	Vulnerable	1240	1192	-48	3.90%
Mangrove	Rare	395	332	-63	15.98%
Moist Foothills Spotted Gum		30780	30768	-12	0.04%
Northern Moist Blackbutt		8700	8611	-88	1.01%
Natural Grassland	Rare	270	267	-3	1.02%
Needlebark Stringybark-Large Fruited Blackbutt		9547	9427	-121	1.26%
New England Stringybark-Blakelys Red Gum	-	1067	1067	-0.1	0.01%
Northern Grassy Sydney Blue Gum	Vulnerable	2856	2855	-1	0.04%
Northern Open Grassy Blackbutt		18876	18681	-194	1.03%
Northern Ranges Dry Tallowwood		19608	19598	-11	0.05%
Open Coastal Brushbox		3440	3398	-43	1.24%
Open Shrubby Brushbox-Tallowwood		96623	9662	-0.7	0.01%
Paperbark	Vulnerable	22405	20765	-1640	7.32%
Red Bloodwood	Rare	207	207	-0.8	0.36%
Red Mahogany		1251	1248	-3	0.21%
Richmond Range Spotted Gum		16415	16408	-7	0.04%
Richmond Range Spotted Gum-Box		17197	17196	-0.7	0.00%
River Oak	Vulnerable	824	819	-5	0.62%
Rough-barked Apples	Vulnerable	1396	1396	-0.5	0.04%
Saltbush	Rare	9	7	-2	22.52%
Sandstone Spotted Gum-Blackbutt		3870	3858	-12	0.30%
Sherwood Needlebark Stringybark		8249	8134	-115	1.39%
South Coast Tallowwood-Blue Gum		2569	2566	-3	0.12%
Stringybark-Apple		5044	5043	-1	0.03%
Swamp	Endangered	11569	10455	-1115	9.63%
Swamp Mahogany	Rare	351	259	-92	26.24%
Swamp Oak	Rare	1946	1626	-320	16.45%
Tallowwood		3563	3561	-2	0.05%
Turpentine		2470	2309	-161	6.53%
Very Wet New England Blackbutt-Tallowwood		434	434	-0.1	0.03%
Wattle		783	749	-35	4.44%
Wet Bloodwood-Tallowwood		25677	25538	-139	0.54%
Wet Coastal Tallowwood-Brushbox		1526	1495	-31	2.04%

Wet Flooded Gum-Tallowwood		5399	5191	-207	3.84%
Forestry Plantations	0	10325	10229	-95	0.92%
Improved Pasture and Cropland	0	507	507	-0.7	0.14%
Rainforest	Endangered	111641	111067	-574	0.51%
Scrub	Vulnerable	4202	3931	-271	6.45%
Cleared-Partially Cleared	0	3118	3088	-30	0.95%
Camphor Laurel	0	6159	5482	-677	10.98%

Under this scenario there was approximately a 50% increase in the area of vegetation lost. The largest losses again included paperbark, swamp and lowlands red gum. In each of these cases the increase in the area of vegetation class lost was approximately proportional to the increase in lost vegetation for the region.

The loss of state listed rare, threatened and vulnerable ecosystems was also proportional in its increase (5015 hectares). This group predominately comprised of paperbark, swamp and banksia, however only 25% of Casuarina woodlands remained and 26% of the swamp mahogany was lost.

5.5 POPULATION 955497 SCENARIO RESULTS

For this scenario the regional population was set to 955497, resulting in more than one million 25x25m cells being added within zone 4, and was 76% of the new urban area (Table 5.10). In comparison zones 1 and 2 have increased by approximately 10 and 20% respectively since the 403839 scenario.

TABLE 5.10: POPULATION 955497

Zone	Current			Population 955497		Estimated Cells Required	Number of Cells to be added
	Number of urban cells	Number of People	Number of Cells / Person	Estimated Population	Estimated Cells / person		
1	3818	5705	0.67	6378	1.36	8646	4828
2	20783	19677	1.06	26765	1.63	43531	22748
3	36325	25742	1.41	37722	2.40	90571	54246
4	149438	144387	1.03	722826	1.79	1291878	1142440
5	45071	46833	0.96	79736	1.75	139876	94805
6	35765	22114	1.62	82069	2.70	221801	186036
Sum		264458		955497		1796304	1505104

This scenario had an obvious visual impact when the resultant LULC change was mapped (Figures 5.11 and 5.12)

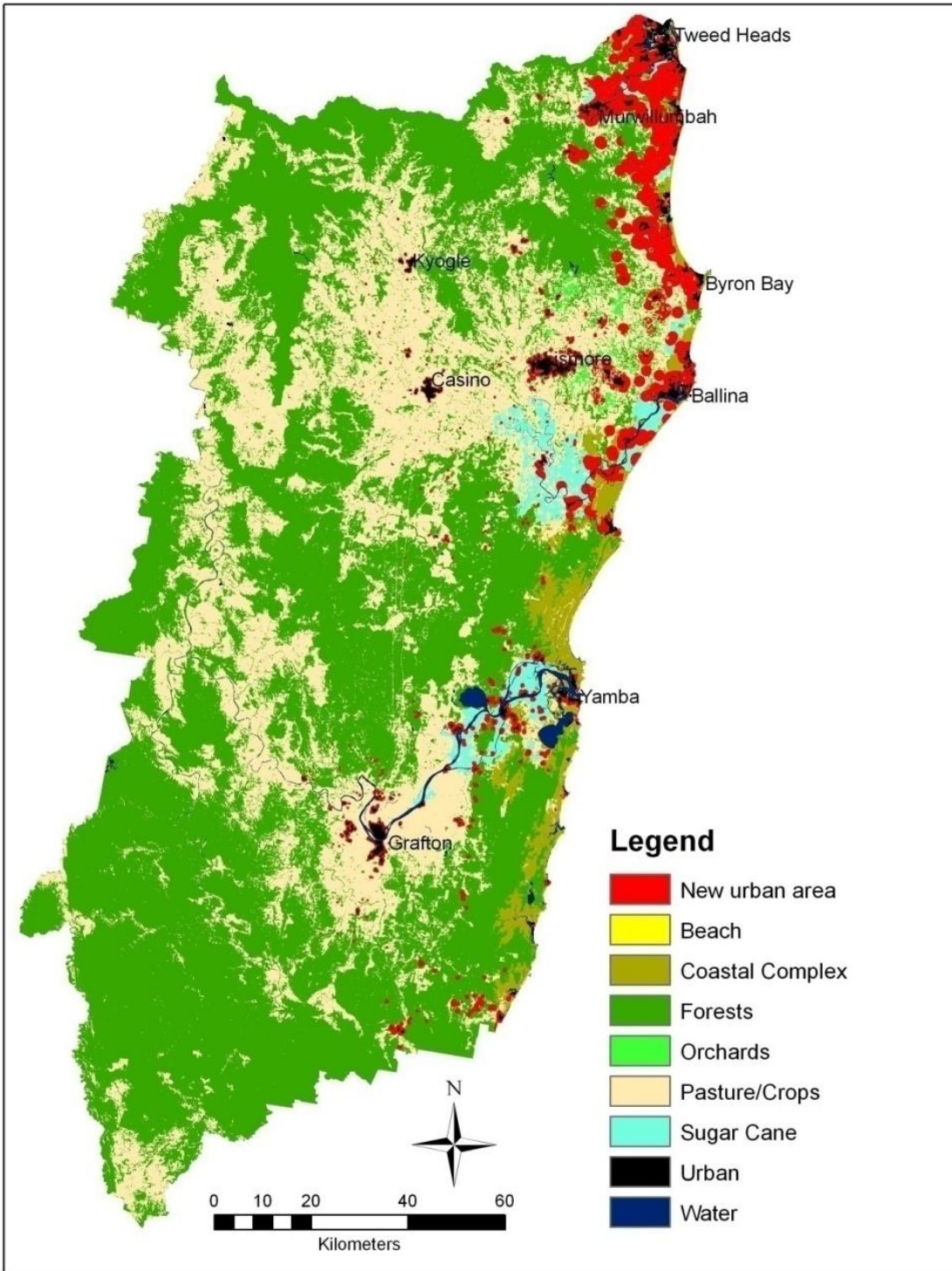


FIGURE 5.10: REGIONAL LULC CHANGE WITH POPULATION 955497

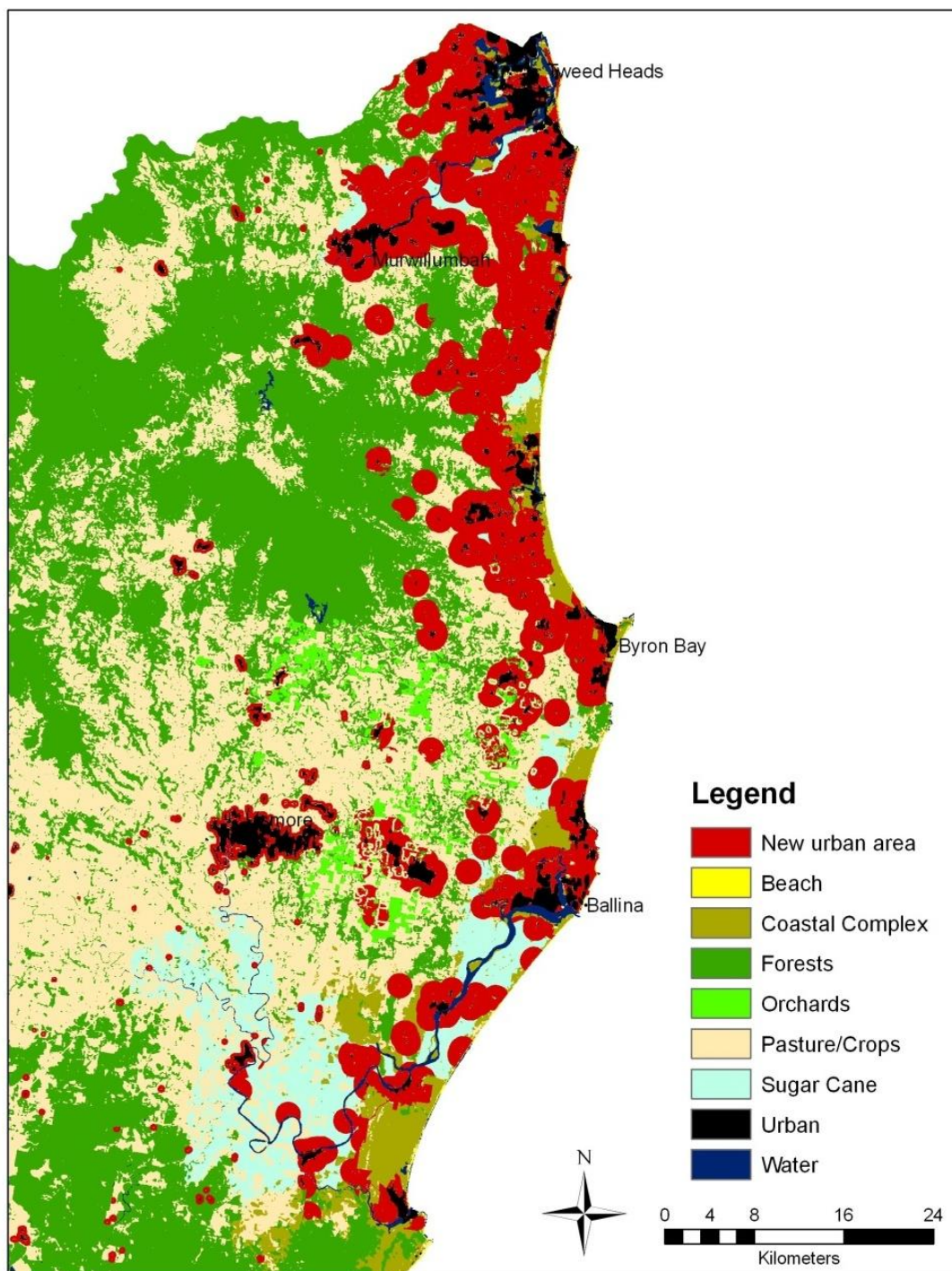


FIGURE 5.11: REGIONAL LULC CHANGE WITH POPULATION 955497, FAR NORTH COAST PORTION

Zone 4 population increased to over 700000 people and the effects of this are apparent along the north-eastern sea board. The placement algorithm extended the trend observed in previous scenarios. As development proceeded in the north east it also started “pushing” inland. Similarly the trend of new development adjacent to the Pacific Highway continued throughout the entire region. This suggests that when past trend data is utilised, specific considerations for development along road corridors is not required (as discussed in Chapter 2).

As a result of the scenarios allocation of new urban development, areas from Byron Bay (spatially more than quadruple the 2004 size) to the Queensland border are represented by a constant sprawl of urban settlement with only a fragmented land use type of protected areas such as national parks. The urban sprawl extended inland some 20 kilometres in the north to Murwillimbah and Mount Warning.

In the south, areas around Maclean through to Yamba continued to demonstrate steady growth of human settlements and inland zones showed little change. Table 5.11 details the landuse for the scenario.

TABLE 5.11: LAND USE CHANGE FOR POPULATION 955497

Land Use / Population	2004	955497		
	Total ha	Total ha	Difference (ha)	% Change
Coastal Complex	67563	54680	-12882	-19.07%
Forests	1205414	1187314	-18100	-1.5%
Pasture/Crops	713725	669917	-43809	-6.14%
Orchards	8730	7403	-1327	-15.2%
Sugar Cane	56069	38417	-17651	-31.42%
Urban	20148	113917	93769	565.41%

The spatial area of urban settlement grew to more than 500% of the 2004 area. Pasture and crops lost the largest physical area (43809 hectares) and sugar cane lost the largest proportion of its current area. 18100 hectares of forest were lost in this scenario. While the conversion of forest was not the largest loss in area or percentage, it is important because the majority of forest converted to urban usage is located in the upper north areas and not spread throughout the region. Similarly coastal complex vegetation types were reduced by almost 20% which included the loss of large patches of habitat. A breakdown of the change in area of ecosystem type is provided in Table 5.12.

TABLE 5.12: CHANGE IN VEGETATION TYPES FOR POPULATION 955497

ECOSYSTEM	JANIS STATUS	2004 (ha)	Population 955497		
			Total (ha)	Change (ha)	% Change
unclassified		151111	136688	-14423	9.54%
Baileys Stringybark		31076	30604	-472	1.52%
Banksia	Rare	1336	1038	-298	22.29%
Casuarina Woodland	Rare	21	5	-16	74.78%
Central Mid Elevation Sydney Blue Gum		3278	3277	-1	0.03%
Clarence Lowland Needlebark Stringybark		10322	10122	-200	1.94%
Lowlands Grey Box	Vulnerable	14455	14420	-34	0.24%
Coast Cypress Pine	Rare	67	63	-4	5.82%
Coast Range Bloodwood-Mahogany		5177	5103	-74	1.43%
Clarence Lowlands Spotted Gum		128339	127592	-747	0.58%
Coast Range Spotted Gum-Blackbutt	Rare	625	620	-5	0.81%
Coastal Flooded Gum		8039	8027	-12	0.15%
Coastal Sands Blackbutt		2821	2766	-55	1.94%
Dry Foothills Blackbutt-Turpentine		2704	2673	-31	1.14%
Dry Foothills Spotted Gum		73800	73789	-11	0.02%
Dry Grassy Blackbutt-Tallowwood		5353	5245	-107	2.00%
Dry Grassy Tallowwood-Grey Gum		2167	2090	-77	3.55%
Dry Heathy Blackbutt-Bloodwood		42039	41260	-779	1.85%
Dry Heathy Sandstone Blackbutt		16634	16494	-140	0.84%
Escarpment Redgum		15211	15207	-4	0.03%

Escarpment Scribbly Gum-Apple		3583	3581	-2	0.05%
Wet Bangalow-Brushbox	Vulnerable	8312	8012	-300	3.60%
Foothill Grey Gum-Ironbark-Spotted Gum		39837	39461	-376	0.94%
Foothills Grey Gum-Spotted Gum		5947	5864	-84	1.40%
Gorge Ironbark-Grey Gum		22685	22683	-2	0.01%
Heath	Vulnerable	8138	7753	-386	4.74%
Heathy Scribbly Gum		7235	7081	-154	2.13%
Herbfield and Fjaeldmark	Rare	25	20	-5	21.20%
High Elevation Open Spotted Gum		42550	42514	-36	0.09%
Ironbark		5467	5443	-24	0.43%
Lowland Red Gum		43876	42573	-1303	2.97%
Lowlands Scribbly Gum	Vulnerable	3204	2954	-250	7.79%
Lowlands Spotted Gum-Box		15578	15550	-28	0.18%
Coastal Mallee	Vulnerable	1240	1177	-63	5.11%
Mangrove	Rare	395	300	-96	24.22%
Moist Foothills Spotted Gum		30780	30757	-23	0.07%
Northern Moist Blackbutt		8700	8492	-208	2.39%
Natural Grassland	Rare	270	266	-4	1.41%
Needlebark Stringybark-Large Fruited Blackbutt		9547	9368	-179	1.87%
New England Stringybark-Blakelys Red Gum		1067	1066	-0.4	0.04%
Northern Grassy Sydney Blue Gum	Vulnerable	2856	2855	-1	0.04%
Northern Open Grassy Blackbutt		18876	18530	-346	1.83%
Northern Ranges Dry Tallowwood		19608	19588	-21	0.11%
Northern Wet Brushbox		10532	10532	-0.4	0.00%
Northern Wet Tallowwood-Blue Gum		14647	14646	-0.2	0.00%
Open Coastal Brushbox		3440	3369	-71	2.07%
Open Shrubby Brushbox-Tallowwood		9663	9662	-0.7	0.01%
Paperbark	Vulnerable	22405	20108	-2297	10.25%
Red Bloodwood	Rare	207	205	-2	0.93%
Red Mahogany		1251	1247	-4	0.32%
Richmond Range Spotted Gum		16415	16406	-9	0.06%
Richmond Range Spotted Gum-Box		17197	17196	-1	0.01%
River Oak	Vulnerable	824	817	-7	0.81%
Rough-barked Apples	Vulnerable	1396	1395	-1	0.09%
Saltbush	Rare	9	7	-2	25.17%
Sandstone Spotted Gum-Blackbutt		3870	3851	-19	0.49%
Sherwood Needlebark Stringybark		8249	8082	-166	2.01%
South Coast Tallowwood-Blue Gum		2569	2564	-5	0.19%
Stringybark-Apple		5044	5043	-1	0.03%
Swamp	Endangered	11569	10211	-1358	11.74%
Swamp Mahogany	Rare	351	227	-124	35.28%
Swamp Oak	Rare	1946	1535	-411	21.14%
Tallowwood		3563	3561	-2	0.05%

Turpentine		2470	2196	-274	11.10%
Very Wet New England Blackbutt-Tallowwood		434	434	-0.1	0.03%
Wattle		783	734	-49	6.26%
Wet Bloodwood-Tallowwood		25677	25378	-298	1.16%
Wet Coastal Tallowwood-Brushbox		1526	1485	-42	2.72%
Wet Flooded Gum-Tallowwood		5399	4992	-407	7.53%
Wet Foothills Blackbutt-Turpentine		1014	1014	-0.1	0.01%
Forestry Plantations		10325	10188	-137	1.33%
Improved Pasture and Cropland		507	507	-0.7	0.14%
Introduced Scrub		989	987	-2	0.20%
Rainforest	Endangered	111641	110705	-935	0.84%
Scrub	Vulnerable	4202	3778	-425	10.11%
Cleared-Partially Cleared		3118	3087	-32	1.01%
Camphor Laurel		6159	4994	-1165	18.91%

This scenario has resulted in similar, though increasing, trend of ecosystem loss. As in previous models, the paperbark, swamp and lowlands redgum are the most affected. In this scenario however there are a number of classes impacted that had not been affected in previous models. These included wet foothills blackbutt-turpentine forests, northern wet brushbox and northern wet tallowwood-bluegum forests, although the loss within these classes was not large in either proportion or area.

The rare, threatened and endangered vegetation classes lost 7023 hectares overall, however there was no change in the loss of casuarina woodlands which remained at 25%. Other rare classes such as swamp mahogany was been reduced to 65% of current levels. Similarily banksia, saltbush, mangroves and herbfield and fjaeldmark classes each lost in excess of 20% of their original area.

5.6 SUMMARY

The population growth and human settlement futures scenarios modeled in this chapter are based on the past and current trend of linear and exponential population growth (see Chapter 4) and planning policies.

The results highlighted the spatially disproportionate nature of population growth and human settlement within the region. The scenarios showed the settlement pattern likely to occur based on the past and current "business as usual", minimal constraints planning approaches of government. The change analysis demonstrated large areas that will be converted from agricultural systems or ecological systems to urban areas.

The creation of these current trend-trajectory scenarios provides a 'futures' baseline for the generation of other models with different constraints. These other future scenarios are plausible alternative futures that might reduce negative effects of the current trajectory scenario, and/or create other positive or negative LULC. Comparison with those already generated then allows for the effectiveness of the constraints to be assessed and provides a tool for future planning. The scenarios in Chapters 6 through 9 focus on the impact and effectiveness of the applied constraints rather than the increasing urbanised area and are presented more succinctly in this regard.

Chapter 6

Environmental Priority Scenario



Anti-Development Protest Sign at Hastings

*We do not inherit the land from our ancestors,
We borrow it from our children.
Native American Proverb*

CHAPTER 6 ENVIRONMENTAL PRIORITY SCENARIO

The trends of past urban settlement patterns provided a trajectory for where future population growth is most likely to locate and spaces it will consume. Such future minimal constraint development is likely to cause considerable ecological impact with a variety of rare, endangered and threatened species being greatly reduced in area and overall a loss in landscape functionality. As well as being recognized for having its own intrinsic value, the ecological heritage within the study area also provides the region with numerous environmental services and significant economic and tourism benefits which are directly related to environmental attributes of the coastal landscapes (NRRS 2003).

Protection of this heritage was one of the priorities listed in NRRS (2003) and a model was produced that allowed for population growth within the region yet provided a level of ecological security. It was not intended by the NRRS (2003) community consultation process that these constraints would create a conservation plan that dictates nature reserve selection, as protection of these areas could be achieved through a number of institutions by various means; for example, inclusion into the reserve system, conservation covenants, easements or offsets and other similar methods. This chapter provides one scenario which demonstrates the capacity for a balance to be found between new development and

ecological concerns through scenario designs for planning using spatially relevant constraints on urban development. When applied on a large scale and at an early stage in urban and regional planning, designed alternative future scenarios can provide practical, long term vision to guide decision making. When different design parameters are given precedence however, externalities are likely to be created which might adversely affect other landscape elements. The LULC change analysis of alternative future scenarios elucidates spatially what, where and how much might be affected.

This chapter describes an alternative future design for a scenario employing constraints aimed at environmental protection and the LULC consequences of the scenario.

6.1 CONSTRAINTS

The minimal constraints scenario utilized the following constraints,

- major roads;
- slope greater than 25%;
- National Parks and Wildlife Estate ;
- water and beach; and
- current urban areas

The environmental priority scenario used these same constraints and then added a number of restrictions specific to the context and environmental attributes of the region.

6.1.1 ACID SULPHATE SOILS

Acid sulfate soils are naturally occurring soils that are formed when water mixes with organic matter and land sediments containing iron oxides in anaerobic conditions. They are often associated with swamp and other wetlands. In their natural state below the water table they have no effect on human land uses. Once disturbed by drainage, lowering of the water table, excavation or other uses the iron sulfides oxidise and produce sulfuric acid lowering the pH of the soil to below 4. The release of this acid can also mobilize iron, arsenic and other metals. Combined, the acid and

metals can kill vegetation, acidify groundwater as well as drain into and denature waterways. When built upon, the levels of acidity can also be high enough to damage concrete and steel beyond repair and hence is also undesirable for new development (Fitzpatrick *et al.* 1996; Naylor *et al.* 1998, Woodhead 1999, 2000).

The NSW Department of Environment and Climate Change supplied spatial data that mapped the location of known areas that have a significant risk of being comprised of acid sulphate soils. The data provided separate layers for areas classed as either low or high risk. Those areas designated as 'high risk' were chosen for exclusion from development as shown in Figure 6.1. Most of these areas are located between Tweed Heads and Murwillumbah, the outlying areas of Ballina including the townships to its south and on the flood plains between Grafton and Yamba. These were all locations of strong urban growth in the minimal constraints scenario (Chapter 5).

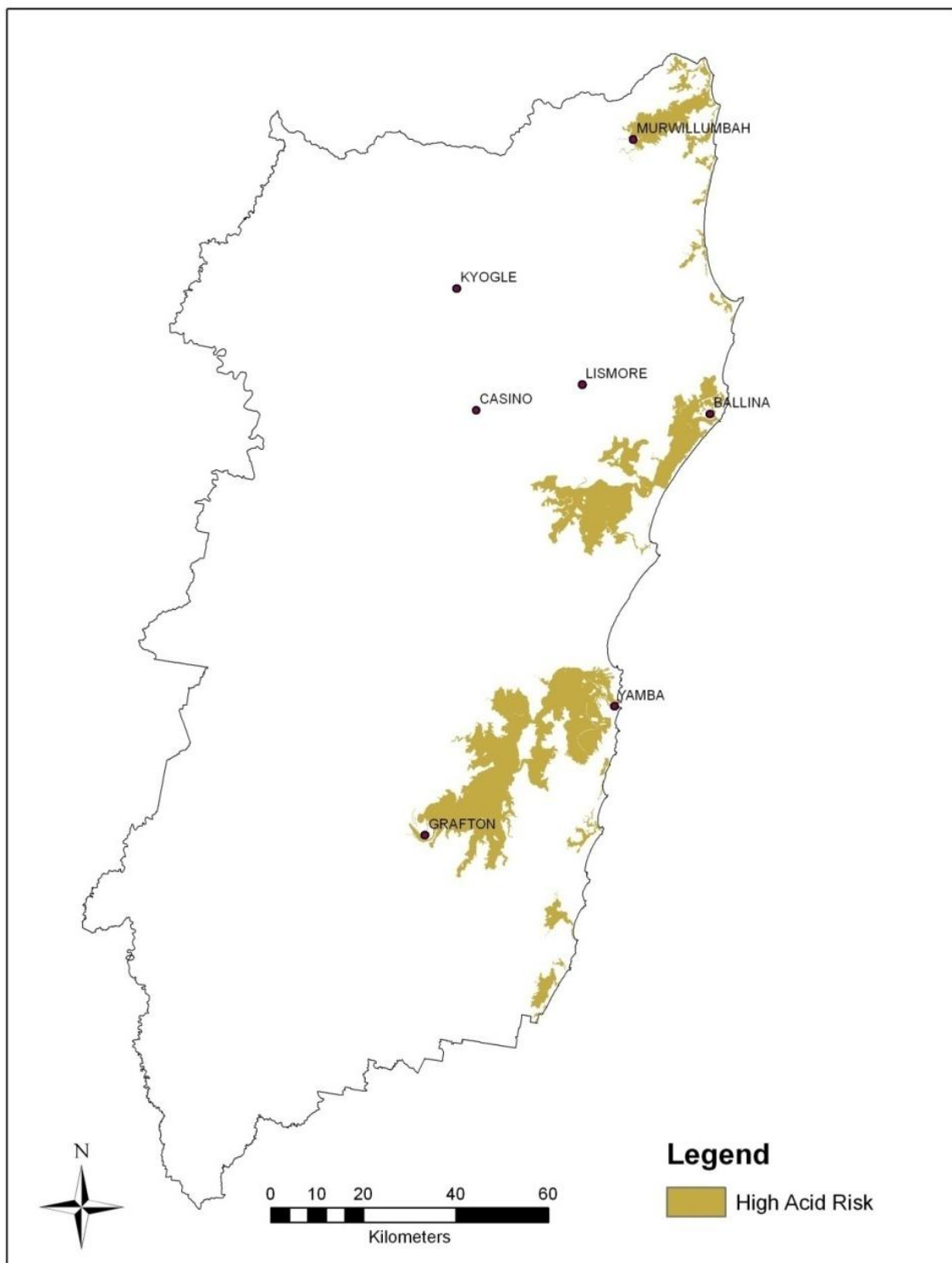


FIGURE 6.1: AREAS WITH A HIGH RISK OF HAVING ACID-SULPHATE SOILS

6.1.2 RIPARIAN VEGETATION

The riparian zone plays an important role in the health of ecosystems. Vegetation in these areas reduces erosion, provides habitat, enhances nutrient cycling and provides biofiltration thereby reducing the effects of runoff and improving water quality (Wissmar 1998). Qureshi and Harrison (2001) state that a buffer of between 3 and 200 metres have all been shown to provide significant functionality for a waterway and recommend a minimum between 6 and 30 metres. The optimal minimum buffer width is dependent on soil, slope, vegetation type, ecosystem type and land use outside of the buffered area.

With the scale of the region and the large amount of drainage within the area, to calculate and provide a variable buffer width for each ecosystem type would have been prohibitive. As such to protect these areas a 100m buffer was placed along each of the waterways, regardless of the size of the watercourse, vegetation extant or other factors. The vegetation from the forest and coastal complex classes in the 2004 LULC model that was contained within this buffer area was then extracted. The derived data layer provides an exclusion area for protection of any remaining vegetation within a 100m of a drainage channel, but does not include areas where the vegetation has been removed and similarly does not attempt to replace vegetation within this area.

This layer was then added to RAMSAR and other important wetlands map layers defined by NSW Department for Environment and Climate Change for inclusion as a scenario constraint on urban development. Overall this constraint covers 65407 hectares and is shown in Figure 6.2.

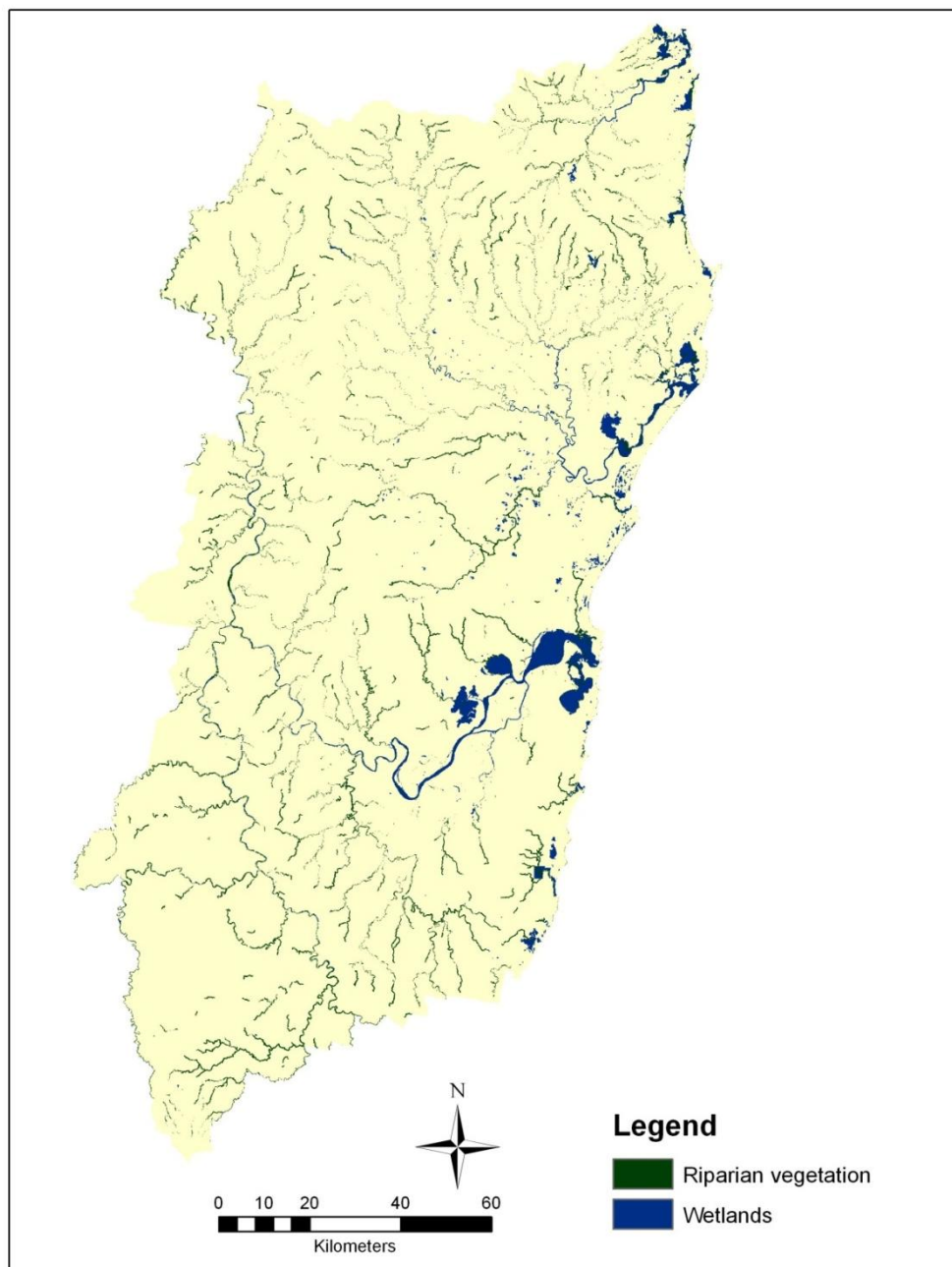


FIGURE 6.2: RIPARIAN VEGETATION, RAMSAR AND IMPORTANT WETLANDS

6.1.3 KEY HABITATS AND CORRIDORS

Landscape connectivity is generally considered at landscape and bioregional scales. It is a key planning tool of landscape ecology that aims to reduce fragmentation and allow for species movement between areas of suitable habitat across a larger spatial range (Harris & Atkins 1991; Forman *et al.* 2003; Jongman & Pungetti 2004; Darcy & Eggleston 2005, Hilty *et al.* 2006).

The NSW Department for Environment and Climate Change also supplied spatial data for key habitats and corridors within the region (Figure 6.3). Overall the designated area encompasses almost 800,000 hectares or 38% of the study area. However a large portion of this attribute is already contained within the National Parks system and was already considered a constraint to new urban development. The conservation planning tool, Marxan (Ball *et al.* 2000, Possingham *et al.* 2000) was used to produce a number of conservation models, however it was felt that the key habitats and corridors data provided a better and more complete landscape level conservation model (see Dramstead 1996).

Of note, is the presence within this dataset of a line of vegetation extending along almost the entire coastline which highlights the value of the coastal complex class represented on the LULC maps. This vegetation

is under considerable pressure from new development, and was considerable impacted by the minimal constraints scenario.

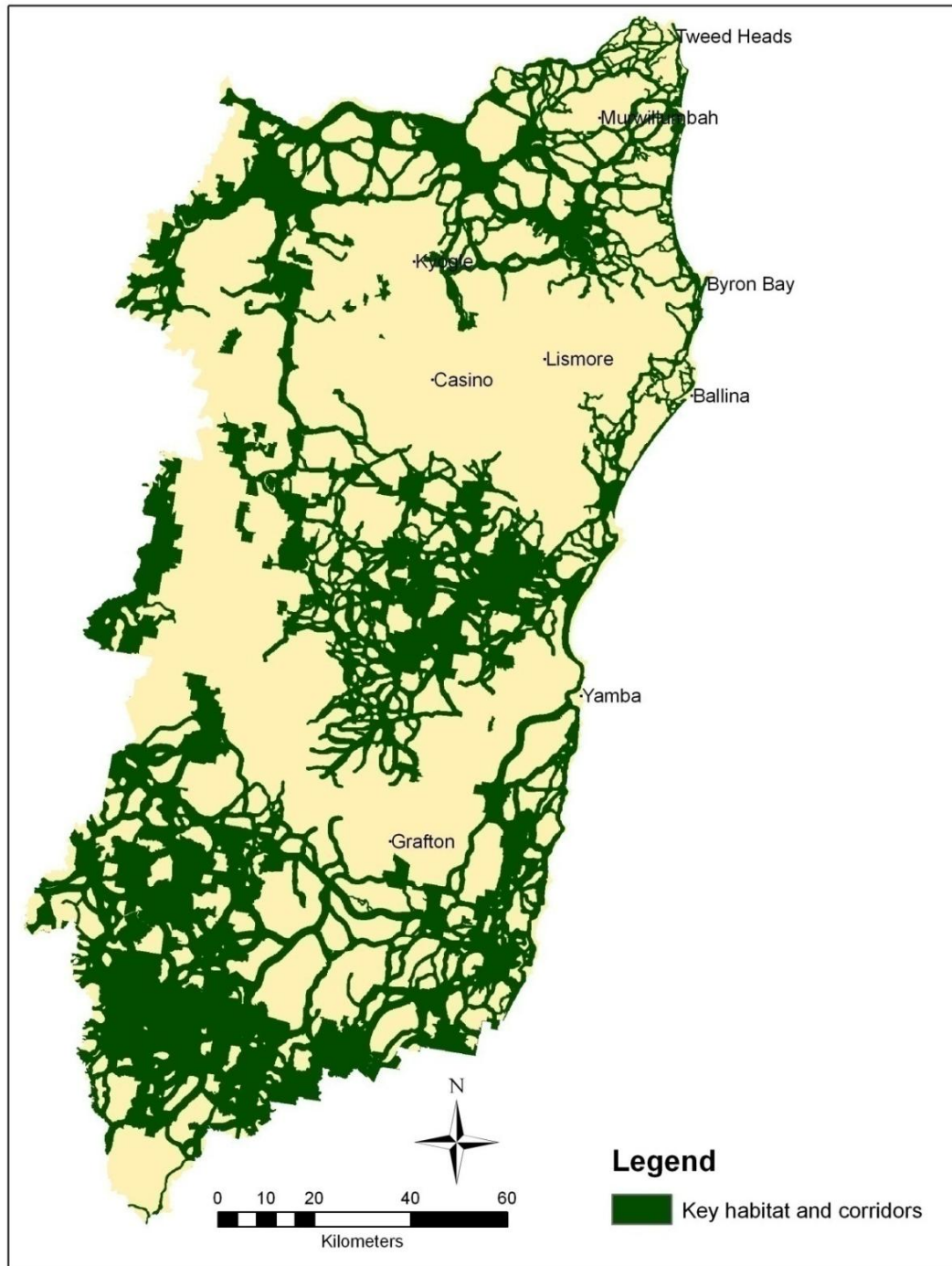


FIGURE 6.3: KEY HABITAT AND CORRIDORS

6.1.4 BUILDABLE AREA

Although the key habitats and corridors represented 798,982 hectares, high risk of acid sulphate soils 348,970 hectares and riparian vegetation some 65,406 hectares there was a large degree of overlap between these maps and with the existing national parks reserve system. When combined with the restrictions from the minimal constraints scenario the buildable area is reduced by 636,583 hectares from 1,628,330 hectares to 991,746 hectares. Overall this was approximately 50% of the study area that had been removed from potential urban development in this scenario (Figure 6.4).

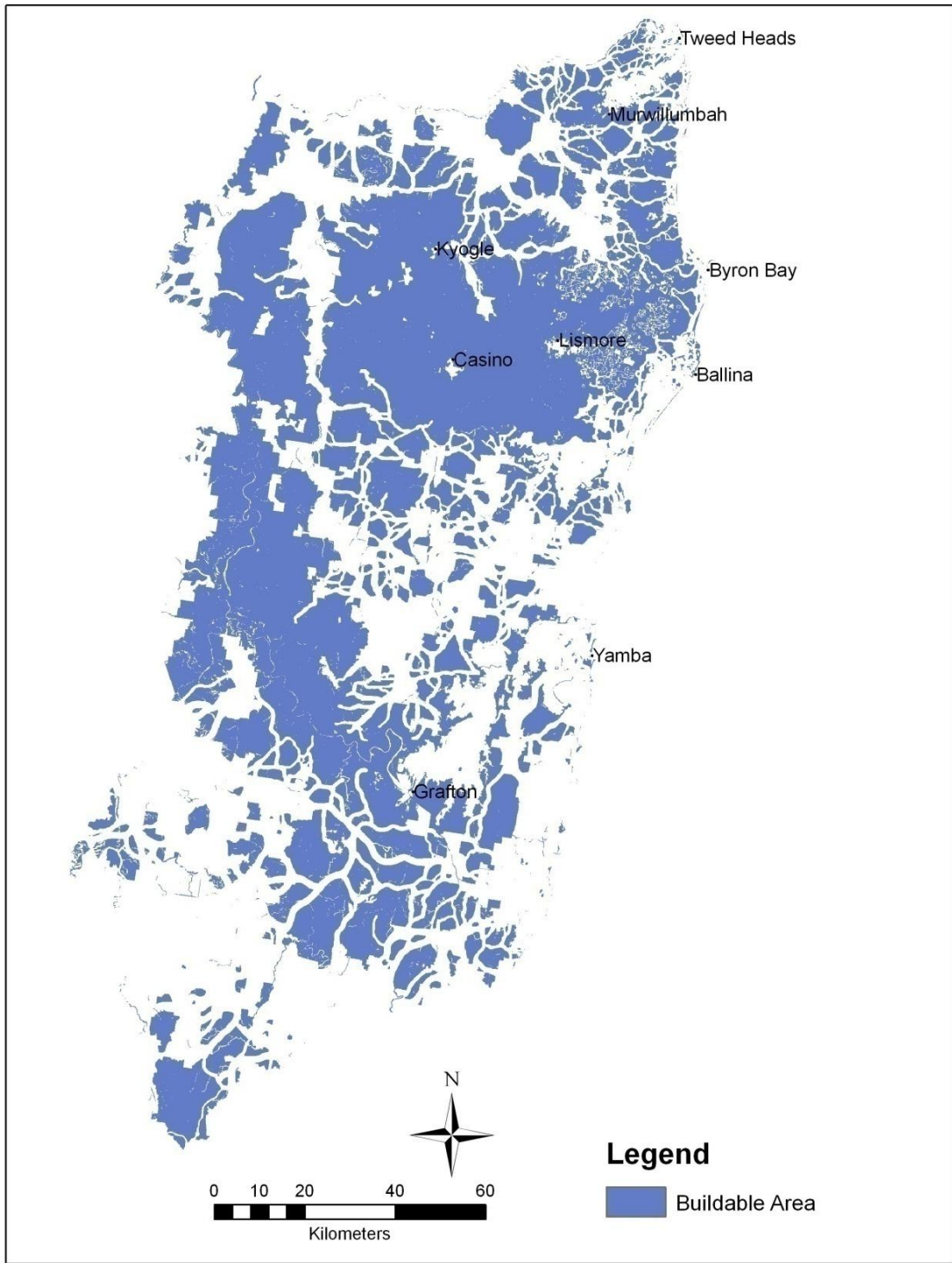


FIGURE 6.4: BUILDABLE AREA ENVIRONMENTAL PRIORITY SCENARIO

6.2 POPULATION

This environmental priority scenario used the same zoning, population growth and urban settlement density as the minimum constraints scenario. The levels of growth and the number of cells to be added for each zone by the placement algorithm were presented in Tables 5.1, 5.4, 5.7 and 5.10 in Chapter 5.

6.3 RESULTS

The future population urban settlement areas for each scenario were compared then merged into the 2004 LULC Map and are shown with extracts of the Far North Coast in Figures 6.5-6.12 respectively.

In the north eastern coastal zone, removal of high risk acid sulphate soils reduced the conversion of sugar cane into urban areas, particularly between Tweed Heads and Murwillumbah and in the area around Ballina. Combined with the other constraints there is less buildable area at the northern and southern most areas within the zone and new urban development therefore became more concentrated within a smaller area between these towns. Together with protection of vegetation along the coastline the growth of the coastal population centres has been significantly reduced. This has caused urban development to extend

further inland and urban sprawl reached approximately 20 kilometres wide in the population 955497 scenario.

In the southern areas the high risk acid soils constraint stopped new urban development on the sugar cane fields around Yamba and Maclean. This caused a slight increase in the amount of urban area bordering these soils and increased the amount of development along the Pacific Highway further to the south. Inland areas were relatively unchanged from the minimal constraints scenario.

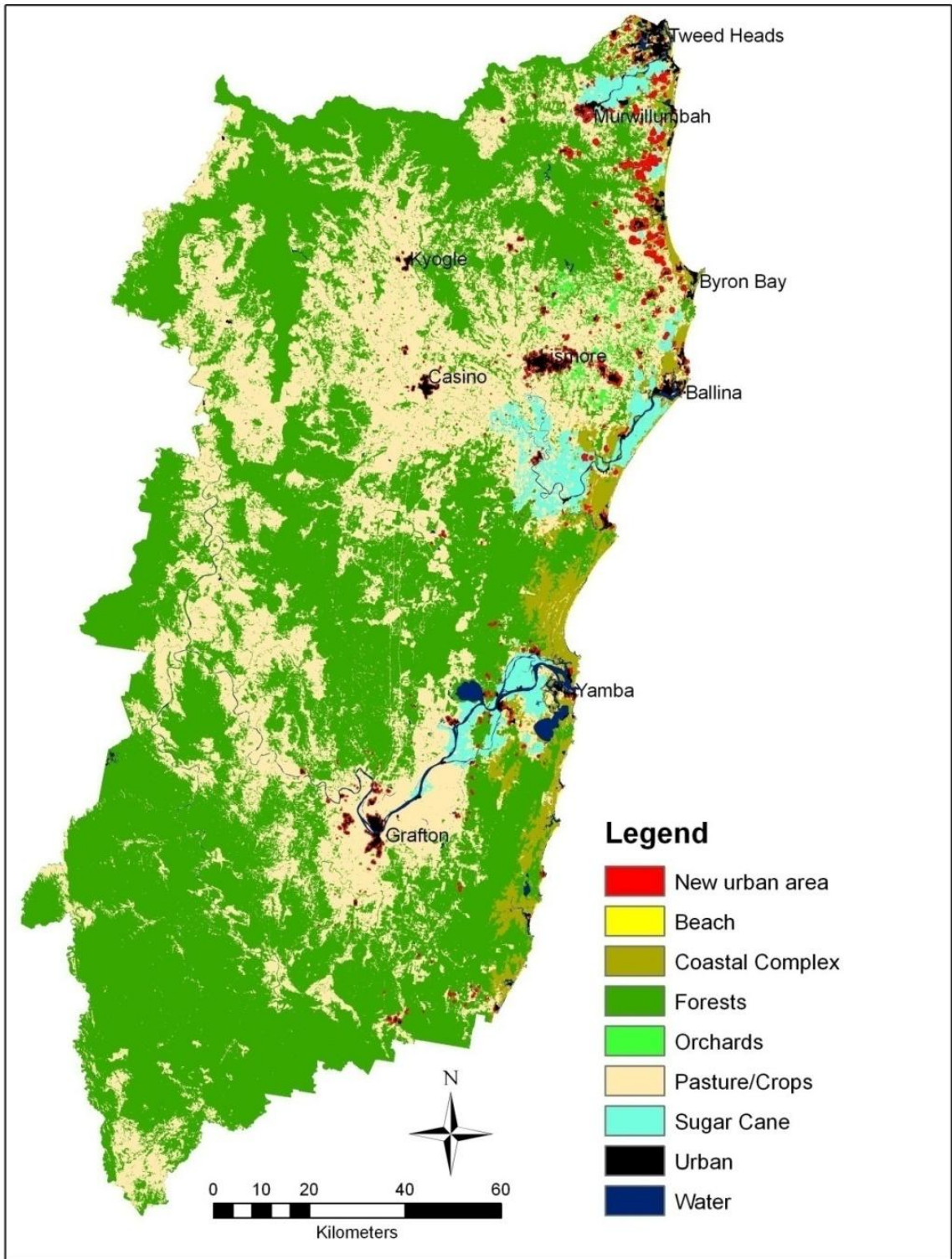


FIGURE 6.5: ENVIRONMENTAL PRIORITY LULC FOR POPULATION 403839

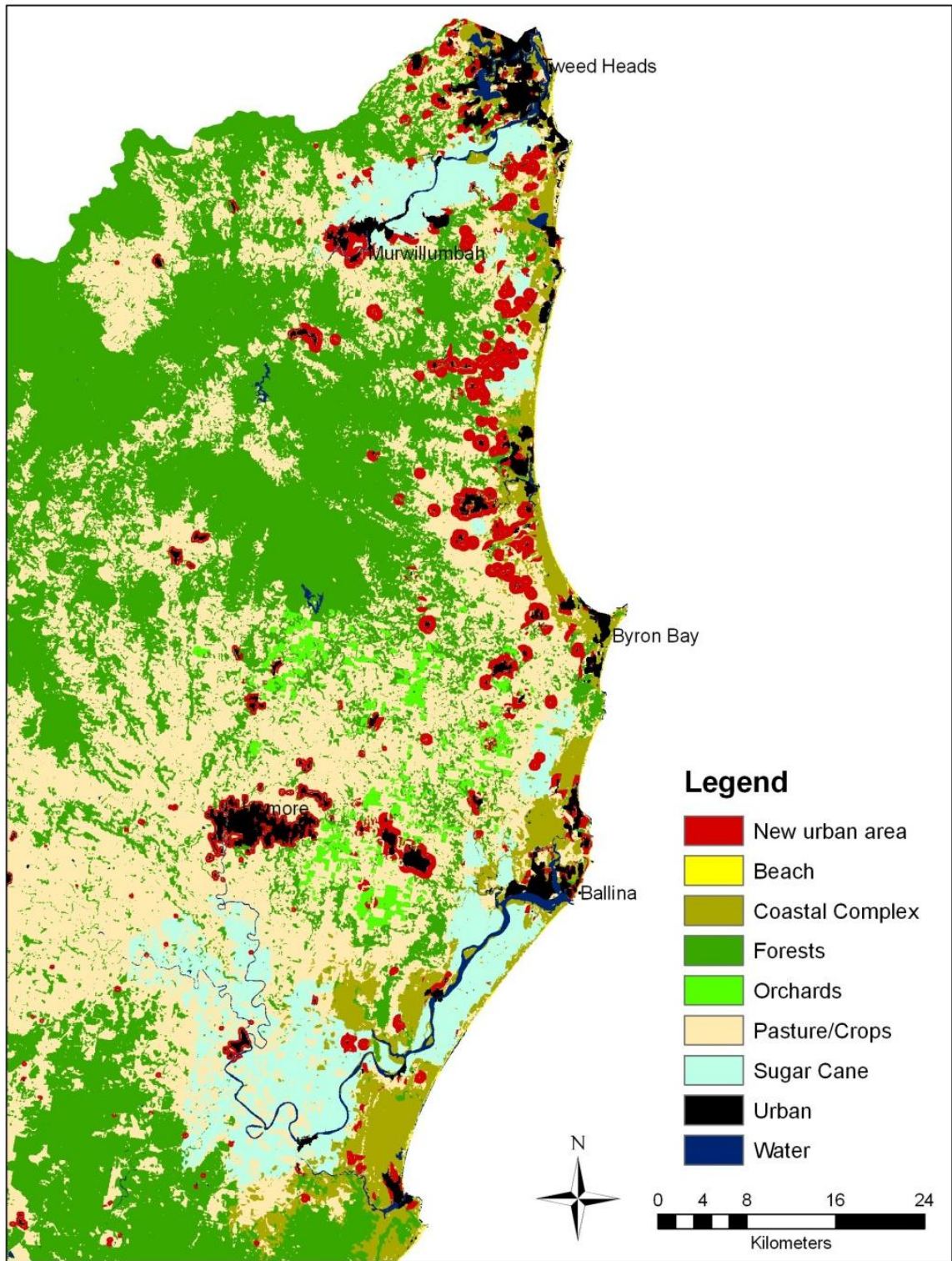


FIGURE 6.6: ENVIRONMENTAL PRIORITY LULC FOR POPULATION 403839, FAR NORTH COAST PORTION

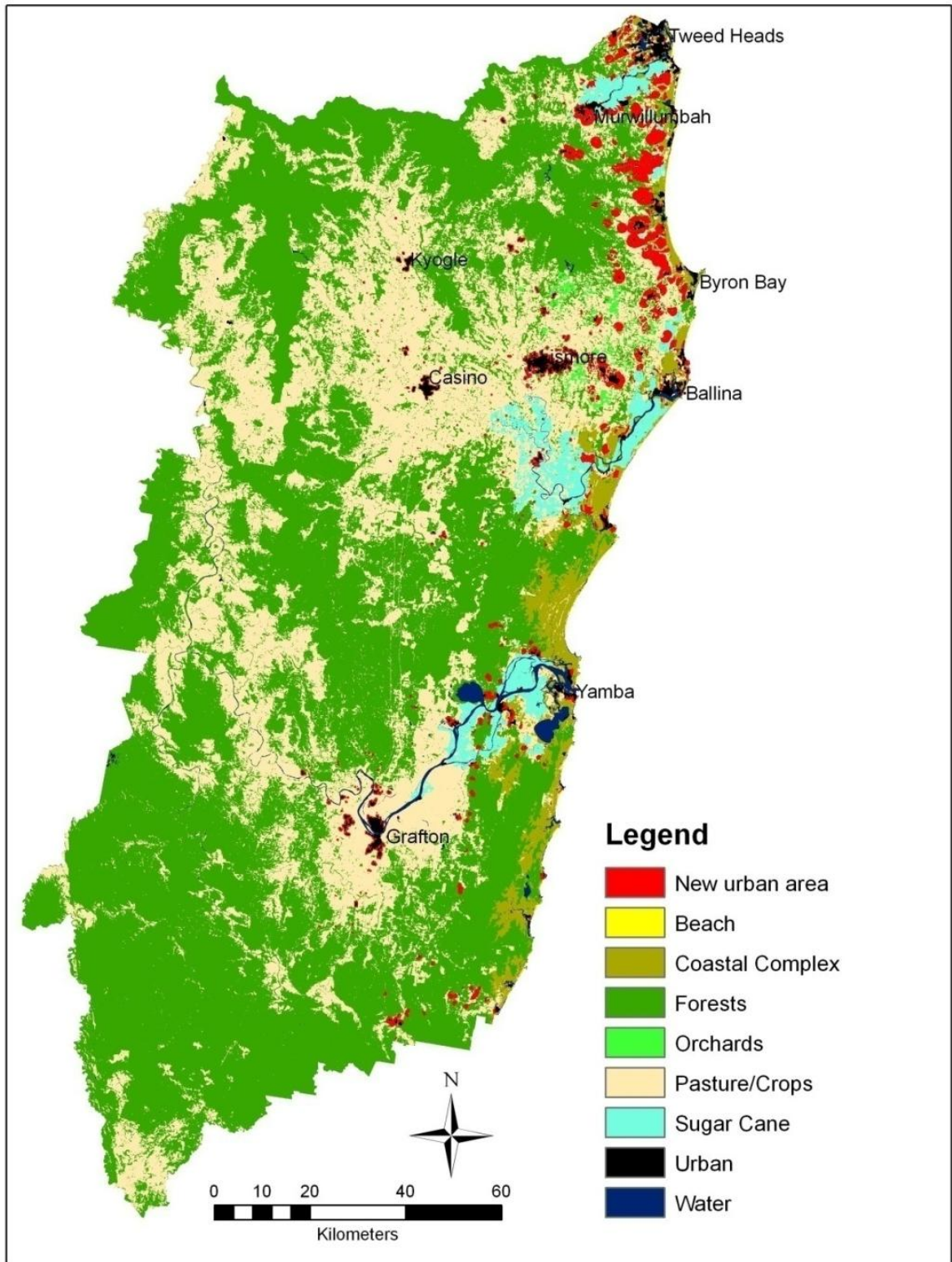


FIGURE 6.7: ENVIRONMENTAL PRIORITY LULC FOR POPULATION 558911

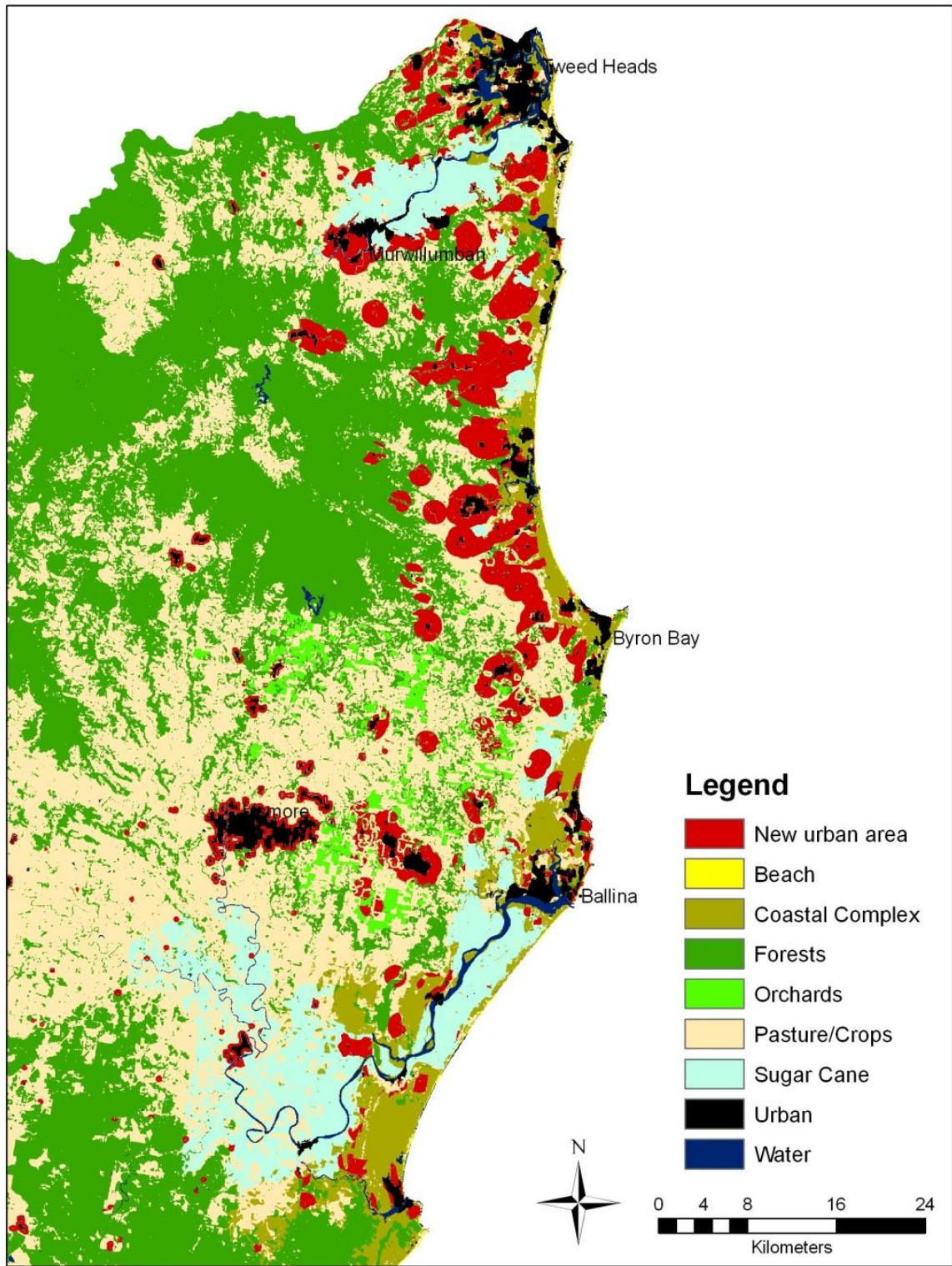


FIGURE 6.8: ENVIRONMENTAL PRIORITY LULC FOR POPULATION 55811, FAR NORTH COAST PORTION

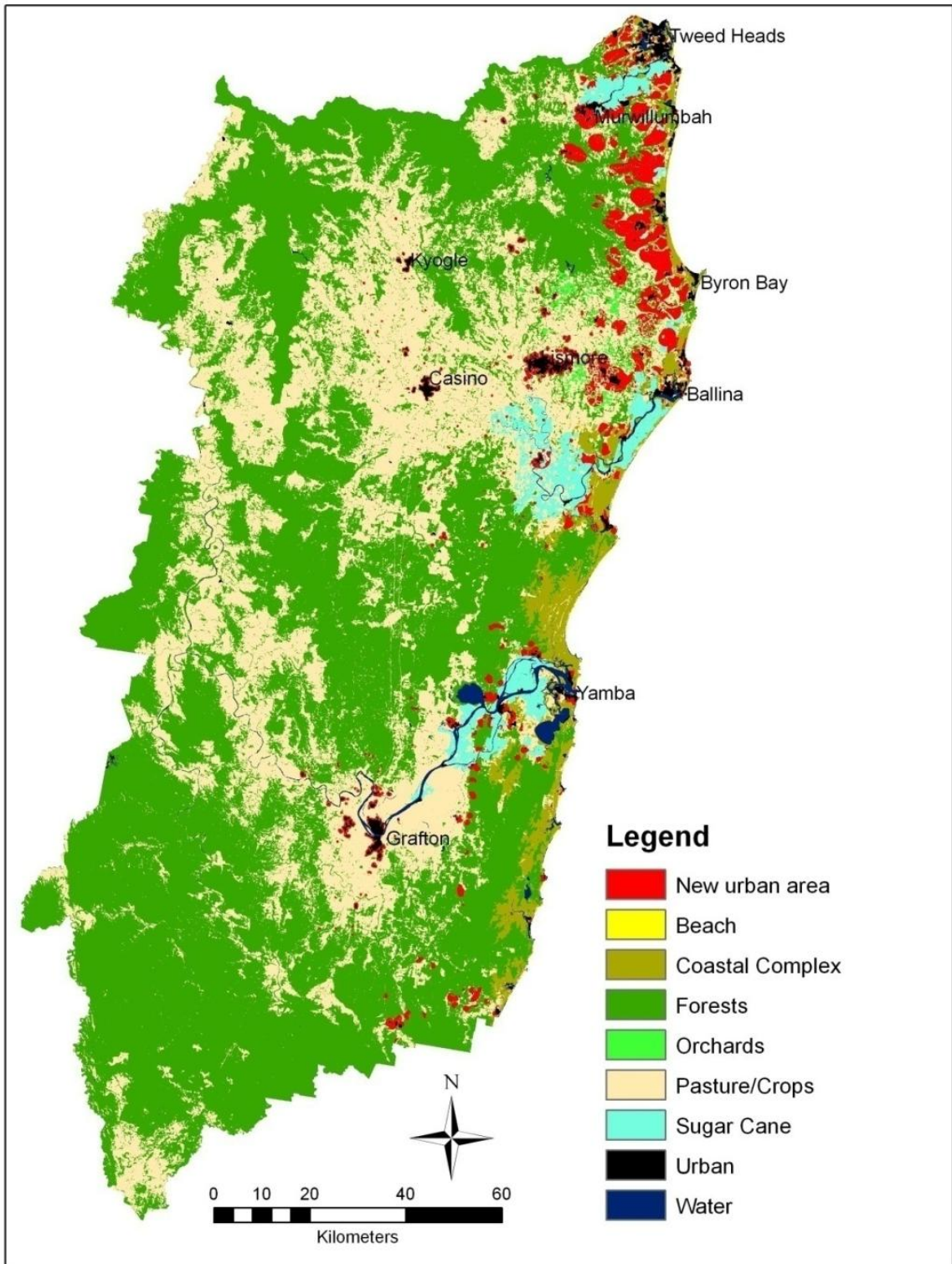


FIGURE 6.9: ENVIRONMENTAL PRIORITY LULC FOR POPULATION 727657

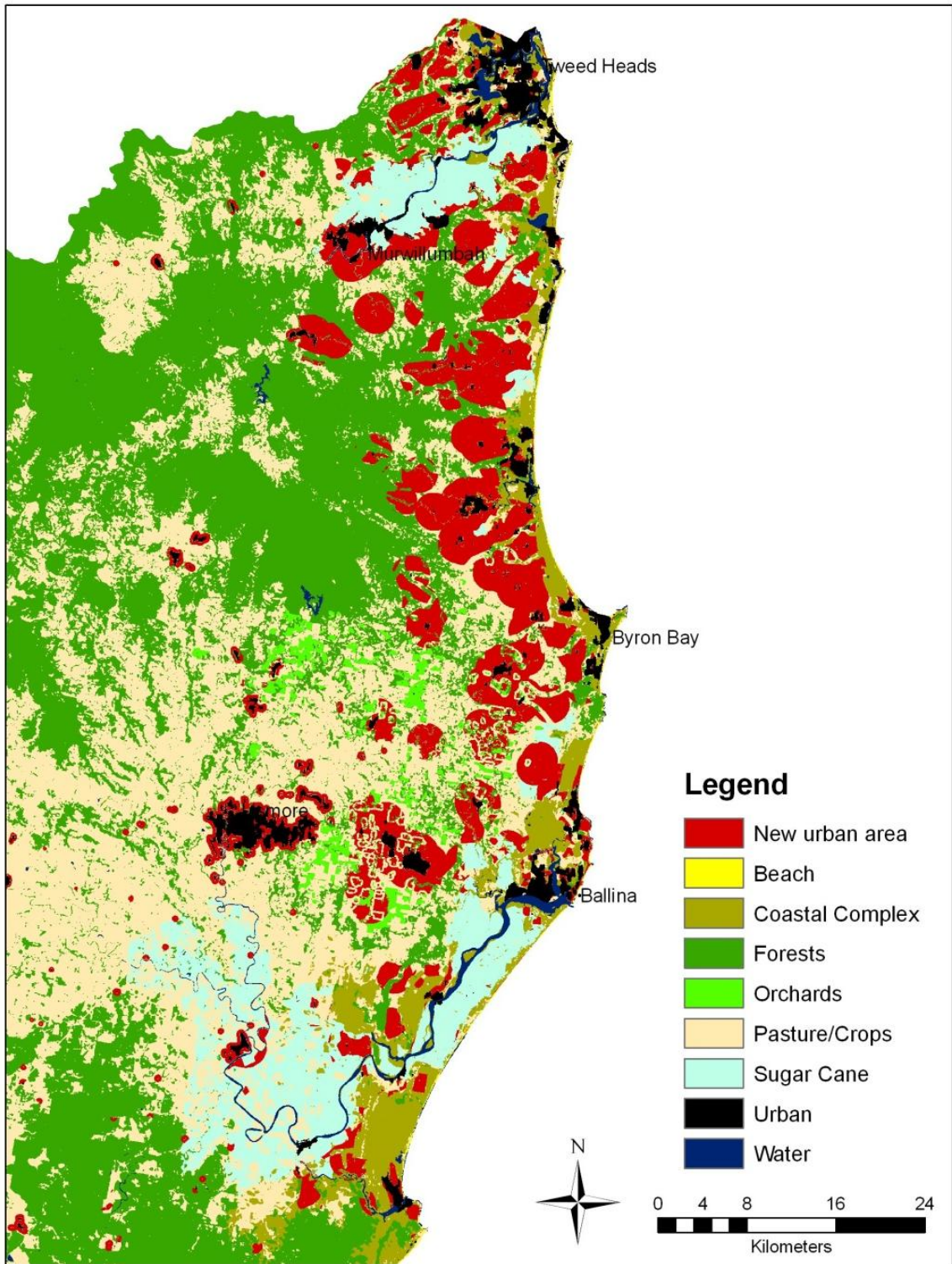


FIGURE 6.10: ENVIRONMENTAL PRIORITY LULC FOR POPULATION 727657, FAR NORTH COAST PORTION

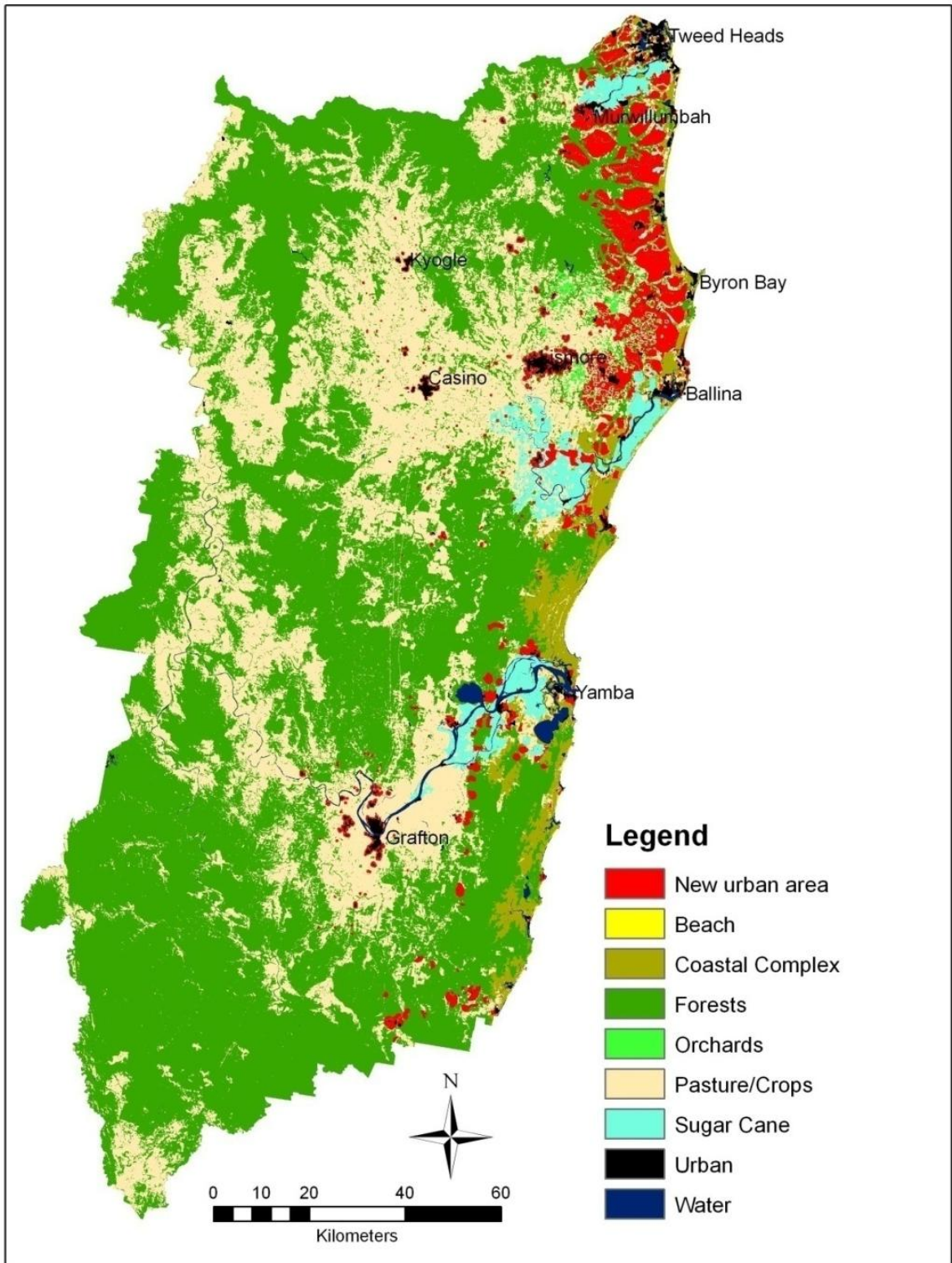


FIGURE 6.11: ENVIRONMENTAL PRIORITY LULC FOR POPULATION 955497, FAR NORTH COAST PORTION

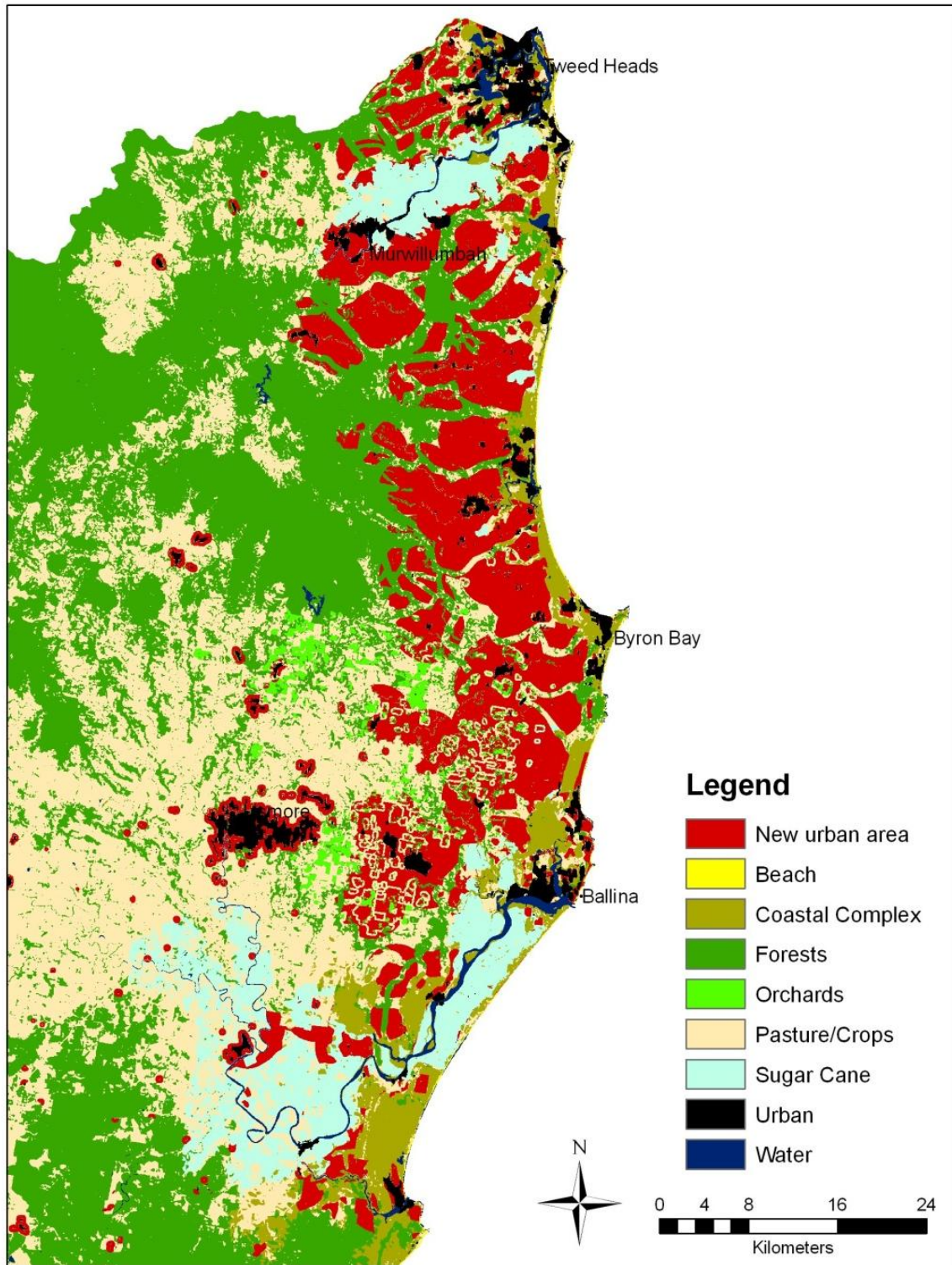


FIGURE 6.12: ENVIRONMENTAL PRIORITY LULC FOR POPULATION 955497, FAR NORTH COAST PORTION

6.3.1 CHANGE TABLES

The change in land use for each population level is presented in Table 6.1

TABLE 6.1 LAND USE CHANGE FOR ENVIRONMENTAL PRIORITY SCENARIOS

Land Use/ Population	2004	Population 403839			Population 558911			Population 727657			Population 955497		
	Total ha	Total ha	Change (ha)	% Change	Total ha	Change (ha)	% Change	Total ha	Change (ha)	% Change	Total ha	Change (ha)	% Change
Coastal Complex	67563	65471	-2092	-3.10%	64279	-3283	-4.86%	63486	-4076	-6.03%	62751	-4811	-7.12%
Forests	1205414	1200020	-5394	-0.45%	1195582	-9832	-0.82%	1190098	-15316	-1.27%	1180879	-24535	-2.04%
Pasture/ Crops	713725	694423	-19303	-2.70%	683944	-29781	-4.17%	672539	-41186	-5.77%	658727	-54998	-7.71%
Orchards	8730	8323	-407	-4.66%	7672	-1058	-12.12%	6852	-1877	-21.51%	5742	-2988	-34.22%
Sugar Cane	56069	53924	-2145	-3.83%	52501	-3568	-6.36%	51339	-4729	-8.43%	49632	-6437	-11.48%
Urban	20148	49488	29340	145.63%	67670	47522	335.87%	87333	67185	433.46%	113917	93769	565.41%

The amount of urban area for the environmental priority scenarios is the same as in the minimal constraints scenario and grows to 113917 hectares in the 955497 population scenario. For each land use class the conversion to urban area has been at a relatively constant linear rate as the population has increased. The constraints have protected a large portion of the coastal complex class with 4881 hectares (7.12%) being converted to urban area compared 12882 hectares (19.07%) in the minimal constraints scenarios. Conversely the area of the forests class impacted increased from 18100 hectares (1.5%) to 24535 hectares (2.04%). There was an overall reduction in the total area of native vegetation converted to urban area. This is detailed by ecosystem type in Table 6.2

As sugar cane tends to be grown on acidic soils the removal of acid sulphate soils from potential urban development provided strong protection for this agricultural class. 6437 hectares (-11.48%) of sugar cane became urban in comparison to 17651 hectares (31.42%) in the minimal constraints scenarios. Reducing the loss of native vegetation and sugar cane has meant that an additional 1.57% of pasture and crops became urbanised elsewhere, and that the loss of orchards more than doubled from 1327 hectares to 2988 hectares. This comprises 34.22% of the orchards that were recognized in the 2004 LULC. Orchards cover a small area but play an important role in local economies.

6.3.2 ECOSYSTEM CHANGE

TABLE 6.2 LAND USE CHANGE BY ECOSYSTEM TYPE FOR ENVIRONMENTAL PRIORITY SCENARIOS

ECOSYSTEM	STATUS_A	LULC2004	Population 403839			Population 558911			Population 727657			Population 955497		
			Total (ha)	Change (ha)	% Change	Total (ha)	Change (ha)	% Change	Total (ha)	Change (ha)	% Change	Total (ha)	Change (ha)	% Change
Unclassified		151111	146828	-4283	-2.83%	144058	-7053	-4.67%	141103	-10008	-6.62%	136765	-14346	-9.49%
Baileys Stringybark	Vulnerable	31076	30896	-181	-0.58%	30748	-328	-1.06%	30599	-478	-1.54%	30397	-680	-2.19%
Banksia		1336	1256	-80	-5.98%	1203	-133	-9.96%	1178	-158	-11.85%	1165	-171	-12.83%
Casuarina Woodland	Rare	21	21	0	-0.89%	21	0	-0.89%	21	0	-0.89%	21	0	-0.89%
Central Mid Elevation Sydney Blue Gum	Rare	3278	3277	-1	-0.03%	3277	-1	-0.03%	3277	-1	-0.03%	3277	-1	-0.03%
Clarence Lowland Needlebark Stringybark	Rare	10322	10257	-65	-0.63%	10189	-133	-1.28%	10111	-211	-2.04%	10022	-300	-2.90%
Lowlands Grey Box	Rare	14455	14440	-15	-0.10%	14436	-18	-0.13%	14432	-23	-0.16%	14424	-30	-0.21%
Coast Cypress Pine	Rare	67	63	-4	-5.63%	63	-4	-5.63%	63	-4	-5.63%	63	-4	-5.63%
Coast Range Bloodwood-Mahogany		5177	5156	-21	-0.41%	5140	-37	-0.71%	5120	-57	-1.11%	5070	-107	-2.06%
Clarence Lowlands Spotted Gum		128339	128055	-284	-0.22%	127861	-478	-0.37%	127605	-734	-0.57%	127144	-1195	-0.93%
Coast Range Spotted Gum-Blackbutt	Vulnerable	625	625	0	0.00%	625	0	0.00%	625	0	-0.01%	616	-9	-1.47%
Coastal Flooded Gum	Rare	8039	8039	0	0.00%	8038	-1	-0.01%	8034	-5	-0.06%	7996	-42	-0.53%
Coastal Sands Blackbutt		2821	2804	-17	-0.59%	2801	-20	-0.71%	2796	-25	-0.87%	2792	-28	-1.01%
Dry Foothills Blackbutt-		2704	2693	-11	-0.40%	2683	-21	-0.76%	2678	-26	-0.96%	2661	-43	-1.59%

Turpentine														
Dry Foothills Spotted Gum	Rare	73800	73797	-3	0.00%	73791	-9	-0.01%	73785	-15	-0.02%	73768	-32	-0.04%
Dry Grassy Blackbutt-Tallowwood		5353	5320	-33	-0.62%	5287	-65	-1.22%	5257	-95	-1.78%	5218	-135	-2.51%
Dry Grassy Tallowwood-Grey Gum		2167	2135	-32	-1.50%	2112	-55	-2.54%	2087	-80	-3.70%	2057	-111	-5.10%
Dry Healthy Blackbutt-Bloodwood		42039	41775	-264	-0.63%	41548	-491	-1.17%	41301	-738	-1.75%	40949	-1090	-2.59%
Dry Healthy Sandstone Blackbutt	Rare	16634	16580	-54	-0.32%	16536	-98	-0.59%	16489	-145	-0.87%	16431	-203	-1.22%
Dry open Redgum-Broad Leaved Apple	Rare	1129	1129	0	0.00%	1129	0	0.00%	1129	0	0.00%	1129	0	0.00%
Dunns White Gum		291	291	0	0.00%	291	0	0.00%	291	0	0.00%	291	0	0.00%
Eastern Red Gums		1774	1774	0	0.00%	1774	0	0.00%	1774	0	0.00%	1774	0	0.00%
Escarpment Redgum		15211	15208	-3	-0.02%	15208	-3	-0.02%	15207	-3	-0.02%	15207	-4	-0.02%
Escarpment Scribbly Gum-Apple		3583	3583	-1	-0.01%	3583	-1	-0.02%	3581	-2	-0.07%	3580	-3	-0.08%
Wet Bangalow-Brushbox		8312	8291	-21	-0.25%	8248	-63	-0.76%	8163	-149	-1.79%	7995	-316	-3.81%
Foothill Grey Gum-Ironbark-Spotted Gum		39837	39705	-132	-0.33%	39577	-260	-0.65%	39430	-406	-1.02%	39233	-604	-1.52%
Foothills Grey Gum-Spotted Gum		5947	5923	-25	-0.42%	5901	-46	-0.78%	5867	-81	-1.36%	5809	-139	-2.34%
Gorge Grey Gum		697	697	0	0.00%	697	0	0.00%	697	0	0.00%	697	0	0.00%
Gorge Ironbark-Grey Gum		22685	22684	-1	0.00%	22683	-3	-0.01%	22680	-5	-0.02%	22675	-10	-0.04%
Heath		8138	8033	-106	-1.30%	7963	-175	-2.15%	7911	-227	-2.79%	7865	-273	-3.36%
Healthy Scribbly Gum	Rare	7235	7197	-37	-0.52%	7158	-77	-1.06%	7105	-130	-1.80%	7038	-196	-2.71%
Herbfield and Fjaeldmark		25	25	0	0.00%	25	0	0.00%	25	0	0.00%	25	0	0.00%

High Elevation Open Spotted Gum		42550	42536	-14	-0.03%	42528	-23	-0.05%	42517	-33	-0.08%	42507	-43	-0.10%
Ironbark	Rare	5467	5459	-8	-0.14%	5458	-9	-0.16%	5454	-12	-0.23%	5450	-16	-0.30%
Lowland Red Gum	Vulnerable	43876	43622	-254	-0.58%	43411	-465	-1.06%	43119	-757	-1.73%	42782	-1094	-2.49%
Lowlands Scribbly Gum		3204	3180	-24	-0.74%	3162	-41	-1.29%	3139	-65	-2.02%	3083	-121	-3.77%
Lowlands Spotted Gum-Box		15578	15567	-10	-0.07%	15559	-19	-0.12%	15557	-21	-0.13%	15551	-27	-0.17%
Coastal Mallee	Vulnerable	1240	1229	-11	-0.92%	1221	-19	-1.57%	1217	-23	-1.85%	1215	-25	-2.03%
Mangrove		395	394	-1	-0.24%	394	-1	-0.33%	394	-1	-0.33%	394	-1	-0.33%
Moist Foothills Spotted Gum		30780	30775	-5	-0.02%	30771	-9	-0.03%	30766	-14	-0.05%	30758	-22	-0.07%
Northern Moist Blackbutt		8700	8690	-9	-0.11%	8654	-46	-0.53%	8607	-93	-1.07%	8356	-344	-3.96%
Natural Grassland		270	270	0	0.00%	270	0	-0.07%	270	0	-0.07%	270	0	-0.09%
Needlebark Stringybark-Large Fruited Blackbutt		9547	9469	-78	-0.82%	9407	-140	-1.47%	9330	-218	-2.28%	9233	-314	-3.29%
New England Stringybark-Blakelys Red Gum		1067	1067	0	0.00%	1067	0	0.00%	1067	0	0.00%	1067	0	0.00%
Northern Grassy Sydney Blue Gum		2856	2856	0	0.00%	2856	0	0.00%	2856	0	0.00%	2856	0	0.00%
Northern Open Grassy Blackbutt		18876	18779	-97	-0.51%	18681	-195	-1.03%	18550	-325	-1.72%	18297	-578	-3.06%
Northern Ranges Dry Tallowwood		19608	19606	-3	-0.01%	19602	-7	-0.03%	19592	-16	-0.08%	19551	-58	-0.29%
Northern Wet Brushbox	Rare	10532	10532	0	0.00%	10532	0	0.00%	10532	0	0.00%	10528	-4	-0.04%
Northern Wet Tallowwood-Blue Gum	Rare	14647	14647	0	0.00%	14647	0	0.00%	14646	0	0.00%	14643	-3	-0.02%
Nymboida Tallowwood-Turpentine		2322	2322	0	0.00%	2322	0	0.00%	2322	0	0.00%	2322	0	0.00%
Open Coastal Brushbox	Vulnerable	3440	3427	-13	-0.39%	3403	-37	-1.07%	3385	-55	-1.60%	3354	-87	-2.52%

Open Shrubby Brushbox-Tallowwood		9663	9662	-1	-0.01%	9662	-1	-0.01%	9662	-1	-0.01%	9662	-1	-0.01%
Paperbark	Rare	22405	22253	-152	-0.68%	22066	-339	-1.51%	21886	-519	-2.32%	21683	-722	-3.22%
Red Bloodwood		207	207	0	0.00%	207	0	0.00%	207	0	0.00%	207	0	0.00%
Red Mahogany	Rare	1251	1248	-2	-0.18%	1248	-2	-0.19%	1248	-2	-0.19%	1248	-2	-0.19%
Richmond Range Spotted Gum		16415	16409	-6	-0.03%	16408	-7	-0.04%	16406	-9	-0.05%	16399	-16	-0.10%
Richmond Range Spotted Gum-Box		17197	17196	-1	0.00%	17196	-1	0.00%	17196	-1	-0.01%	17195	-2	-0.01%
River Oak		824	824	0	-0.04%	822	-2	-0.24%	821	-3	-0.41%	819	-5	-0.58%
Rough-barked Apples	Rare	1396	1396	-1	-0.04%	1396	-1	-0.04%	1396	-1	-0.04%	1394	-2	-0.13%
Saltbush		9	9	0	-3.97%	9	-1	-7.95%	8	-2	-15.89%	8	-2	-15.89%
Sandstone Spotted Gum-Blackbutt	Vulnerable	3870	3860	-9	-0.24%	3853	-16	-0.42%	3848	-22	-0.56%	3839	-31	-0.80%
Sherwood Needlebark Stringybark		8249	8205	-43	-0.52%	8171	-78	-0.94%	8134	-115	-1.39%	8064	-185	-2.24%
South Coast Tallowwood-Blue Gum	Vulnerable	2569	2568	-1	-0.05%	2565	-4	-0.16%	2564	-5	-0.21%	2553	-16	-0.63%
Stringybark-Apple	Rare	5044	5043	-1	-0.01%	5043	-1	-0.02%	5043	-1	-0.02%	5043	-1	-0.02%
Swamp		11569	11386	-183	-1.58%	11275	-294	-2.54%	11247	-322	-2.79%	11209	-360	-3.11%
Swamp Mahogany	Rare	351	350	-1	-0.27%	350	-1	-0.27%	350	-1	-0.27%	350	-1	-0.29%
Swamp Oak	Vulnerable	1946	1914	-32	-1.63%	1891	-55	-2.84%	1884	-62	-3.21%	1875	-71	-3.63%
Sydney Peppermint-Stringybark		205	203	-2	-0.92%	203	-2	-0.92%	203	-2	-0.92%	203	-2	-0.76%
Tallowwood		3563	3563	0	0.00%	3563	0	0.00%	3563	0	0.00%	3561	-2	-0.05%
Turpentine	Rare	2470	2437	-33	-1.33%	2390	-80	-3.25%	2320	-150	-6.06%	2208	-263	-10.63%

Very Wet New England Blackbutt-Tallowwood		434	434	0	0.00%	434	0	0.00%	434	0	0.00%	434	0	0.00%
Wattle		783	771	-12	-1.56%	765	-18	-2.35%	745	-39	-4.92%	720	-63	-8.09%
Wet Bloodwood-Tallowwood		25677	25646	-31	-0.12%	25572	-105	-0.41%	25477	-199	-0.78%	25238	-438	-1.71%
Wet Coastal Tallowwood-Brushbox		1526	1512	-14	-0.94%	1498	-28	-1.83%	1485	-42	-2.73%	1465	-62	-4.03%
Wet Flooded Gum-Tallowwood		5399	5357	-42	-0.77%	5287	-112	-2.07%	5178	-220	-4.08%	4954	-445	-8.24%
Wet Foothills Blackbutt-Turpentine		1014	1014	0	0.00%	1014	0	0.00%	1014	0	0.00%	1012	-2	-0.17%
Forestry Plantations		10325	10313	-12	-0.12%	10310	-15	-0.15%	10310	-15	-0.15%	10310	-15	-0.15%
Improved Pasture and Cropland		507	507	-1	-0.14%	507	-1	-0.14%	507	-1	-0.14%	507	-1	-0.14%
Introduced Scrub		989	989	0	0.00%	989	0	0.00%	987	-2	-0.20%	982	-8	-0.76%
Rainforest	Rare	111641	111517	-124	-0.11%	111365	-275	-0.25%	111100	-541	-0.48%	110623	-1018	-0.91%
Scrub		4202	4168	-35	-0.83%	4136	-66	-1.57%	4125	-78	-1.85%	4082	-121	-2.87%
Sand Ridge		822	819	-4	-0.46%	818	-5	-0.58%	814	-8	-1.02%	813	-10	-1.17%
Cleared-Partially Cleared		3118	3115	-3	-0.10%	3115	-3	-0.10%	3115	-4	-0.11%	3113	-5	-0.17%
Camphor Laurel	Vulnerable	6159	5914	-245	-3.98%	5564	-594	-9.65%	5136	-1023	-16.60%	4233	-1925	-31.26%

In the population 955497 scenario, the largest change amongst vegetation classes was for the non-native camphor laurel which is considered an undesirable weed species. 1095 hectares (31.26% of its 2004 area) was converted to urban area. The most affected native species was the Clarence lowlands spotted gum of which 1195 hectares (0.93%) became urbanised; a reduced loss of extent compared to the minimal constraints scenarios. The lowland red gum (1094 hectares), dry heathy blackbutt-bloodwood (1090 hectares) and rainforest (1018 hectares) had the next highest conversion to urban and in each case had a greater area converted to urban than the minimal constraints scenarios.

6778 hectares of endangered, rare and threatened native vegetation were lost when the population reached 955497. Most of the individual species of these at risk designations were less impacted and lost proportionally less area to urbanization than the previous scenarios. In particular, the impact on Casuarina woodlands reduced from a loss of 75% of its area within the minimal constraints scenario to 0.89% of its area, mangroves from 24.22% to 0.33% and paperbark from 10.22% to 3.22%. Swamp reduced from 11.74% to 3.11% and the rare herbfield and fjaeldmark, which lost 21.2% of its area, was not affected in this environmental protection scenario.

6.4 SUMMARY

Whilst there was an increase in the forest area converted to urban area, there was a reduction on the impact of the coastal complex class and an overall reduction in the areas of native vegetation lost. The losses that occurred were spread across species. The rare, threatened and endangered species were more effectively protected. Additionally areas of key habitat were protected as was the structure, functionality and connectivity in the landscape.

A 'side effect' of constraining development on acid sulphate soils was protection of large areas of sugar cane production. However the environmental protection design for these scenarios increased the impact of urbanization on other agricultural land-pasture, croplands and orchards. Chapter 3 showed that orchards are a growth industry within the region and the next chapter examines their growth and provides a scenario for greater overall protection for valued agricultural areas.