

Chapter 9

Coastal Protection Scenario



Byron Bay Beach

Nothing endures but change

Heraclitus

CHAPTER 9 COASTAL PROTECTION SCENARIO

The urban shift scenario provided a high level of protection for coastal vegetation and resources while providing a relatively balanced solution to exponential urban growth in the far north east section of the region. The coastal protection scenario further develops the strategy of shifting the population growth further inland and strengthened the reallocation of new urban development from the Far North Coast into the surrounding zones. As in the agricultural and environmental priority scenario (Chapter 8), two variations of this scenario are provided.

The first model followed the past trend 'business as usual' urban growth of the minimal constraints scenario (Chapter 5). The second variation utilised the constraints of the agricultural and environmental protection scenario (Chapter 8).

9.1 POPULATION

The population was calculated by using the same trends and regional population as previous scenarios. However in this scenario design the population increase for zones 3 to 6 were summed and then evenly divided between these four zones (Table 9.1).

TABLE 9.1: POPULATION CALCULATIONS FOR COASTAL PROTECTION SCENARIOS

Estimated Regional Population	Change in population	Population change for zones 1+2	Difference (Region – Zones 1+2)	To be added to each of Zones 3-6 (Difference /4)
403839	139381	4152	135229	33807
559911	295453	4762	290691	72673
727657	463199	6222	456977	114244
955497	691039	7761	683278	170819

This method significantly increased population growth in the central inland zones (zones 3 and 5) along the Summerland Highway. Furthermore, population was also shifted south, increasing urban settlement in the south coastal zone (zone 6). Zones 1 and 2 which had only low levels of projected growth were maintained at the same rate as in previous scenarios.

Population figures and the allocation of new urban development cells are presented in Table 9.2

TABLE 9.2: POPULATION AND URBAN CELL ALLOCATION FOR COASTAL PROTECTION SCENARIOS

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	59549	2.40	142978	106653
4	149438	144387	1.03	178194	1.79	318479	169041
5	45071	46833	0.96	80640	1.75	141463	96392
6	35765	22114	1.62	55921	2.70	151133	115368
Sum		264458		403839		800412	509212

Zone	Current (2004)			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	98165	2.40	235693	199368
4	149438	144387	1.03	216810	1.79	387495	238057
5	45071	46833	0.96	119256	1.75	209203	164132
6	35765	22114	1.62	94537	2.70	255495	219730
Sum		264458		558911		1135235	844035

Zone	Current (2004)			Population 727657			
	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	6288	1.36	8524	4706
2	20783	19677	1.06	25316	1.63	41174	20391
3	36325	25742	1.41	139986	2.40	336107	299782
4	149438	144387	1.03	258631	1.79	462241	312803
5	45071	46833	0.96	161077	1.75	282569	237498
6	35765	22114	1.62	136358	2.70	368523	332758
Sum		264458		727657		1499137	1207937

Zone	Current (2004)			Population 955497			
	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	6378	1.36	8646	4828
2	20783	19677	1.06	26765	1.63	43531	22748
3	36325	25742	1.41	196561	2.40	471945	435620
4	149438	144387	1.03	315206	1.79	563355	413917
5	45071	46833	0.96	217652	1.75	381816	336745
6	35765	22114	1.62	192933	2.70	521424	485659
Sum		264458		955497		1990716	1699516

9.2 COASTAL PROTECTION WITH MINIMAL CONSTRAINTS RESULTS

The new urban development generated at the four population levels was combined with the 2004 LULC model and is shown with Far North Coast portions in Figures 9.1 to 9.8.

In comparison to the minimal constraints scenario (Chapter 5) which has the same restrictions to potential development, the results of the placement of new urban areas in zone 4 appears to result in similar settlement patterns as the minimal constraints scenario at lower population levels. At the population level of 955497, the coastal protection scenario is similar to patterns in the minimal constraints scenario between population levels of 403839 and 533628. This probably occurred because of the shared constraints and the coastal protection scenario (population 955497) placement of 413917 cells into this zone when the two minimal constraints scenarios placed 291211 and 533628 cells respectively, in the same area.

However southern and central inland areas do not follow the minimal constraints trend. The increased population in zone 5 caused the spatial extent of Lismore and surrounding towns to more than double in area and created a number of "satellite" urban settlement areas in the southern parts of this zone.

In the southern parts of the region a large portion of the beach-side coastal area is contained within the NSW National Parks estate and

therefore urban development occurred in the area between Yamba and Maclean. With this population shift and lack of other constraints, the town of Maclean would become a major population centre and spatially larger than the 2004 size of Ballina or Lismore.

Inland from Maclean, large areas of the pasture and cropland around Grafton were converted to urban areas. Together with outlying areas this could have the effect of making Grafton the largest city within the region. The spatial impact of the changes affected by this scenario is summarised in Table 9.3.

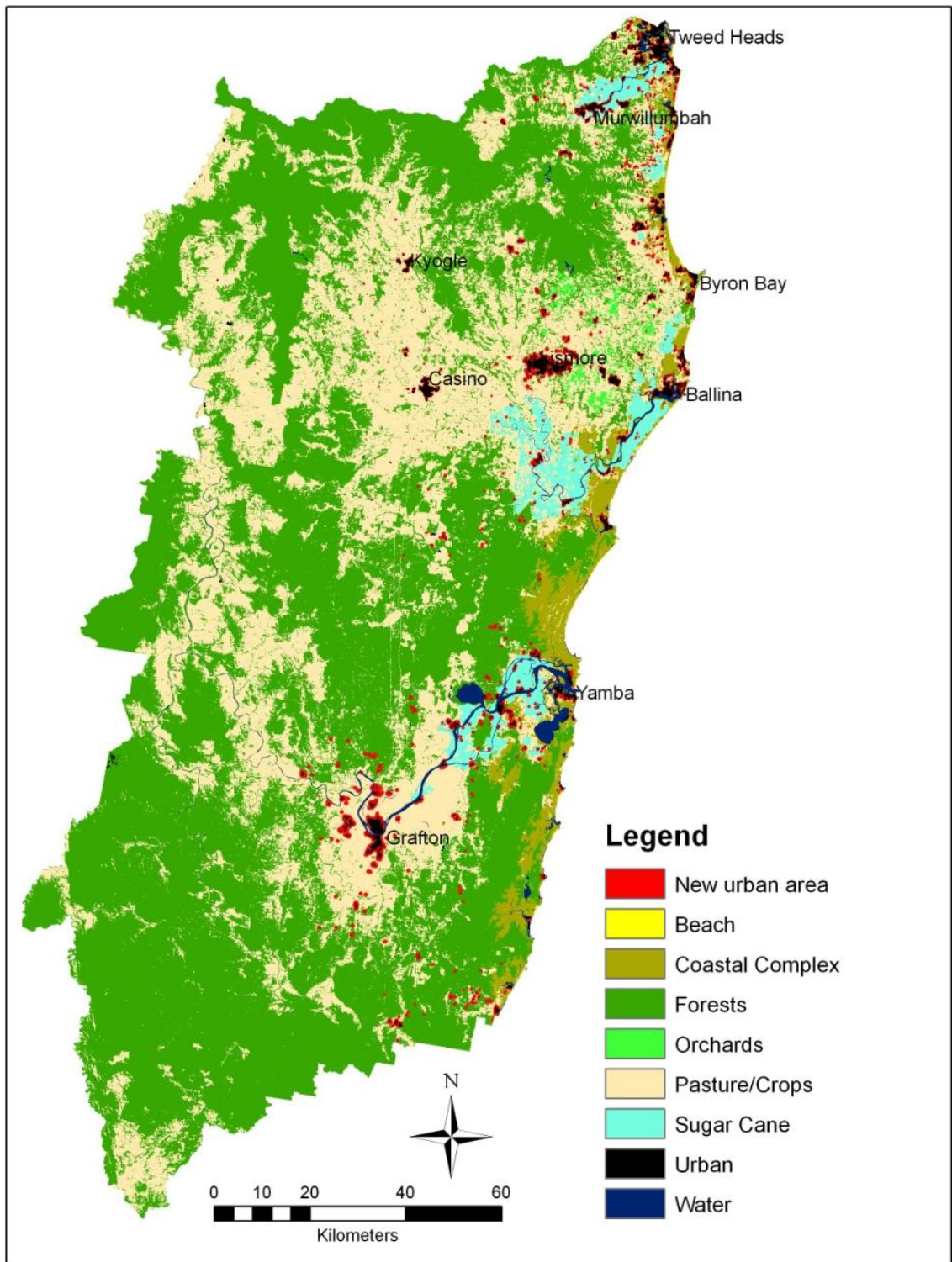


FIGURE 9.1: COASTAL PROTECTION WITH MINIMAL CONSTRAINTS POPULATION 403839.

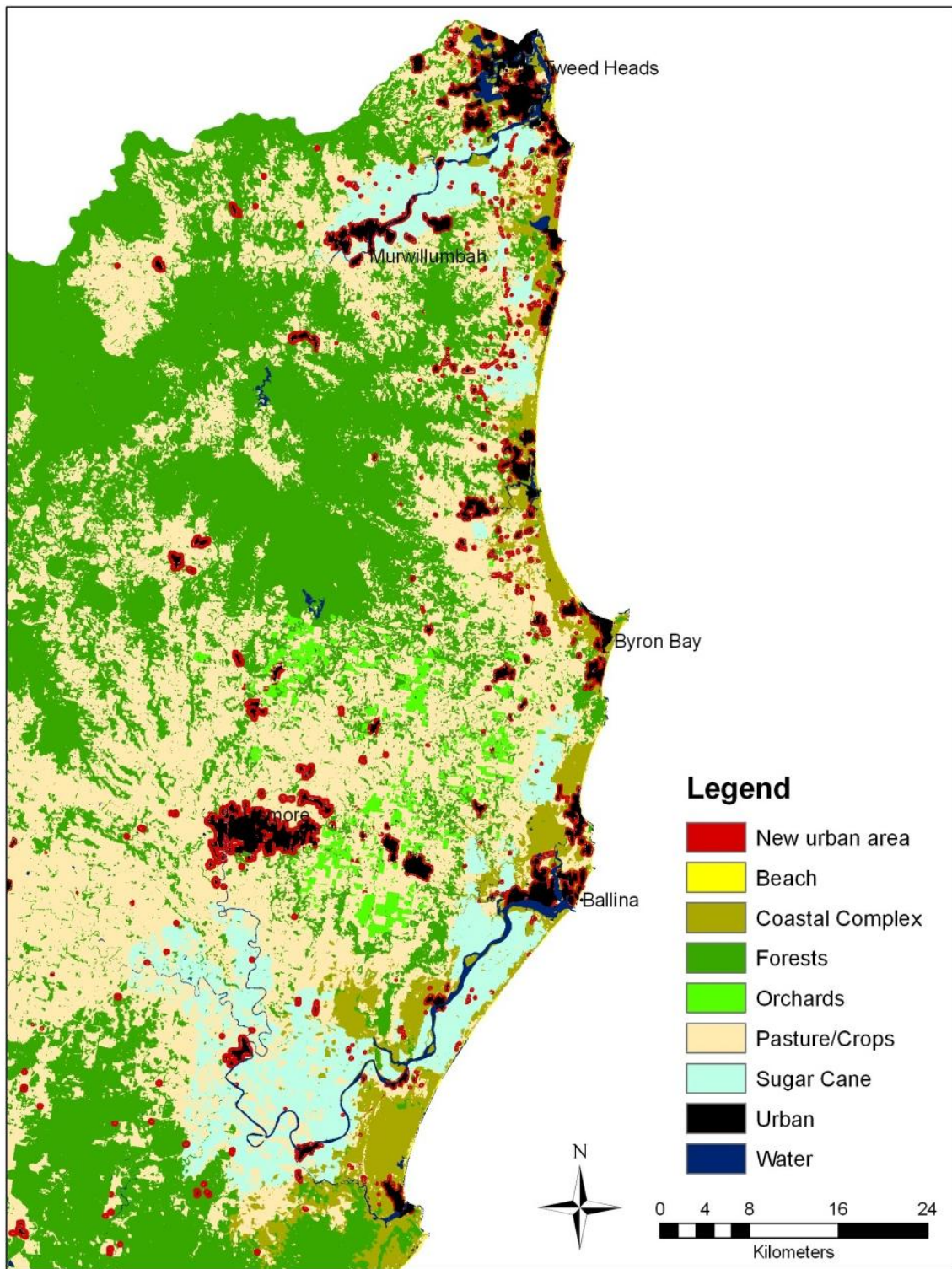


FIGURE 9.2: COASTAL PROTECTION WITH MINIMAL CONSTRAINTS POPULATION 403839, FAR NORTH COAST PORTION

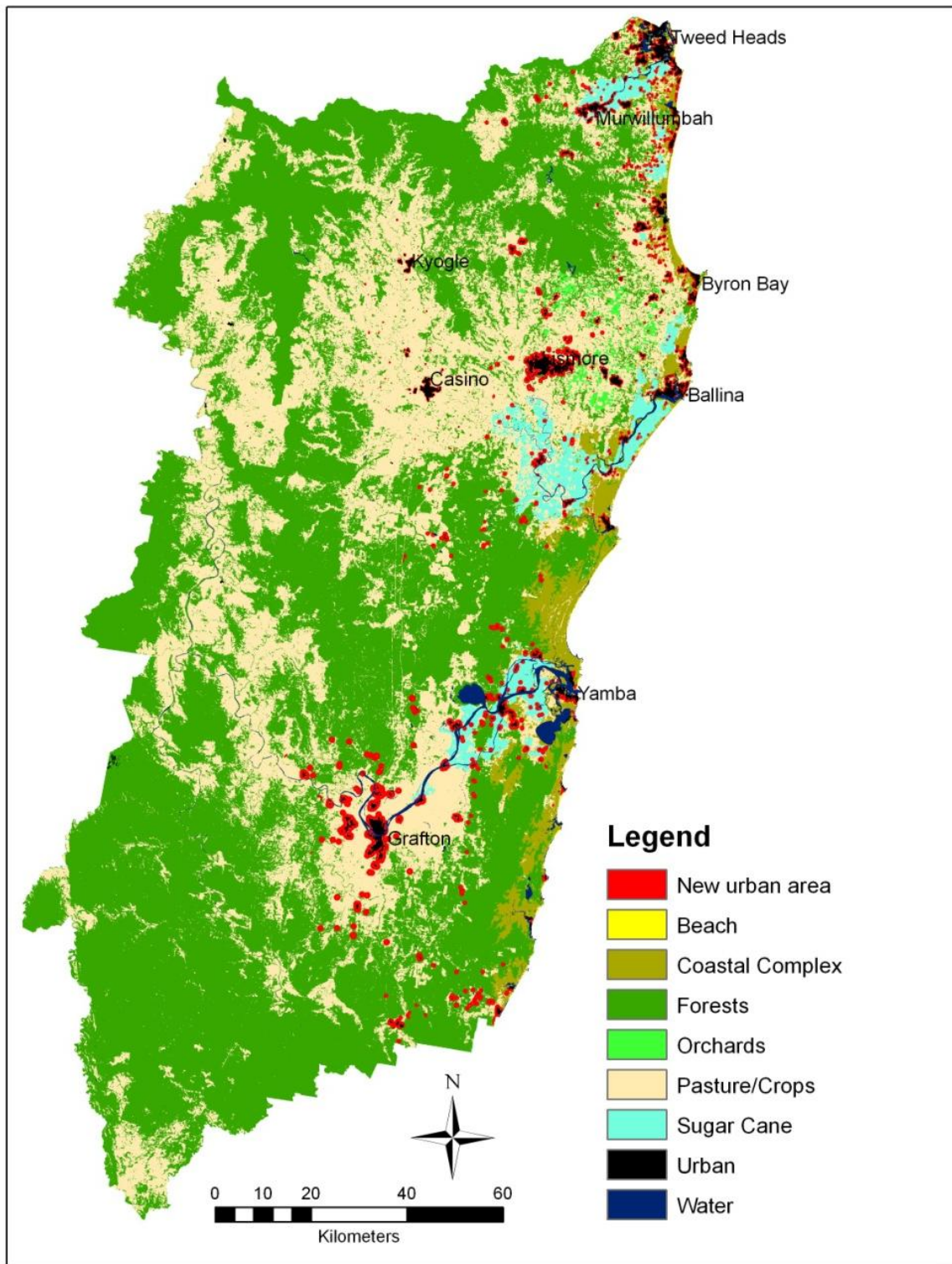


FIGURE 9.3: COASTAL PROTECTION WITH MINIMAL CONSTRAINTS POPULATION 558911

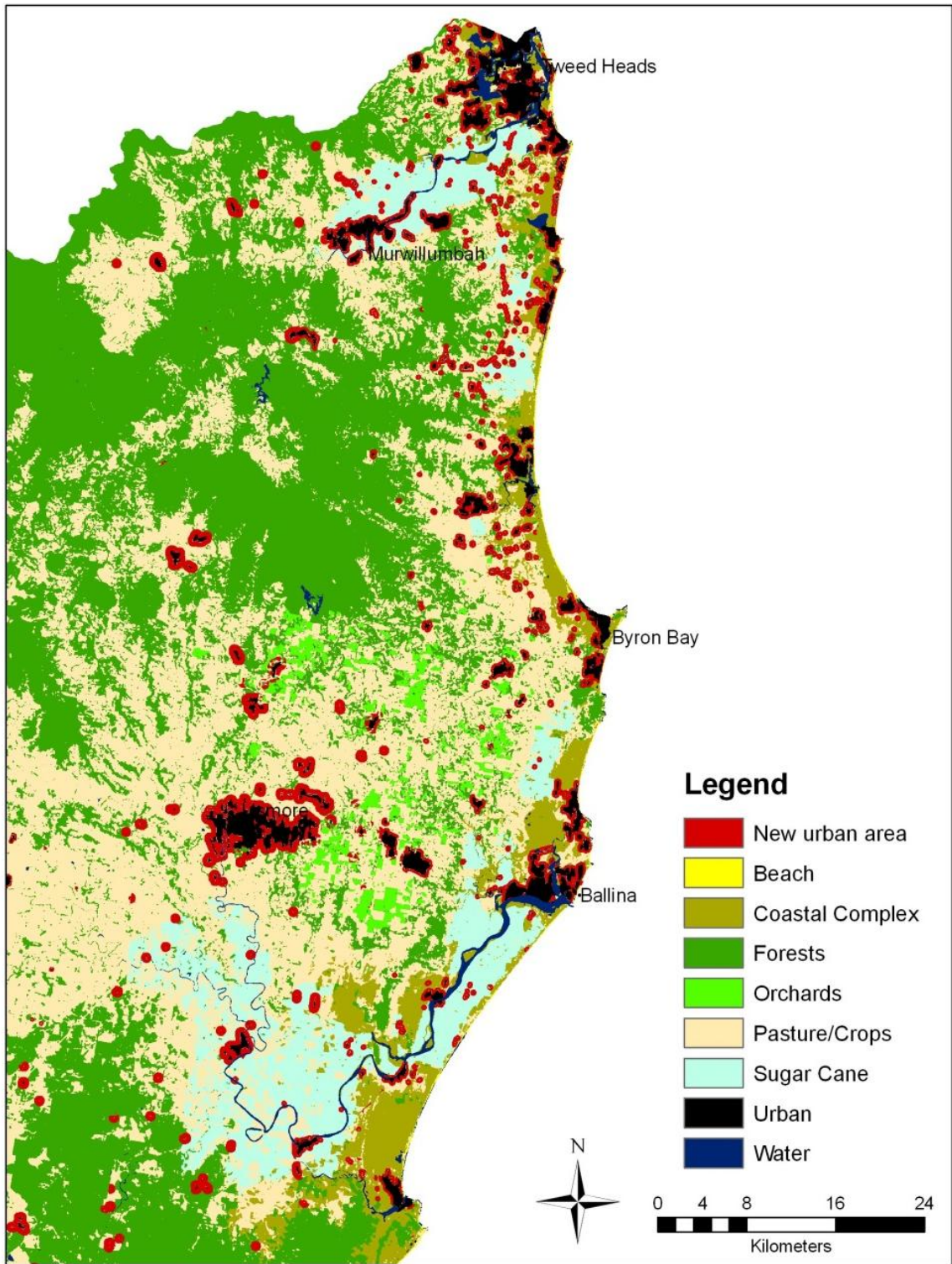


FIGURE 9.4: COASTAL PROTECTION WITH MINIMAL CONSTRAINTS POPULATION 558911, FAR NORTH COAST PORTION

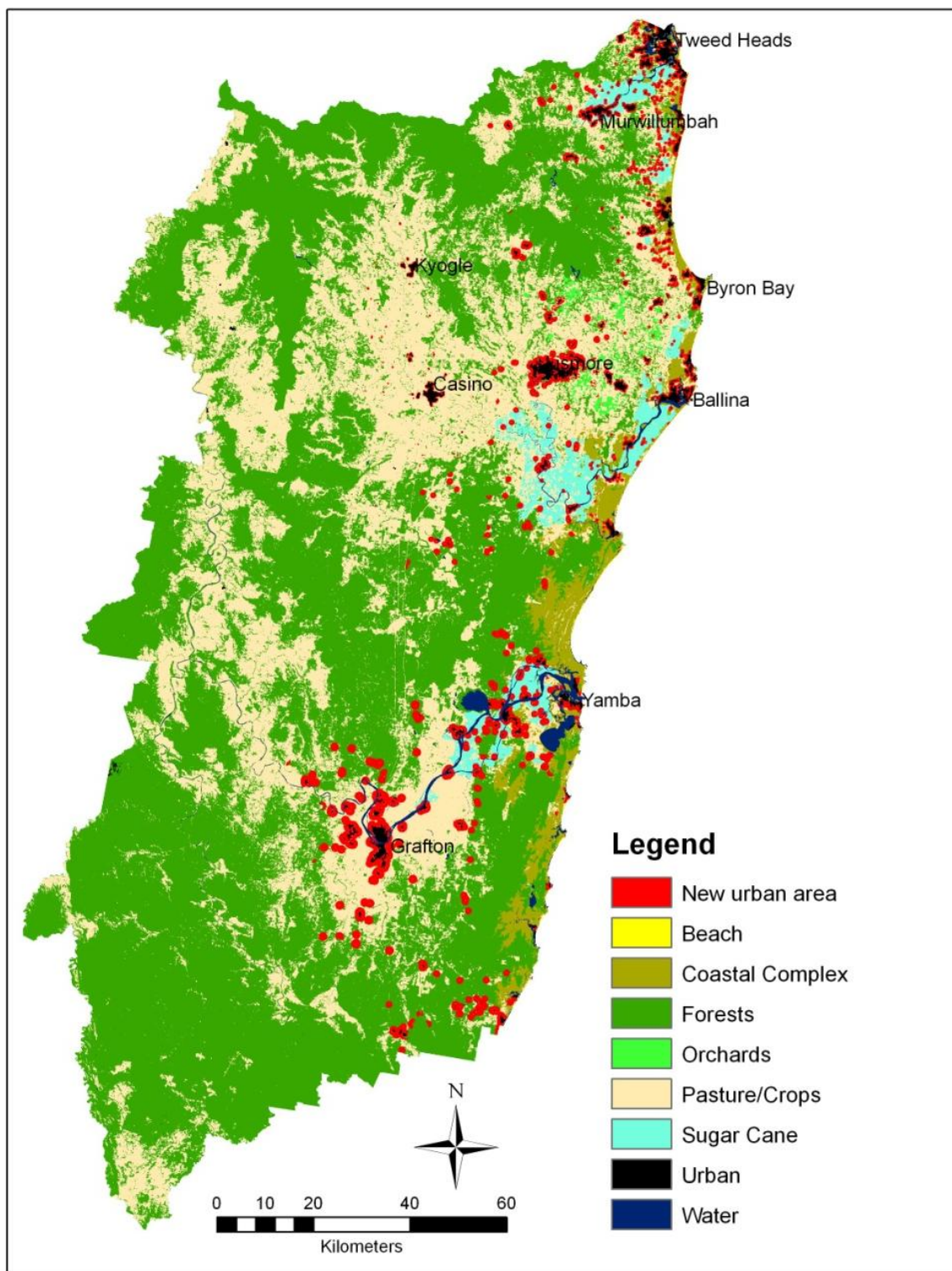


FIGURE 9.5: COASTAL PROTECTION WITH MINIMAL CONSTRAINTS POPULATION 727657

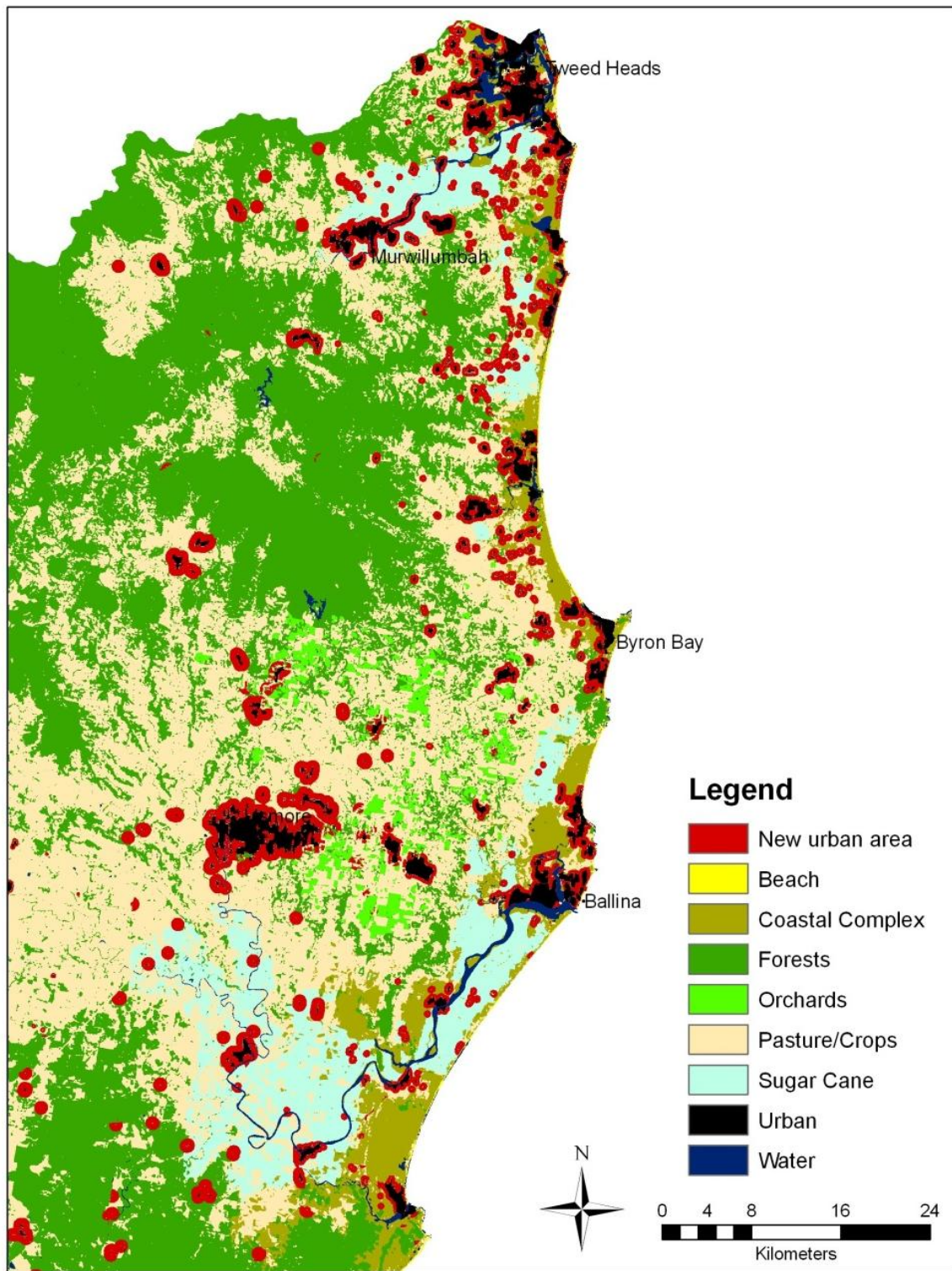


FIGURE 9.6: COASTAL PROTECTION WITH MINIMAL CONSTRAINTS POPULATION 727657, FAR NORTH COAST PORTION

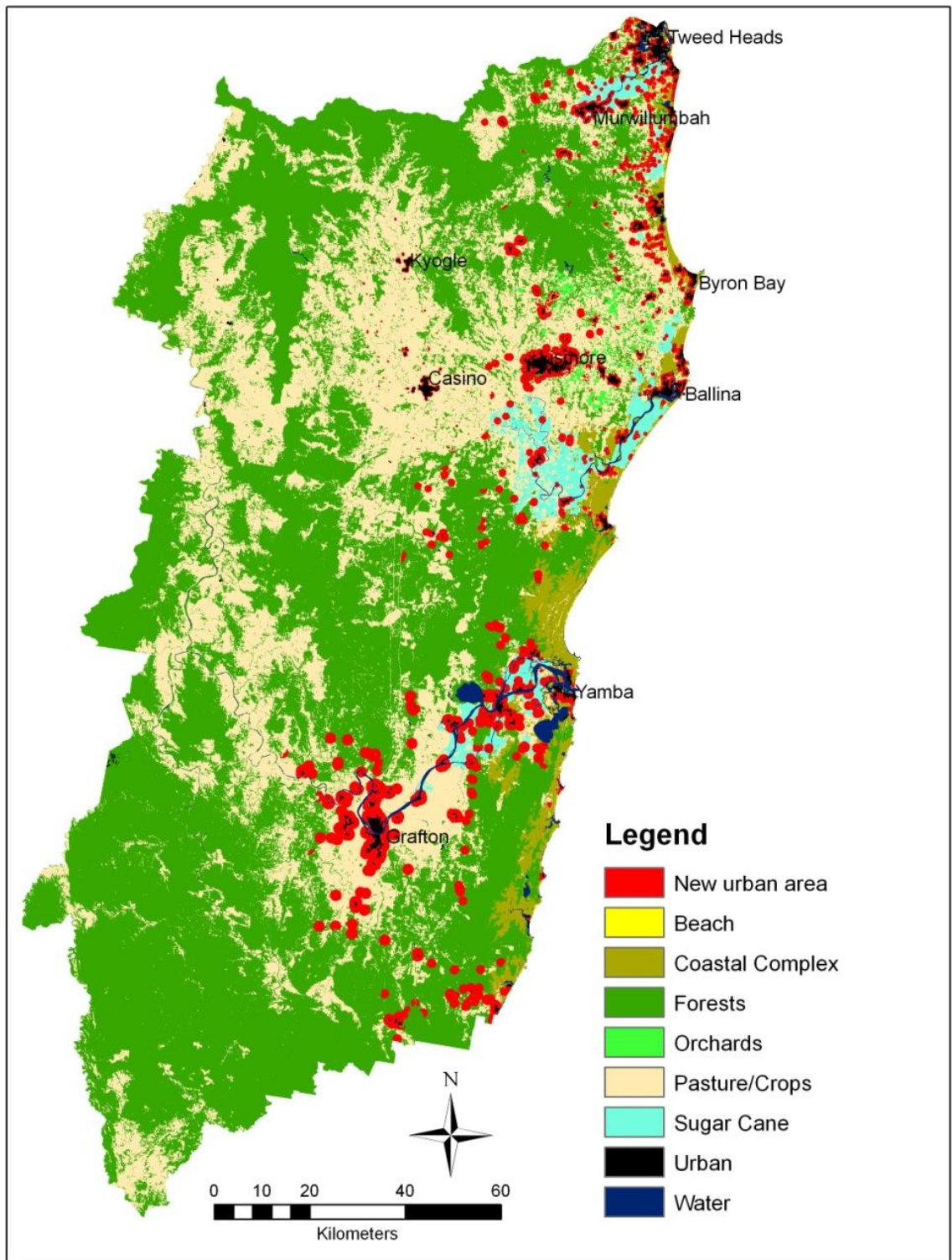


FIGURE 9.7: COASTAL PROTECTION WITH MINIMAL CONSTRAINTS POPULATION 955497

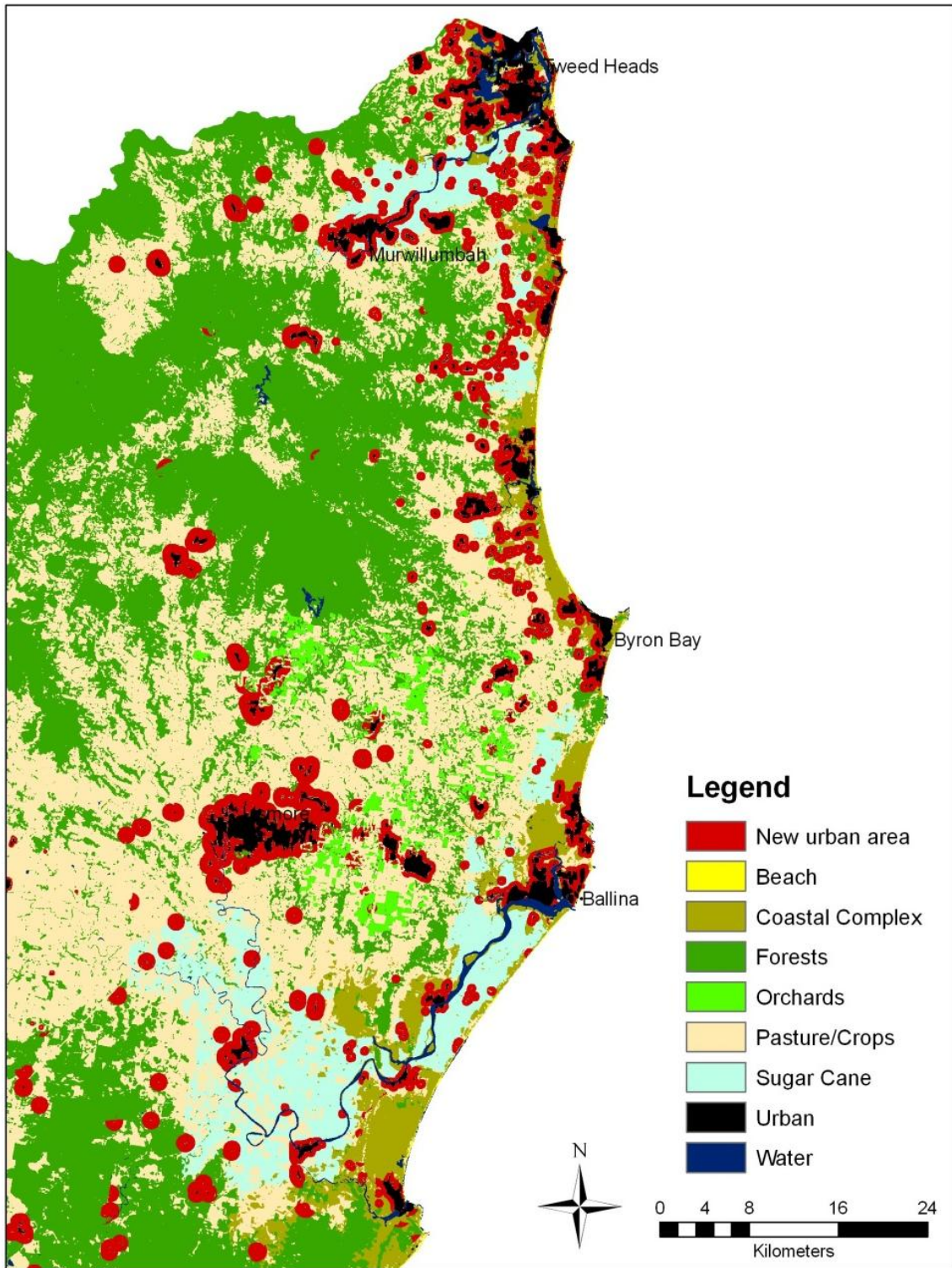


FIGURE 9.8: COASTAL PROTECTION WITH MINIMAL CONSTRAINTS POPULATION 955497, FAR NORTH COAST PORTION

9.2.1 CHANGE TABLES

The effects of the changes created in this scenario are shown in Table 9.3

TABLE 9.3: LAND USE CHANGE FOR COASTAL PROTECTION WITH MINIMAL CONSTRAINTS 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	64490	-3073	-4.55%	63074	-4489	-6.64%	61290	-6272	-9.28%	59221	-8341	-12.35%
Forests	1205414	1198707	-6707	-0.56%	1193403	-12011	-1.00%	1185574	-19840	-1.65%	1175539	-29876	-2.48%
Pasture/ Crops	713725	695394	-18332	-2.57%	685368	-28358	-3.97%	674170	-39555	-5.54%	660162	-535628	-7.50%
Orchards	8730	8549	-180	-2.06%	8392	-338	-3.87%	8225	-505	-5.78%	8016	-714	-8.17%
Sugar Cane	56069	52820	-3248	-5.79%	50579	-5489	-9.79%	47038	-9030	-16.11%	42645	-13424	-23.94%
Urban	20148	51688	31541	256.55%	70832	50684	351.56%	95350	75202	473.26%	126065	105917	625.70%

In the same manner as the urban shift scenario of Chapter 8, the reallocation of new urban development into zones with lower population densities increased the overall urban area for the region. At the population 955497 level, the extent of the urban area was more than 625% larger than the 2004 levels.

Predominately due to the large amount of growth around Grafton and Lismore more than half a million hectares of pasture and crop was converted to urban area. This is only slightly less than the change for this class in the environmental constraints scenario.

With a large proportional change of land used for sugar cane, 23.94% became urbanised, which is similar to the minimal constraints scenario. Almost 30000 hectares of forest was converted to urban use and another 8341 hectares of coastal native vegetation became urbanised. The breakdown by vegetation class for this change is presented in Table 9.4.

TABLE 9.4: LAND USE CHANGE BY VEGETATION TYPE FOR COASTAL PROTECTION MINIMAL CONSTRAINTS SCENARIOS

ECOSYSTEM	STATUS_A	LULC 2004	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
undclassified		151111	146569	-4542	-3.01%	144534	-6577	-4.35%	142202	-8909	-5.90%	139408	-11703	-7.74%
BaileysStringybark		31076	30720	-357	-1.15%	30323	-753	-2.42%	29767	-1310	-4.21%	29104	-1972	-6.35%
Banksia	Rare	1336	1286	-50	-3.77%	1259	-78	-5.80%	1219	-118	-8.80%	1166	-170	-12.75%
Casuarina Woodland	Rare	21	18	-3	-16.32%	16	-5	-24.93%	15	-6	-30.27%	12	-9	-43.92%
Central Mid Elevation Sydney Blue Gum		3278	3277	-1	-0.03%	3277	-1	-0.03%	3275	-3	-0.10%	3274	-4	-0.11%
Clarence Lowland Needlebark Stringybark		10322	10224	-98	-0.95%	10105	-217	-2.10%	9907	-415	-4.02%	9692	-630	-6.11%
Lowlands Grey Box	Vulnerable	14455	14371	-84	-0.58%	14200	-254	-1.76%	13956	-498	-3.45%	13590	-865	-5.98%
Coast Cypress Pine	Rare	67	63	-3	-4.97%	63	-3	-4.97%	63	-4	-5.25%	63	-4	-5.82%
Coast Range Bloodwood-Mahogany		5177	5142	-35	-0.67%	5119	-58	-1.12%	5059	-118	-2.28%	4978	-199	-3.84%
Clarence Lowlands Spotted Gum		128339	127722	-617	-0.48%	127022	-1317	-1.03%	125986	-2353	-1.83%	124581	-3758	-2.93%
Coast Range Spotted Gum-Blackbutt	Rare	625	624	-2	-0.30%	621	-4	-0.66%	612	-14	-2.21%	602	-24	-3.81%
Coastal Flooded Gum		8039	8039	0	0.00%	8039	0	0.00%	8037	-1	-0.02%	8035	-4	-0.05%
Coastal Sands Blackbutt		2821	2799	-22	-0.77%	2791	-30	-1.06%	2783	-38	-1.34%	2771	-50	-1.76%
Dry Foothills Blackbutt-Turpentine		2704	2687	-17	-0.61%	2673	-31	-1.16%	2655	-49	-1.82%	2618	-86	-3.17%
Dry Foothills Spotted Gum		73800	73795	-5	-0.01%	73787	-13	-0.02%	73773	-27	-0.04%	73741	-59	-0.08%
Dry Grassy Blackbutt-Tallowwood		5353	5297	-56	-1.04%	5242	-111	-2.07%	5146	-207	-3.86%	5043	-310	-5.78%
Dry Grassy Tallowwood-Grey Gum		2167	2125	-42	-1.93%	2088	-79	-3.67%	2008	-159	-7.33%	1933	-234	-10.81%
Dry Heathy Blackbutt-		42039	41572	-467	-1.11%	41112	-927	-2.21%	40404	-1635	-3.89%	39576	-2463	-5.86%

Bloodwood														
Dry Heathy Sandstone Blackbutt		16634	16534	-100	-0.60%	16437	-197	-1.18%	16317	-317	-1.91%	16169	-465	-2.80%
Dry open Redgum-Broad Leaved Apple		1129	1129	0	0.00%	1129	0	0.00%	1128	-2	-0.14%	1125	-5	-0.41%
Dunns White Gum	Rare	291	291	0	0.00%	289	-2	-0.52%	281	-10	-3.40%	279	-11	-3.93%
Eastern Red Gums	Vulnerable	1774	1774	0	0.00%	1774	0	0.00%	1774	0	0.00%	1774	0	0.00%
Escarpment Redgum		15211	15207	-4	-0.02%	15202	-9	-0.06%	15194	-16	-0.11%	15180	-30	-0.20%
Escarpment Scribbly Gum-Apple		3583	3582	-2	-0.05%	3581	-3	-0.08%	3580	-3	-0.09%	3577	-7	-0.18%
Wet Bangalow-Brushbox	Vulnerable	8312	8285	-27	-0.33%	8267	-45	-0.54%	8249	-63	-0.76%	8212	-99	-1.20%
Foothill Grey Gum-Ironbark-Spotted Gum		39837	39640	-197	-0.49%	39425	-412	-1.03%	39034	-803	-2.02%	38628	-1208	-3.03%
Foothills Grey Gum-Spotted Gum		5947	5904	-44	-0.73%	5861	-87	-1.46%	5756	-192	-3.23%	5659	-288	-4.84%
Gorge Grey Gum		697	695	-2	-0.34%	694	-3	-0.45%	691	-6	-0.83%	682	-15	-2.20%
Gorge Ironbark-Grey Gum		22685	22684	-1	0.00%	22682	-3	-0.01%	22675	-10	-0.05%	22668	-17	-0.07%
Heath	Vulnerable	8138	8077	-62	-0.76%	8039	-99	-1.22%	7983	-156	-1.91%	7920	-218	-2.68%
Heathy Scribbly Gum		7235	7174	-61	-0.84%	7114	-120	-1.66%	7012	-223	-3.08%	6898	-336	-4.65%
Herbfield and Fjaeldmark	Rare	25	24	-1	-3.49%	23	-2	-7.23%	22	-3	-12.22%	21	-4	-17.21%
High Elevation Open Spotted Gum		42550	42519	-31	-0.07%	42492	-59	-0.14%	42450	-101	-0.24%	42392	-159	-0.37%
Ironbark		5467	5443	-24	-0.44%	5409	-58	-1.05%	5368	-99	-1.81%	5312	-155	-2.83%
Low Relief Coastal Blackbutt	Rare	310	310	0	0.00%	310	0	0.00%	310	0	0.00%	310	0	0.00%
Lowland Red Gum		43876	43458	-418	-0.95%	43063	-813	-1.85%	42381	-1496	-3.41%	41417	-2459	-5.61%
Lowlands Scribbly Gum	Vulnerable	3204	3171	-33	-1.01%	3155	-48	-1.51%	3116	-87	-2.73%	3074	-129	-4.03%
Lowlands Spotted Gum-Box		15578	15547	-30	-0.19%	15489	-88	-0.57%	15416	-162	-1.04%	15301	-276	-1.77%
Coastal Mallee	Vulnerable	1240	1230	-11	-0.86%	1224	-16	-1.29%	1207	-34	-2.73%	1188	-53	-4.25%
Mangrove	Rare	395	385	-10	-2.61%	380	-15	-3.90%	372	-23	-5.90%	357	-38	-9.63%

Moist Foothills Spotted Gum		30780	30771	-9	-0.03%	30755	-25	-0.08%	30715	-65	-0.21%	30685	-95	-0.31%
Northern Moist Blackbutt		8700	8689	-11	-0.13%	8678	-22	-0.25%	8655	-45	-0.51%	8624	-76	-0.87%
Natural Grassland	Rare	270	268	-2	-0.65%	266	-4	-1.41%	264	-6	-2.11%	262	-8	-3.10%
Needlebark Stringybark-Large Fruited Blackbutt		9547	9446	-102	-1.06%	9364	-183	-1.92%	9194	-353	-3.70%	8990	-557	-5.84%
New England Stringybark-Blakelys Red Gum		1067	1063	-4	-0.33%	1058	-9	-0.83%	1039	-27	-2.55%	1012	-55	-5.13%
Northern Open Grassy Blackbutt		18876	18730	-145	-0.77%	18583	-293	-1.55%	18325	-550	-2.92%	17972	-904	-4.79%
Northern Ranges Dry Tallowwood		19608	19606	-2	-0.01%	19603	-5	-0.03%	19599	-9	-0.05%	19589	-20	-0.10%
Northern Wet Brushbox		10532	10532	0	0.00%	10531	-1	-0.01%	10531	-1	-0.01%	10531	-1	-0.01%
Northern Wet Tallowwood-Blue Gum		14647	14646	0	0.00%	14646	-1	-0.01%	14644	-2	-0.01%	14643	-3	-0.02%
Open Coastal Brushbox		3440	3409	-31	-0.91%	3386	-55	-1.58%	3350	-91	-2.64%	3307	-133	-3.87%
Open Shrubby Brushbox-Tallowwood		9663	9662	-1	-0.01%	9662	-1	-0.01%	9662	-1	-0.01%	9662	-1	-0.01%
Paperbark	Vulnerable	22405	22073	-332	-1.48%	21819	-586	-2.61%	21402	-1002	-4.47%	20868	-1536	-6.86%
Red Bloodwood	Rare	207	205	-2	-1.06%	199	-8	-4.07%	192	-15	-7.39%	186	-22	-10.43%
Red Mahogany		1251	1248	-2	-0.19%	1247	-4	-0.30%	1244	-7	-0.57%	1242	-8	-0.66%
Richmond Range Spotted Gum		16415	16409	-6	-0.04%	16406	-9	-0.05%	16399	-16	-0.10%	16381	-34	-0.21%
Richmond Range Spotted Gum-Box		17197	17196	-1	-0.01%	17193	-4	-0.02%	17191	-6	-0.03%	17191	-6	-0.03%
River Oak	Vulnerable	824	821	-3	-0.40%	817	-7	-0.85%	813	-11	-1.29%	807	-17	-2.09%
Rough-barked Apples	Vulnerable	1396	1396	-1	-0.04%	1393	-4	-0.26%	1388	-8	-0.58%	1385	-11	-0.79%
Saltbush	Rare	9	8	-2	-16.56%	7	-2	-25.17%	6	-3	-33.11%	6	-3	-33.11%
Sandstone Spotted Gum-Blackbutt		3870	3856	-14	-0.36%	3834	-36	-0.92%	3794	-76	-1.95%	3744	-125	-3.24%
Sherwood Needlebark		8249	8143	-106	-1.29%	8027	-222	-2.69%	7827	-422	-5.11%	7554	-695	-8.42%

Stringybark														
South Coast Tallowwood-Blue Gum		2569	2567	-2	-0.08%	2564	-5	-0.19%	2558	-11	-0.43%	2543	-26	-1.00%
Stringybark-Apple		5044	5041	-3	-0.06%	5039	-5	-0.11%	5036	-8	-0.16%	5028	-16	-0.32%
Swamp	Endangered	11569	11269	-300	-2.59%	11096	-473	-4.09%	10917	-652	-5.64%	10646	-923	-7.98%
Swamp Mahogany	Rare	351	340	-11	-3.12%	331	-20	-5.67%	320	-31	-8.75%	305	-46	-12.99%
Swamp Oak	Rare	1946	1882	-64	-3.28%	1830	-116	-5.96%	1754	-192	-9.88%	1670	-277	-14.21%
Sydney Peppermint-Stringybark	Rare	205	205	0	0.00%	205	0	0.00%	205	0	0.00%	205	0	0.00%
Tallowwood		3563	3561	-2	-0.05%	3561	-2	-0.05%	3559	-4	-0.11%	3558	-5	-0.14%
Turpentine		2470	2446	-24	-0.97%	2432	-38	-1.55%	2414	-56	-2.25%	2390	-80	-3.23%
Very Wet New England Blackbutt-Tallowwood		434	434	0	-0.03%	434	0	-0.03%	434	0	-0.03%	434	-1	-0.14%
Wattle		783	770	-13	-1.68%	762	-21	-2.67%	753	-30	-3.81%	734	-49	-6.29%
Wet Bloodwood-Tallowwood		25677	25656	-21	-0.08%	25639	-37	-0.15%	25617	-59	-0.23%	25570	-107	-0.42%
Wet Coastal Tallowwood-Brushbox		1526	1501	-25	-1.64%	1483	-43	-2.81%	1449	-77	-5.07%	1407	-119	-7.81%
Wet Flooded Gum-Tallowwood		5399	5359	-40	-0.74%	5326	-73	-1.35%	5276	-123	-2.27%	5218	-181	-3.35%
Wet Foothills Blackbutt-Turpentine		1014	1014	0	0.00%	1014	0	-0.01%	1012	-3	-0.25%	1008	-7	-0.65%
Forestry Plantations		10325	10292	-32	-0.31%	10248	-77	-0.74%	10160	-164	-1.59%	10034	-291	-2.82%
Introduced Scrub		989	989	0	0.00%	988	-1	-0.11%	985	-4	-0.39%	979	-10	-1.00%
Rainforest	Endangered	111641	111513	-128	-0.11%	111424	-217	-0.19%	111306	-335	-0.30%	111132	-509	-0.46%
Scrub	Vulnerable	4202	4144	-58	-1.38%	4124	-78	-1.85%	4103	-100	-2.37%	4065	-137	-3.27%
Cleared-Partially Cleared		3118	3104	-14	-0.45%	3099	-19	-0.62%	3093	-25	-0.80%	3085	-33	-1.06%
Camphor Laurel		6159	6015	-144	-2.34%	5938	-221	-3.58%	5855	-304	-4.93%	5762	-397	-6.45%

Two vegetation classes unaffected in previous scenarios, the rare Dunn's white gum and dry open redgum-broad leaved apple, were impacted by the land use changes of the scenario. Overall, the Clarence lowlands spotted gum was most heavily impacted in terms of area, with 3757 hectares being urbanised. Other vegetation classes losing considerable areas included dry heathy blackbutt (2462 hectares), lowland red gum (2459 hectares) and Bailey's stringybark (1972 hectares).

Vegetation that had a proportionally large amount of area converted to urban use in this scenario followed a similar pattern to the minimal constraints scenario. Casuarina woodlands lost 43.92% of the 2004 area and saltbush areas were reduced by 33.11%. The extent of herbfield and fjaeldmark was reduced by 17.21% and swamp oak by 14.21%. These vegetation types were collectively part of the 5114 hectares of rare, vulnerable or endangered classified areas lost to urban use in this coastal protection (minimal constraints) scenario.

The second scenario variation of coastal protection, with protection of agricultural lands and environmental constraints, is examined next.

9.3 COASTAL PROTECTION WITH AGRICULTURAL AND ENVIRONMENTAL PROTECTION RESULTS

The coastal protection with agricultural and environmental constraints to urban development follows a similar model to that of the urban shift scenarios presented in Chapter 8. Urban development patterns at the low population levels, generated by this scenario and merged with the 2006 land use are shown (with Far North Coast portion) in Figures 9.9 to 9.16.

New areas for urban development followed a similar structure and placement as in the previous scenario variation (9.2) although to a lesser extent due to the reduced population. However priority agricultural and environmental areas were protected. This meant for example, that the sugar cane fields at both the northern and southern parts of the zone were protected from urban growth, as well as a 1-2km wide corridor of native vegetation along the coastline (Figures 9.15, 9.16). The population centres within zone 4 only grew marginally and the largest area of urban growth was in the area between Murwillumbah and Byron Bay.

Urban development in zone 5 was more concentrated around Lismore and the towns to the north than the minimal constraints variation of this scenario although a large number of patches of "satellite" urbanisation are present in both variations in the southern part of this zone. As in the urban shift scenario the effect of the constraints upon the pattern and shape of new development areas is visually apparent (Figures 9.15, 9.16).

In the southern parts of the region these constraints shifted new development from the sugar cane area between Yamba and Maclean to ribbon development along the Pacific Highway. This development formed a line of urban sprawl approximately 50 kilometres long and 3 kilometres wide. Similar to the minimal constraints variation, new urban growth in zone 3 centered on the agricultural area around Grafton, although constraints to development pushed this growth to the south and west of the city (Figure 9.15, 9.16). The spatial impact of the changes effected by this scenario is summarised in Table 9.5.

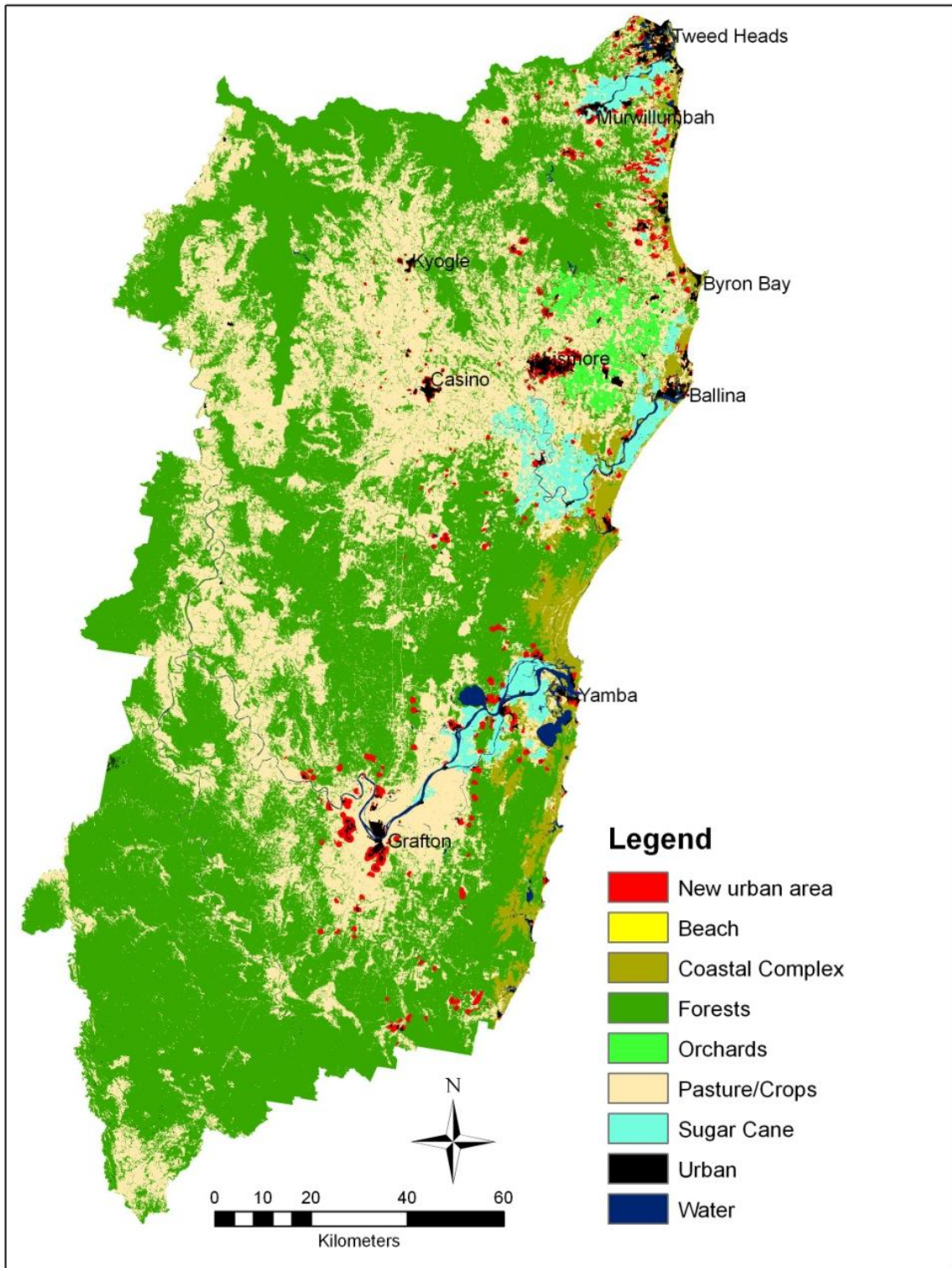


FIGURE 9.9: COASTAL PROTECTION WITH POPULATION 403839

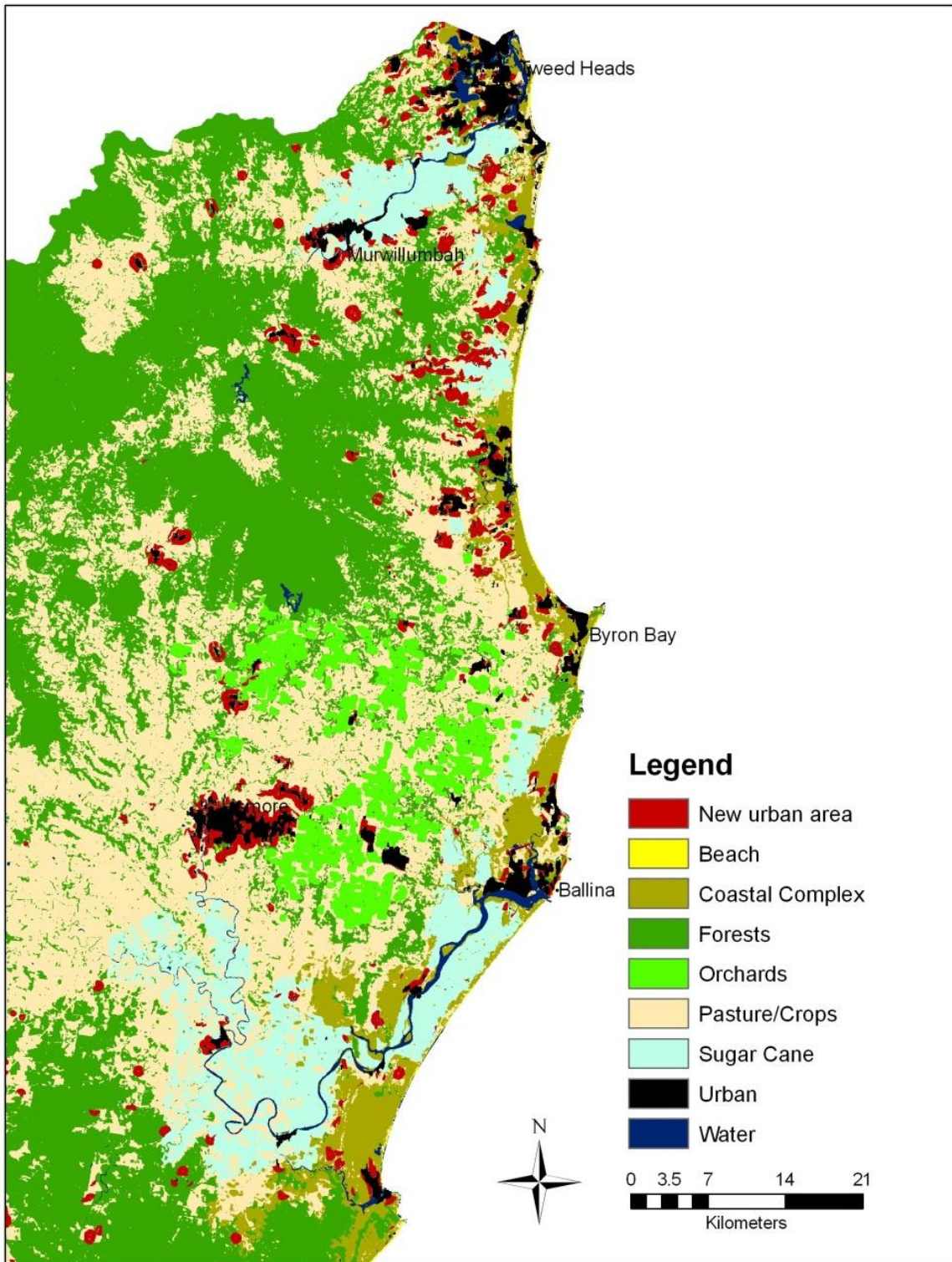


FIGURE 9.10: COASTAL PROTECTION WITH POPULATION 403839, FAR NORTH COAST PORTION

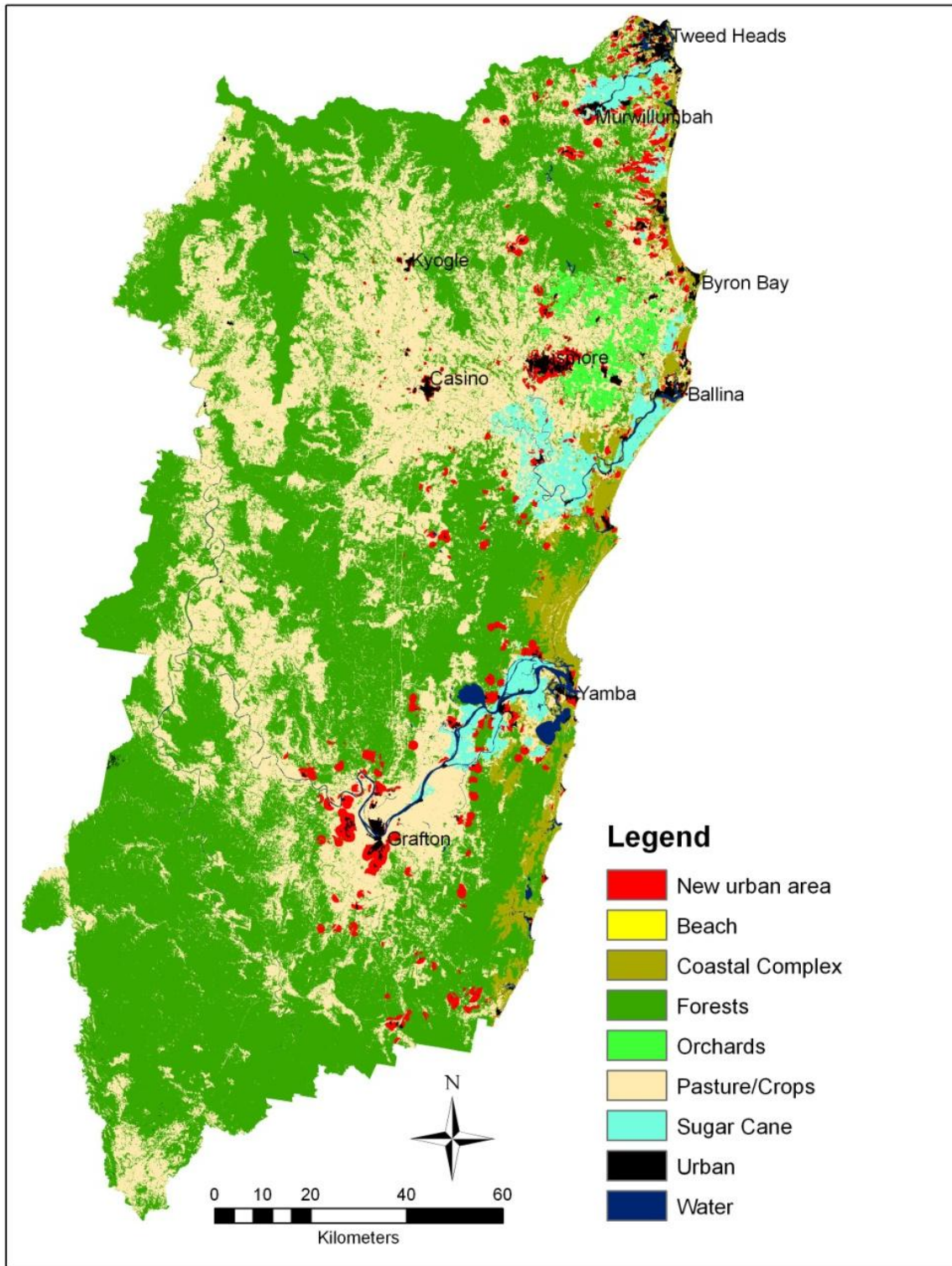


FIGURE 9.11: COASTAL PROTECTION WITH POPULATION 558911

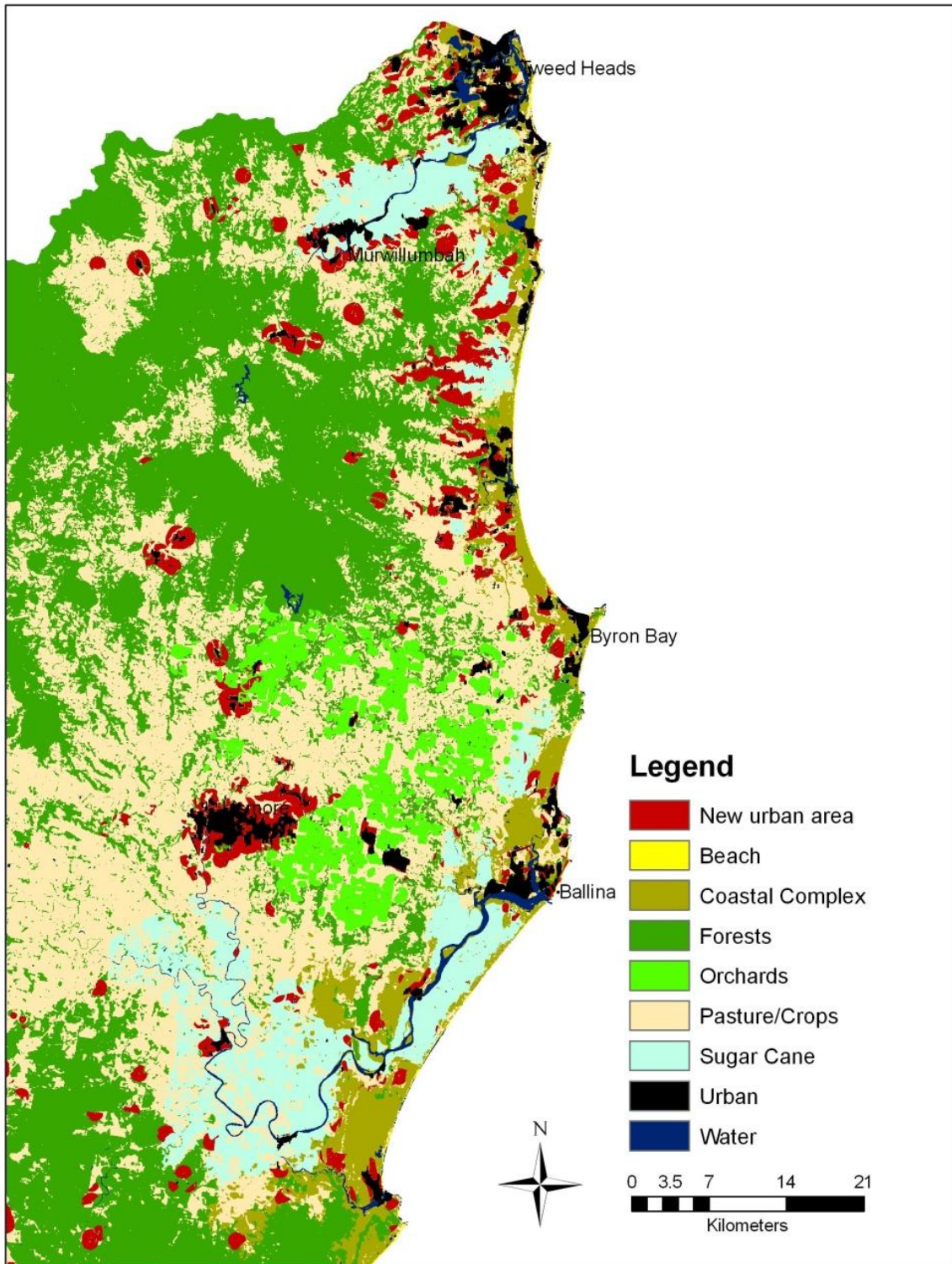


FIGURE 9.12: COASTAL PROTECTION WITH POPULATION 558911, FAR NORTH COAST PORTION

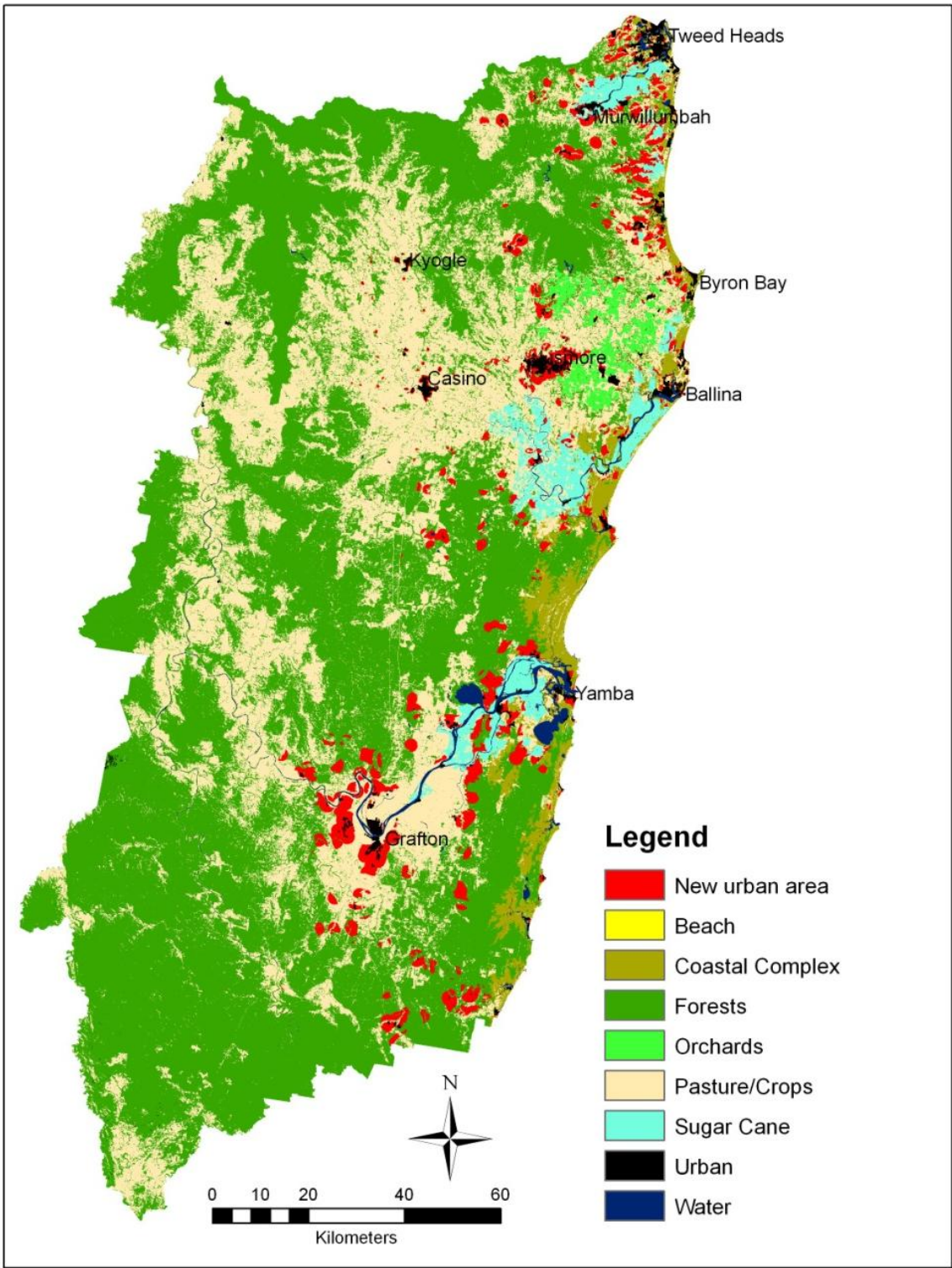


FIGURE 9.13: COASTAL PROTECTION WITH POPULATION 727657

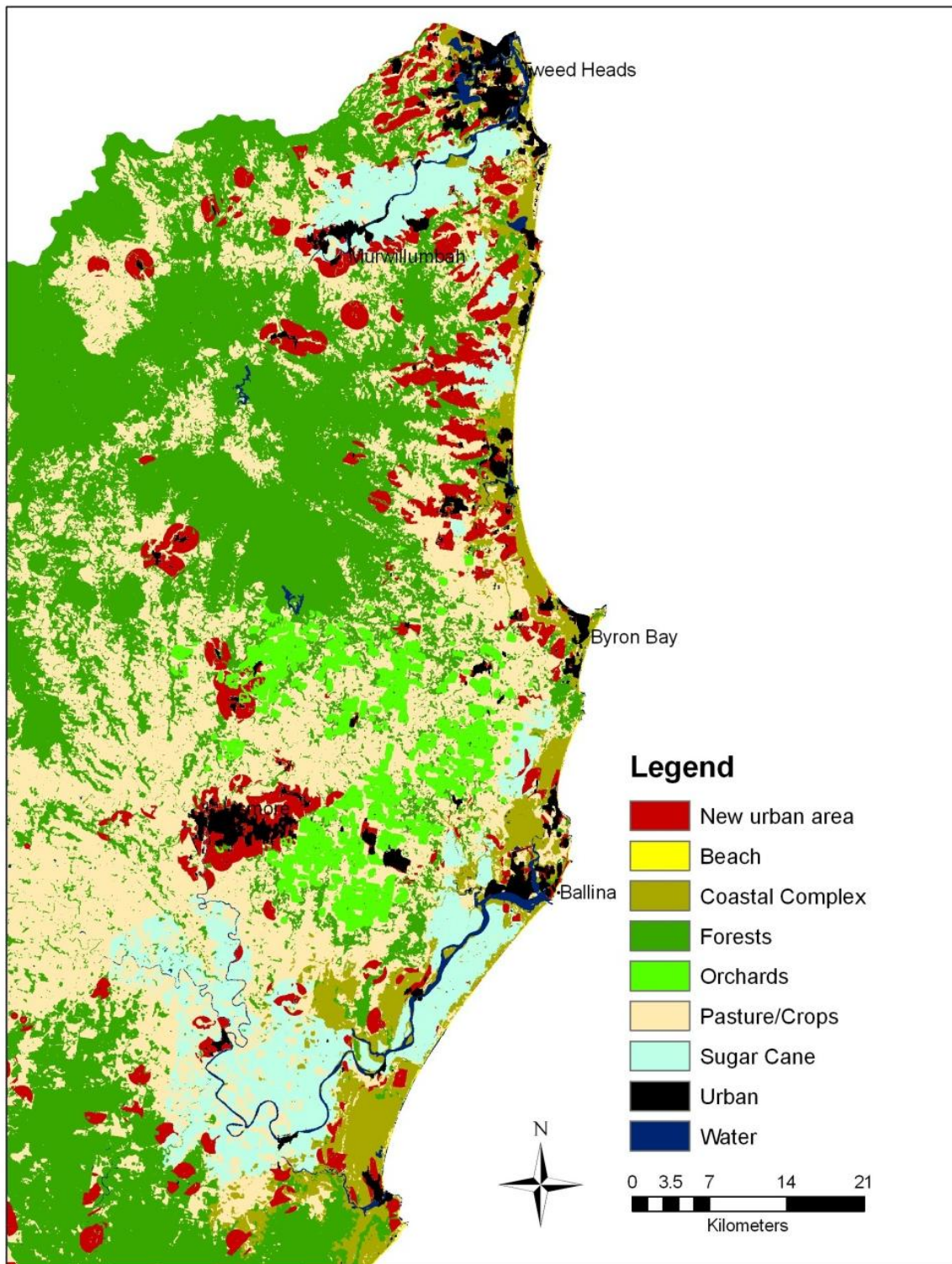


FIGURE 9.14: COASTAL PROTECTION WITH POPULATION 727657, FAR NORTH COAST PORTION

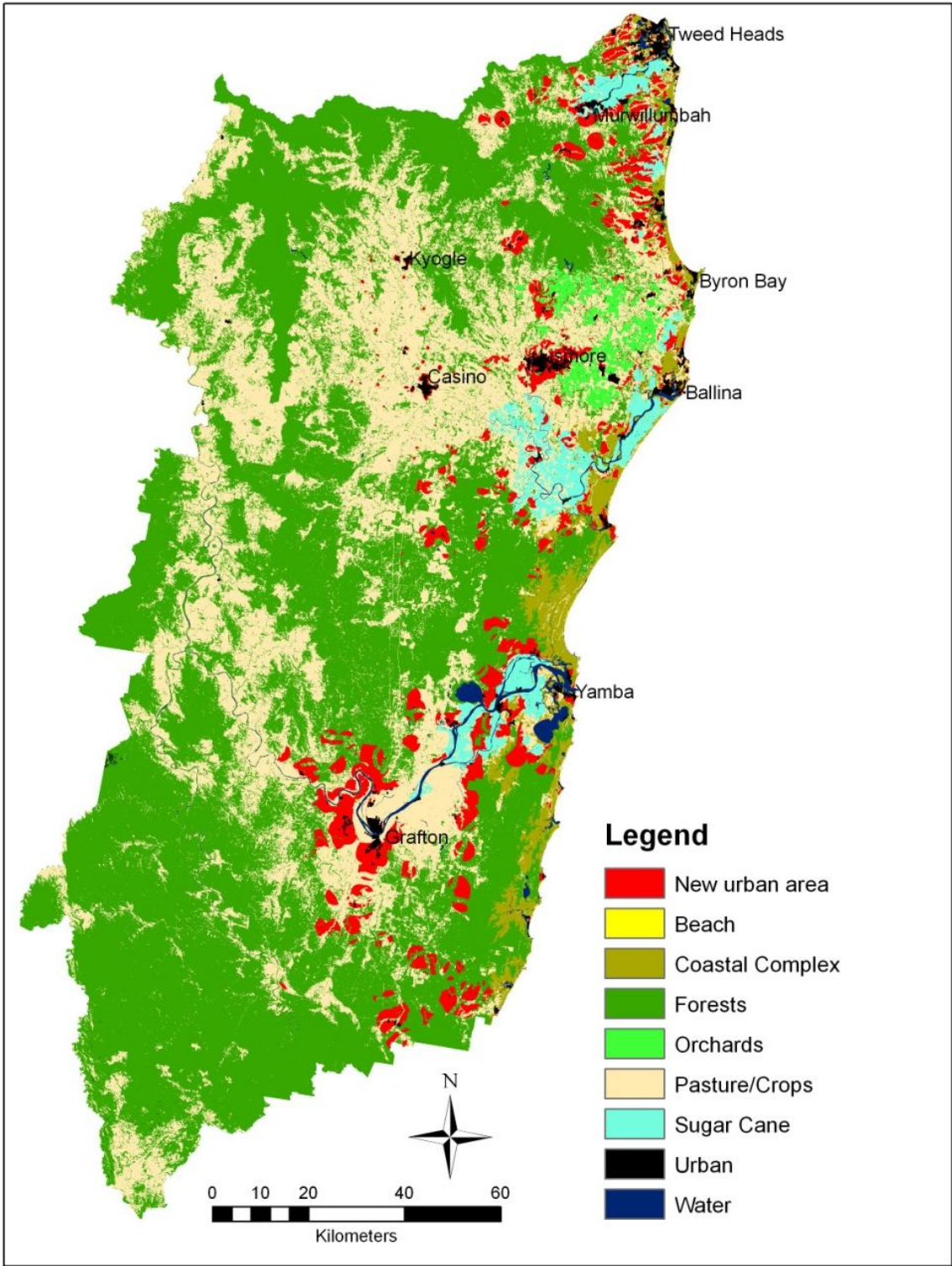


FIGURE 9.15: COASTAL PROTECTION WITH POPULATION 955497

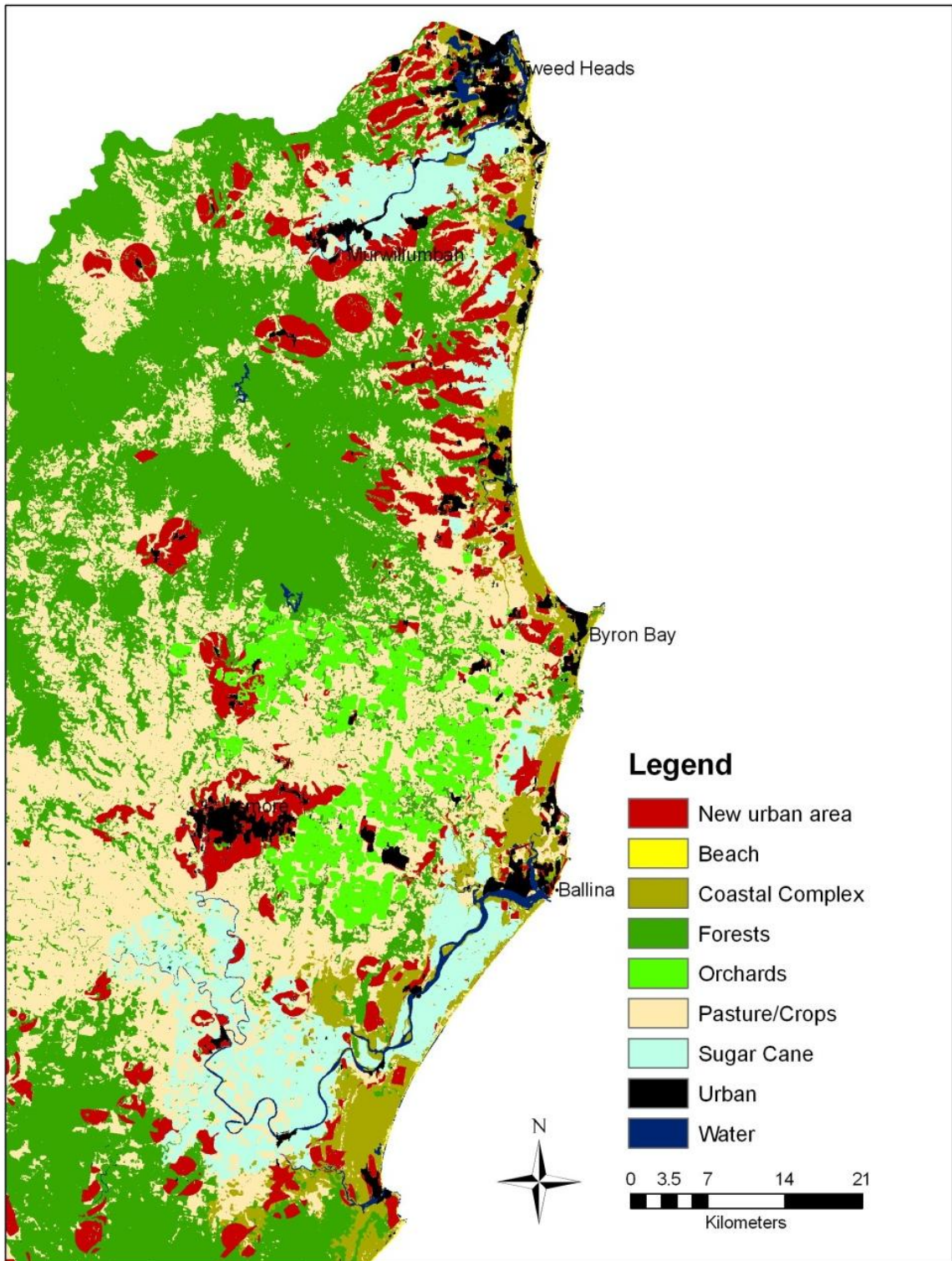


FIGURE 9.16: COASTAL PROTECTION WITH POPULATION 955497, FAR NORTH COAST PORTION

9.3.1 CHANGE TABLES

TABLE 9.5 LAND USE CHANGE BY CLASS FOR COASTAL PROTECTION AGRICULTURAL AND ENVIRONMENTAL PROTECTION 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	65537	-2026	-3.00%	64686	-2876	-4.26%	63880	-3683	-5.45%	63017	-4546	-6.73%
Forests	1205414	1193041	-12374	-1.03%	1185509	-19905	-1.65%	1174218	-31196	-2.59%	1160382	-45033	-3.74%
Pasture/ Crops	713725	685043	-28682	-4.02%	674768	-38957	-5.46%	662917	-50808	-7.12%	647547	-66179	-9.27%
Orchards	8730	21120	12390	141.94%	21120	12390	141.94%	21120	12390	141.94%	21120	12390	141.94%
Sugar Cane	56069	55295	-773	-1.38%	54861	-1208	-2.15%	54319	-1750	-3.12%	53693	-2376	-4.24%
Urban	20148	51688	31541	256.55%	70832	50684	351.56%	95350	75202	473.26%	126065	105917	625.70%

Land use changes in this scenario had a similar distribution across land use classes as the urban shift scenarios of Chapter 8 (Table 9.5). The increased population in lower density areas expanded the overall urban area within the region and reached 105917 hectares at the highest population level (62.5% of 2004 urban extent).

The constraints combined with relocation of urban development reduced the impact on sugar cane with 4.24% becoming urbanised. This was the smallest area lost of this class to urban development conversion for all scenarios. Similarly 6.73% (4545 hectares) of the coastal complex class was lost to urban development; the least area lost to urban settlement in all scenarios, except for the controlled density scenario.

However, 9.27% of the extent of pasture and crops was converted to urban development which was the highest level for all scenarios and was primarily due to the population shift and increased development in the southern parts of the region. The amount of forests was reduced by 3.74% which is also a large figure in comparison to other scenarios. The breakdown of change by vegetation ecosystem classes, under this scenario is presented in Table 9.6.

TABLE 9.5: LAND USE CHANGE BY VEGETATION TYPE FOR COASTAL PROTECTION AGRICULTURAL AND ENVIRONMENTAL PROTECTION SCENARIOS

ECOSYSTEM	STATUS_A	LULC 2004	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		1511109	1554267	-43158	-2.86%	1576922	-65813	-4.36%	1603376	-92267	-6.11%	1636983	-125874	-8.33%
BaileysStringybark	-	310763	316426	-5663	-1.82%	322030	-11267	-3.63%	330430	-19667	-6.33%	339978	-29214	-9.40%
Banksia	Rare	13363	14191	-829	-6.20%	14664	-1301	-9.74%	14906	-1543	-11.55%	15350	-1988	-14.87%
Casuarina Woodland	Rare	211	213	-2	-0.89%	213	-2	-0.89%	213	-2	-0.89%	213	-2	-0.89%
Central Mid Elevation Sydney Blue Gum	-	32782	32792	-10	-0.03%	32793	-11	-0.03%	32793	-11	-0.03%	32793	-11	-0.03%
Clarence Lowland Needlebark Stringybark	-	103218	105091	-1874	-1.82%	106547	-3329	-3.23%	109686	-6468	-6.27%	112955	-9738	-9.43%
Lowlands Grey Box	Vulnerable	144545	145861	-1316	-0.91%	148430	-3885	-2.69%	151569	-7024	-4.86%	155548	-11003	-7.61%
Coast Cypress Pine	Rare	666	704	-38	-5.63%	704	-38	-5.63%	711	-44	-6.66%	721	-55	-8.26%
Coast Range Bloodwood-Mahogany	-	51770	52173	-403	-0.78%	52723	-953	-1.84%	53726	-1956	-3.78%	54693	-2923	-5.65%
Clarence Lowlands Spotted Gum	-	1283389	1292884	-9495	-0.74%	1303046	-19656	-1.53%	1318388	-34998	-2.73%	1337654	-54265	-4.23%
Coast Range Spotted Gum-Blackbutt	Rare	6254	6254	0	-0.00%	6293	-39	-0.62%	6403	-149	-2.39%	6511	-257	-4.11%
Coastal Flooded Gum	-	80385	80385	0	-0.00%	80403	-18	-0.02%	80409	-24	-0.03%	80481	-96	-0.12%
Coastal Sands Blackbutt	-	28208	28419	-212	-0.75%	28468	-260	-0.92%	28516	-309	-1.09%	28584	-377	-1.34%
Dry Foothills Blackbutt-Turpentine	-	27039	27264	-226	-0.83%	27509	-471	-1.74%	28107	-1068	-3.95%	28539	-1501	-5.55%
Dry Foothills Spotted Gum	-	737998	738121	-123	-0.02%	738350	-352	-0.05%	738791	-793	-0.11%	739303	-1305	-0.18%
Dry Grassy Blackbutt-Tallowwood	-	53525	54301	-776	-1.45%	54872	-1347	-2.52%	56039	-2514	-4.70%	57011	-3486	-6.51%
Dry Grassy Tallowwood-Grey Gum	-	21672	22355	-683	-3.15%	22796	-1124	-5.19%	23882	-2210	-10.20%	24953	-3281	-15.14%

Dry Heathy Blackbutt-Bloodwood	-	420389	427463	-7074	-1.68%	433865	-13476	-3.21%	443976	-23587	-5.61%	455309	-34920	-8.31%
Dry Heathy Sandstone Blackbutt	-	166340	167966	-1626	-0.98%	169318	-2978	-1.79%	171534	-5194	-3.12%	173438	-7098	-4.27%
Dry open Redgum-Broad Leaved Apple	-	11293	11293	0	0.00%	11326	-33	-0.29%	11329	-36	-0.32%	11349	-56	-0.50%
Dunns White Gum	Rare	2908	2908	0	0.00%	2908	0	0.00%	2908	0	0.00%	2908	0	0.00%
Eastern Red Gums	Vulnerable	17735	17738	-3	-0.01%	17754	-19	-0.11%	17824	-89	-0.50%	18014	-279	-1.58%
Escarpment Redgum	-	152105	152164	-59	-0.04%	152256	-151	-0.10%	152377	-272	-0.18%	152508	-403	-0.26%
Escarpment Scribbly Gum-Apple	-	35833	35864	-31	-0.09%	35879	-46	-0.13%	35906	-74	-0.21%	35984	-151	-0.42%
Wet Bangalow-Brushbox	Vulnerable	83117	83365	-248	-0.30%	83621	-504	-0.61%	84067	-950	-1.14%	84821	-1704	-2.05%
Foothill Grey Gum-Ironbark-Spotted Gum	-	398366	401949	-3583	-0.90%	404748	-6381	-1.60%	409170	-10804	-2.71%	414187	-15821	-3.97%
Foothills Grey Gum-Spotted Gum	-	59474	60118	-644	-1.08%	60934	-1459	-2.45%	62224	-2750	-4.62%	63476	-4001	-6.73%
Gorge Ironbark-Grey Gum	-	226850	226884	-34	-0.01%	226943	-93	-0.04%	226999	-149	-0.07%	227099	-249	-0.11%
Heath	Vulnerable	81383	82614	-1231	-1.51%	83191	-1808	-2.22%	84088	-2704	-3.32%	84465	-3082	-3.79%
Heathy Scribbly Gum	-	72345	73314	-969	-1.34%	74213	-1868	-2.58%	75709	-3364	-4.65%	77324	-4979	-6.88%
Herbfield and Fjaeldmark	Rare	251	251	0	0.00%	251	0	0.00%	251	0	0.00%	251	0	0.00%
High Elevation Open Spotted Gum	-	425504	425876	-373	-0.09%	426233	-729	-0.17%	426944	-1441	-0.34%	427941	-2437	-0.57%
Ironbark	-	54666	54978	-313	-0.57%	55336	-670	-1.23%	55714	-1048	-1.92%	56303	-1638	-3.00%
Lowland Red Gum	-	438761	443798	-5037	-1.15%	449226	-10466	-2.39%	457215	-18454	-4.21%	467912	-29151	-6.64%
Lowlands Scribbly Gum	Vulnerable	32035	32324	-289	-0.90%	32543	-508	-1.58%	32926	-891	-2.78%	33370	-1335	-4.17%
Lowlands Spotted Gum-Box	-	155776	156203	-427	-0.27%	156667	-891	-0.57%	157511	-1734	-1.11%	158769	-2993	-1.92%
Coastal Mallee	Vulnerable	12404	12516	-111	-0.90%	12558	-154	-1.24%	12595	-191	-1.54%	12630	-226	-1.82%
Mangrove	Rare	3954	3963	-9	-0.24%	3967	-13	-0.33%	3967	-13	-0.33%	3967	-13	-0.33%
Moist Foothills Spotted Gum	-	307799	307917	-118	-0.04%	308043	-244	-0.08%	308301	-502	-0.16%	308538	-738	-0.24%

Northern Moist Blackbutt	-	86996	87138	-142	-0.16%	87303	-306	-0.35%	87630	-634	-0.73%	88148	-1151	-1.32%
Natural Grassland	Rare	2701	2703	-2	-0.07%	2704	-3	-0.12%	2708	-7	-0.25%	2940	-239	-8.86%
Needlebark Stringybark-Large Fruited Blackbutt	-	95474	97354	-1881	-1.97%	98946	-3473	-3.64%	102436	-6963	-7.29%	106235	-10761	-11.27%
New England Stringybark-Blakelys Red Gum	-	10666	10694	-29	-0.27%	10891	-226	-2.12%	11149	-483	-4.53%	11337	-671	-6.29%
Northern Grassy Sydney Blue Gum	Vulnerable	28564	28564	0	0.00%	28564	0	0.00%	28564	0	0.00%	28564	0	0.00%
Northern Open Grassy Blackbutt	-	188758	191155	-2398	-1.27%	193591	-4833	-2.56%	197419	-8662	-4.59%	202423	-13666	-7.24%
Northern Ranges Dry Tallowwood	-	196084	196144	-59	-0.03%	196195	-111	-0.06%	196327	-243	-0.12%	196523	-438	-0.22%
Northern Wet Brushbox	-	105321	105329	-8	-0.01%	105329	-8	-0.01%	105332	-11	-0.01%	105332	-11	-0.01%
Northern Wet Tallowwood-Blue Gum	-	146465	146473	-8	-0.01%	146493	-28	-0.02%	146515	-50	-0.03%	146536	-71	-0.05%
Open Coastal Brushbox	-	34403	34749	-347	-1.01%	35036	-634	-1.84%	35839	-1436	-4.17%	36542	-2139	-6.22%
Open Shrubby Brushbox-Tallowwood	-	96629	96636	-7	-0.01%	96636	-7	-0.01%	96645	-16	-0.02%	96667	-38	-0.04%
Paperbark	Vulnerable	224048	226093	-2045	-0.91%	228393	-4345	-1.94%	231013	-6965	-3.11%	234639	-10592	-4.73%
Red Bloodwood	Rare	2073	2073	0	-0.00%	2088	-16	-0.75%	2114	-41	-1.99%	2114	-41	-1.99%
Red Mahogany	-	12507	12530	-23	-0.18%	12531	-24	-0.19%	12591	-84	-0.67%	12621	-114	-0.91%
Richmond Range Spotted Gum	-	164150	164252	-102	-0.06%	164376	-226	-0.14%	164597	-447	-0.27%	164789	-639	-0.39%
Richmond Range Spotted Gum-Box	-	171969	172008	-39	-0.02%	172024	-55	-0.03%	172037	-68	-0.04%	172061	-92	-0.05%
River Oak	Vulnerable	8240	8269	-29	-0.36%	8280	-40	-0.49%	8344	-104	-1.26%	8437	-197	-2.39%
Rough-barked Apples	Vulnerable	13963	13999	-37	-0.26%	14065	-103	-0.73%	14106	-143	-1.03%	14198	-236	-1.69%
Saltbush	Rare	94	108	-13	13.91%	109	-15	15.89%	109	-15	-15.89%	109	-15	-15.89%
Sandstone Spotted Gum-	-	38696	38988	-292	-0.75%	39318	-623	-1.61%	39664	-968	-2.50%	40113	-1418	-3.66%

Blackbutt														
Sherwood Needlebark Stringybark	-	82486	83684	-1199	-1.45%	85059	-2574	-3.12%	87958	-5472	-6.63%	92694	-10208	-12.38%
South Coast Tallowwood-Blue Gum	-	25689	25734	-44	-0.17%	25876	-186	-0.73%	26123	-433	-1.69%	26416	-727	-2.83%
Stringybark-Apple	-	50442	50473	-31	-0.06%	50509	-68	-0.13%	50575	-133	-0.26%	50666	-224	-0.44%
Swamp	Endangered	115692	117709	-2017	-1.74%	118806	-3114	-2.69%	119847	-4155	-3.59%	120778	-5086	-4.40%
Swamp Mahogany	Rare	3506	3516	-9	-0.27%	3516	-9	-0.27%	3516	-9	-0.27%	3516	-9	-0.27%
Swamp Oak	Rare	19461	19735	-274	-1.41%	19903	-442	-2.27%	20139	-679	-3.49%	20327	-866	-4.45%
Sydney Peppermint-Stringybark	Rare	2045	2045	0	0.00%	2045	0	0.00%	2045	0	0.00%	2045	0	0.00%
Tallowwood	-	35629	35648	-19	-0.05%	35648	-19	-0.05%	35689	-60	-0.17%	35698	-68	-0.19%
Turpentine	-	24700	25036	-336	-1.36%	25283	-583	-2.36%	25633	-933	-3.78%	26204	-1504	-6.09%
Wattle	-	7831	8007	-176	-2.24%	8138	-306	-3.91%	8362	-531	-6.78%	8560	-729	-9.31%
Wet Bloodwood-Tallowwood	-	256767	257186	-419	-0.16%	257647	-880	-0.34%	258401	-1634	-0.64%	259503	-2736	-1.07%
Wet Coastal Tallowwood-Brushbox	-	15263	15613	-351	-2.30%	15886	-623	-4.08%	16494	-1231	-8.07%	16807	-1544	-10.12%
Wet Flooded Gum-Tallowwood	-	53986	54594	-608	-1.13%	55075	-1089	-2.02%	55851	-1865	-3.45%	57091	-3106	-5.75%
Wet Foothills Blackbutt-Turpentine	-	10141	10141	0	0.00%	10164	-23	-0.22%	10209	-68	-0.67%	10263	-122	-1.20%
Forestry Plantations	0	103246	103366	-119	-0.12%	103386	-140	-0.14%	103396	-149	-0.14%	103399	-153	-0.15%
Improved Pasture and Cropland	0	5072	5084	-12	-0.23%	5084	-12	-0.23%	5084	-12	-0.23%	5084	-12	-0.23%
Introduced Scrub	0	9891	9903	-12	-0.12%	9910	-19	-0.19%	9951	-60	-0.61%	9994	-103	-1.04%
Rainforest	Endangered	1116406	1117851	-1445	-0.13%	1118948	-2541	-0.23%	1120597	-4191	-0.38%	1123939	-7533	-0.67%
Scrub	Vulnerable	42023	42418	-396	-0.94%	42607	-584	-1.39%	42747	-724	-1.72%	42864	-841	-2.00%
Cleared-Partially Cleared	0	31181	31215	-34	-0.11%	31244	-63	-0.20%	31289	-108	-0.35%	31378	-197	-0.63%
Camphor Laurel	0	61588	63900	-2312	-3.75%	65546	-3958	-6.43%	67535	-5947	-9.66%	69797	-8209	-13.33%

The spatial shift in urban development caused the extent of the classified vulnerable eastern red gum class to be reduced by 1.58%. This class had not been impacted in previous scenarios. However, the Dunn's white gum which had been affected in the minimal constraints version of the coastal protection scenarios was not impacted in this scenario variation.

Proportionally, approximately 15% of the saltbush, dry grass tallwood and banksia classes became urbanised. The largest change in area was in the Clarence lowlands spotted gum (5426 hectares) and dry heathy blackwood-bloodwood (3492 hectares) classes. Bailey's stringybark and lowland red gum were also both reduced by approximately 2900 hectares. In comparison to other scenarios these represent large losses for any one vegetation class and mirror large impact on the forest class that occurred within this scenario variation.

Overall, 4559 hectares of rare, vulnerable and endangered vegetation types were converted to urban, including 1100 hectares of lowland grey box and 1059 hectares of paperbark.

9.4 SUMMARY

These scenarios, and variations, show alternatives to the problem of balancing conflicting land uses by shifting population growth into other areas. By generating scenarios with differing constraints it was possible to represent a 'business as usual' approach regarding restrictions to development and allow the singular concept of shifting the growth of future urban development to be visualised and areas impacted calculated. By applying the agricultural and environmental constraints of Chapter 8 this design approach was expanded to allow for the protection of both agricultural productivity and the region's environmental heritage.