

“Learn From Yesterday, Live For Today, Hope For Tomorrow”

Attempting to plan for coastal change in South West Victoria

Murray Herron
Deakin University
herron_murray@yahoo.com

David Jones
Deakin University
david.jones@deakin.edu.au

John Rollo
Deakin University
john.rollo@deakin.edu.au

“Learn from yesterday, live for today hope for tomorrow.” When Albert Einstein penned these opening words, the realm of planning was least on his mind despite the aptness of the thoughts. This paper, having regard to this quotation, questions whether demographic change in one coastal area is occurring at a faster rate than in non-coastal areas? The South West coastal area of Victoria, from 1981 onwards, has witnessed a dramatic increase in population and also major shifts in the social and economic characteristics of the region. What have been the historic demographic and employment characteristics of the area and has there been a shift in these characteristics leading to the rapid population growth?

These questions are considered using the City of Warrnambool, the largest urban centre in South West Victoria, as a study vehicle. The impact of a growing population on the municipal landscape can be demanding in terms of land use planning, land supply and the urban design.

This paper will review the population growth using a shift share analysis method compared against overall growth patterns in the Victorian state population and Australia overall. It will then examine government population forecasts for the City of Warrnambool and suggest those impacts upon the current City of Warrnambool landscape.

Keywords: coastal planning; urban design; South-Western Victoria

Overview

This paper begins with a brief historic overview of the City of Warrnambool followed by review of demography in coastal Victoria, land use planning in South West Victoria and the changing economic landscape in the area.

The second part of this paper looks forward to determine the future environmental and economic sustainability of Warrnambool.

Research Introduction and Methodology

The Australian coast and its thousands of beaches have an iconic status in the Australian culture and way of life. Most Australians live on or near the coast where there is continuing population and development pressure, particularly along non-metropolitan coastlines. (Victorian Coastal Strategy, 2006)

Australia reflects the rest of the world's love affair towards living near or on the coast. Agenda 21 (17.3) stated that in 1992 more than half of the world's population lived within 60 km of the coast, and that by the year 2020 this proportion could rise to two thirds. Hinrichsen (1998) quotes a figure of 3.2 billion people living within 200 km of the coast, on about 10% of the Earth's land area, and two thirds of the world's population already living within 400 km of the coast.

In addition to populating the coast, humans are highly dependent on coastal resources. (Victorian Coastal Strategy, 2006) Although the coastal ocean accounts for only 8% of the global ocean surface and less than 0.5% of its volume, it accounts for about 14% of its production; up to 50% of its gentrification; up to 80% of global organic matter burial; 90% of global sedimentary mineralisation; 75 to 90% of the global sink of suspended river load and associated elements/pollutants; in excess of 50% of present-day global carbonate deposition; and approximately 90% of the world's fish catch (Pernetta & Milliman 1995, p 16).

As Albert Einstein once said, "Learn from yesterday, live for today, hope for tomorrow:"

Since the 1990's Australia and its respective states have done extensive reviews into policy relevant legislation and strategies. The proposed research will review the past 60 plus years of land use activity as a precursor to looking forward to the year 2100. What will the coastline look like? What will be the land use activities and patterns and how will those patterns differ from what currently exists?

What is the future for Australia's and more specifically South West Victoria's coastline? Will there be hope for the South Western Victoria coastline? This study will shed some light on the usually cloudy and ever changing coastal landscape.

In the past ten years only 32 theses (Appendix A) have dealt with coastal planning issues around the world. This figure was obtained by doing a search on the Proquest dissertation and thesis database using variants of the search phrase 'coastal planning'. The search was further refined to determine what if any thesis had looked at the Victorian coastal planning and land using planning in general. The redefined search was unable to identify any relevant work.

The State Government of Victoria through its Victorian Coastal Strategy (VCS) set a long term vision for the Victorian coastline. The vision and strategy was in response to three issues facing the Victorian coastline namely:

- Climate change which will result in impacts on the coast including rising sea levels;
- Rapid population growth in coastal areas; and,
- The health of the marine environment.

The strategy was to provide policies, frameworks, coastal action and management plans as well as being a guide for decisions makers. The VCS provides a broad brush approach to coastal management but does not go in detailed analysis of any coastal region. As a strategic planner in a coastal south west Victorian shire coastal planning issues we experienced continual pressure to allow developments in environmental sensitive areas. One of the great deficiencies coastal planners in south west Victoria experienced was the lack of data or studies directly relating to the region.

The research explained in this paper provides a platform of knowledge which will allow planners to make better informed coastal planning decisions. To undertake a research project of this complexity a multi-step methodology was devised. The methodology had to take into account the following

Undertake Literature Search

Review all relevant literature on coastal / land use planning; sea level rise; climate change and its effect on coastal regions; Victorian demographic and economic development.

Determine Coastal movement

The steps in this process include:

1. Data acquisition and conversion of suitable data into a usable digital format
2. Load newly established digital data into the Digital Shoreline Analysis System
3. Develop a series of orthogonal transects or baselines illustrating where the respective relevant coastline line is at a certain point in time.
4. Run comparison of the different baselines to establish a time line series of actual coastline movements

Figure 1 highlights the digital data conversion process which transforms paper maps into digital maps which can be analysed through the GIS.

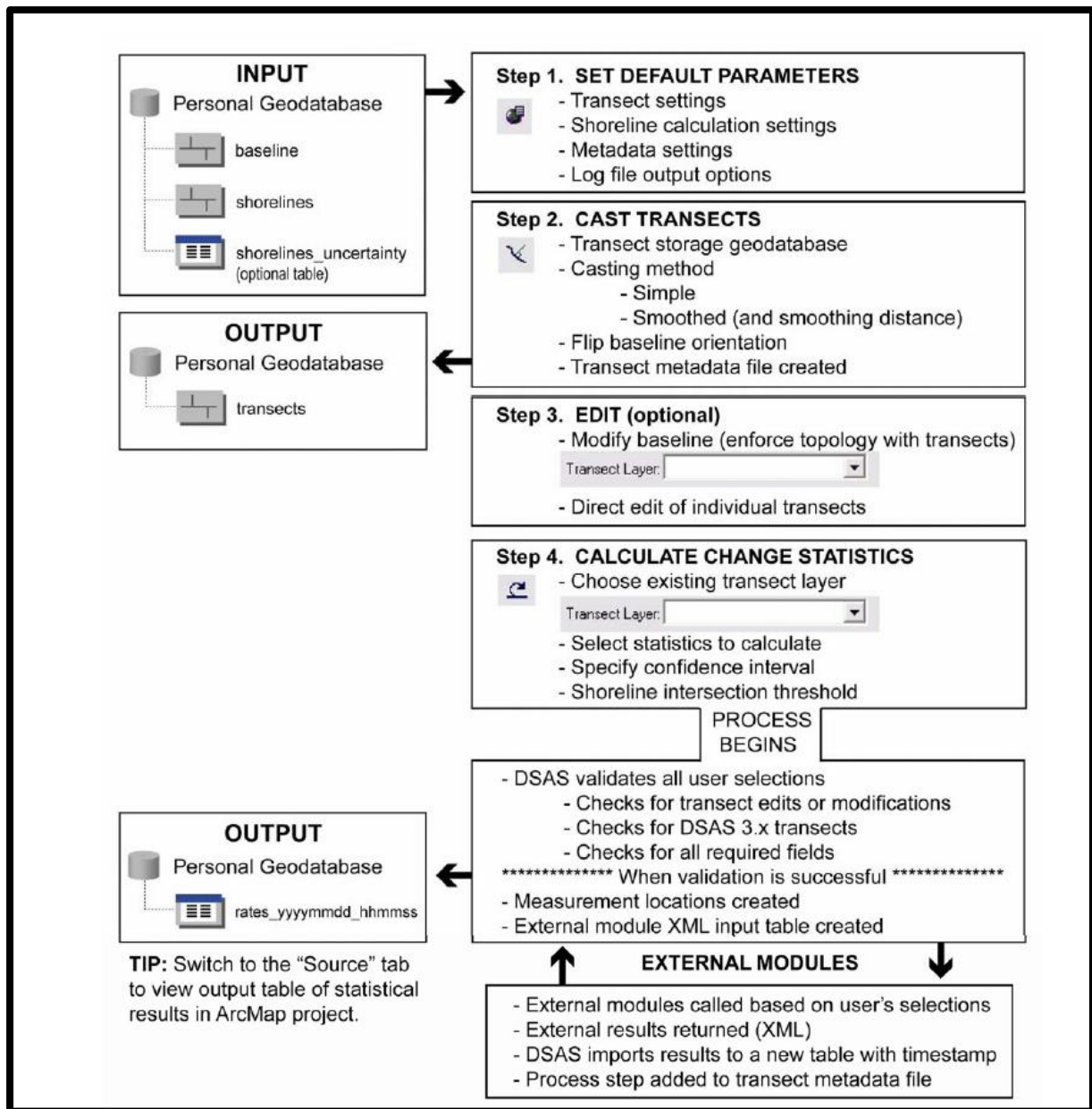


Figure 1: Digital Data Conversion Process for Estimating Coastal Change. Source : (U.S. Department of the Interior U.S. Geological Survey 2012).

Once the paper data was transformed into a digital database it was loaded into GIS. GIS uses a variety of models and supplemental programs. These programs include the Digital Shoreline Analysis System (DSAS) and Community Vis which is a land use planning software attachment to ESRI ArcView GIS software platform. Figure 2 is a schematic of the Land Use model that was developed for this study. As illustrated by the schematic, spatial data was processed through a matrix which examined the probability and validity of each of the data sets and set a priority relating to scenario development. Each scenario was then ranked by priority and land rezoned in accordance to the scenario.

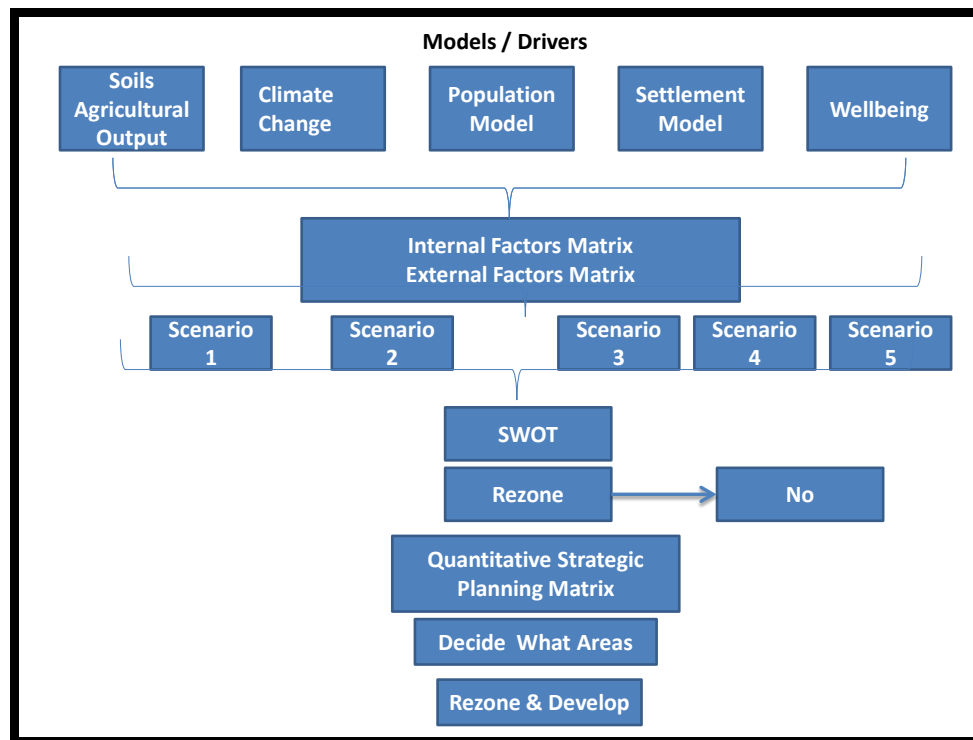


Figure 2: Schematic of Land Use Model. Source:(Herron, M 2012).

The analyses listed below indicate the area and type of specialization that were undertaken during this research.

- **GIS Analysis:** Load the study area current cadastre, demographic, environmental and climate data and do the analysis. Use population and climate projections and model those out to 2050; Undertake the following analyses on the projected following categories
- **Population:** Population Density; Employment and Employment Density; Composite residential/non-residential population
- **Land Use:** Single-family units; Multifamily units; non-residential density; retail square feet ; office square feet, other non-residential square feet; average lot size; open space use mix (residential vs. non-residential); open space by type (spot parks, regional parks, trails, preserves); residential density; retail/service floor space
- **Environment and Climate Change:** Buildings in 100-year floodplain; Buildings in 50-year floodplain; Buildings in environmentally sensitive areas; Open space percentage.
- **Transportation:** Vehicle miles travelled (VMT); VMT per capita; Sidewalk ratio; Bicycle trail density; Walkability; Households served by transit; Average distance to transit (residential)
- The statistical methodology and software to be used in the analysis includes:
 - **Descriptive Statistics:** Frequencies; Cross tabulations
 - **Compare Means:** T Test; One way ANOVA
 - **Correlation:** Bivariate
 - **Regression:** Linear
 - **Non Parametric Test:** Chi-square analysis

Introduction to Warrnambool

Warrnambool like the majority of early settlements in colonial Australia was developed using the colonial/imperial grid model. This planning model contained eight key features (Home 1997) including:

- A policy of deliberate urbanization or town planning, in preference to dispersed settlement;
- Land rights allocated in a combination of town, suburban and country lots;
- The town planned and laid out in advance of settlement;
- Wide streets laid out in geometric, usually grid form, on an area of one square mile;
- Public squares;
- Standard-sized rectangular plots, spacious in comparison with those in British towns of the time;
- Some plots reserved for public purposes; and
- A physical distinction between town and country usually by a common land or an encircling green belt

Warrnambool was first incorporated as a municipality in 1855 and by 1863 became a shire and in 1883 graduated to town status. The early development of Warrnambool can be explained using several planning theories. These include the Concentric Theory which describes community growth patterns in terms of five concentric rings, the Radial Sector Theory which provides an explanation of how Warrnambool developed following the major transport routes and Multi Nuclei Theory which provides any understanding into how and why Warrnambool growth can be attributed to the effects of several locations in the Warrnambool area.

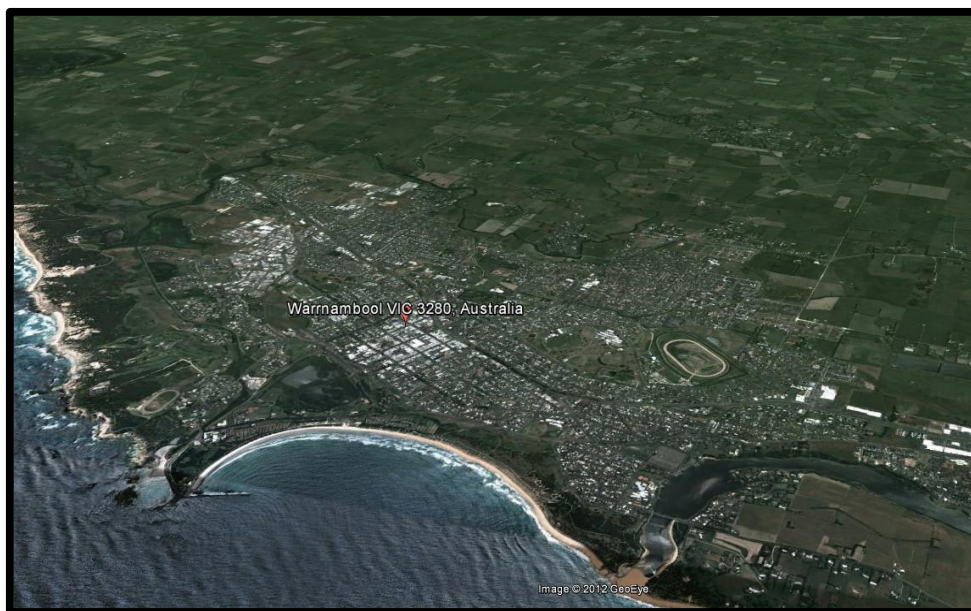


Figure 3: City of Warrnambool aerial view. Source: (Google Earth 2012),

Warrnambool's structural and organizational changes have continued from 1883 to the present. Warrnambool reached city status in 1918 expanding its boundaries through the 1950's into the 1970's.

The urban parts of the Shire of Warrnambool in 1918 became the City of Warrnambool whilst the rural portions remained in the Shire of Warrnambool. The City of Warrnambool grew in size by annexing land from the Shire of Warrnambool in 1955 and in 1978. The present City of Warrnambool with current boundaries officially came into being on September 1994. Warrnambool is the largest settlement in South West Victoria with a population of 32,000. Warrnambool is the administrative, educational and commercial centre for South West Victoria.

Historic Demography

The population of Warrnambool has grown at a steady rate since its inception. For the purpose of this discussion 1947 has been selected as the first year of demographic analysis. This year selected as it was the first modern census conducted after WW II.

Table 1 shows the Warrnambool Population Profiles from 1947 to 2010. Double digit population growth occurred during the following time periods 1961-1966; 1966 -1971 and 1996-2001 as illustrated by Table 1. As indicated in Table 1 the 2010 population of Warrnambool (ABS Census 2010) was 32,028 while the population of Australia was 21,507,719. From 1947 to 2010 Australia's population grew 183.76 % (13,928,356 / 7,579,358) and Warrnambool grew by 221.79 % (22035 / 9993) indicating that Warrnambool excided the 63 year Australian population growth pattern (1947 to 2010). The Warrnambool growth rate was similar o other coastal regions in Australia.

To highlight the changing demographic pattern from 1947 through 2010 the census was re-arranged into 4 age categories (0-14; 25-54; 45+ and 65+).

The rationale for recoding the data into the four nominated age categories was based on the premise the four age categories have a particular importance to current and future land use planning.

The under 15 years of age category represents current and future school children and this group also represents the potential demand for day care and education facilities.

The second group is 25- 54 age group. This group represents the largest group of potential and current home owners and rate payers for local government. This group traditionally pays the majority of local government rates and fees.

The third group is the 45 years of age and older group. This group represents the long term demand for old age services.

The fourth group is the 65 year of age and older group which represents the current and immediate future demand for old age community services such as meals on wheels, senior citizens housing, home nursing.

Table 1: Australia/Warrnambool Population 1947-2010. Source:(Australian Bureau of Statistics 1954, 1966, 1971, 1976, 1981, 1986, 1991, 1996; Australian Bureau of Statistics 1947, 1961, 2000, 2006, 2010, 2012).

Year	Australia	Population change between census	% change between census	Warrnambool	Population change between census	% change between census
1947	7579358	0	0	9993	0	0
1954	8986530	1407172	18.56	10850	857	9%
1961	10508186	1521656	16.93	15762	4912	45%
1966	11550462	1042276	9.99	17499	1737	11%
1971	12755638	1205176	10.43	18684	1185	7%
1976	13548445	792802	6.21	20195	1511	8%
1981	14576330	1027885	7.58	21414	1219	6%
1986	15602156	1025826	7.03	22868	1454	7%
1991	16850540	1248384	8.00	23946	1078	5%
1996	17892423	1041883	6.18	26777	2831	12%
2001	18972350	1079927	6.03	26842	65	0%
2006	19853288	882938	4.65	28149	1307	5%
2010	21507719	1652431	8.32	32028	3879	13.7%
		13,928,356			22,035	

Table 2: Australia /Warrnambool Population in Four Age Classes 1947-2010. Source:(Australian Bureau of Statistics 1947, 2010).

Age Class	Australia 1947	Australia 2010	Persons Increased	% Change	W'bool 1947	W'bool 2010	Persons Increase	% Change
0-14	1,899,053	4,144,021	2,244,968	118.82%	2527	5736	3209	126.99%
25-54	3,117,414	8,981,581	5,864,167	188.11%	3994	11086	7092	177.57%
45+	2,202,937	8,467,191	6,264,254	284.36%	2916	12243	9327	319.86%
65+	604,897	3,012,283	2,407,386	397.98%	920	6937	6017	654.02%

As shown in Table 2 the growth rate for two Warrnambool age groups i.e. (45+ and 65+) are significantly higher than their Australian counterparts. Warrnambool has become a retirement destination, with forecasts indicating that this trend for these population segments (45+ and 65+) will continue to increase in overall number and percentage.

Historic Land Use Planning

The City of Warrnambool and its surrounding area represents an area of 43.5 Square Kilometres. The Victorian Department of Primary Industry has identified 61 distinct land use activities or categories with in Warrnambool ranging from residential developments, industrial sites, commercial premises, factories, universities sites, hospitals and infrastructure/transportation facilities. To regulate this activity and development Warrnambool has at its disposal 25 planning zones and 488 planning overlays. Warrnambool has been a centre for manufacturing (textiles), primary industry (dairying

and food processing), service industries (government services), health and education (primary, secondary and tertiary). Changes in employment patterns have resulted in changes in land use.

Warrnambool has seen its land dedicated to open space i.e. parkland (municipal parks; gardens; and reserves/sporting reserves) decrease with Warrnambool having a total of 1572.54 HA for the city which represents 0.04 HA per resident. This figure when compared to other South West settlements such as Portland which has 229.78 HA (i.e. 0.0229 HA per resident) or Port Fairy which has 363.86HA (i.e.0.129 HA per resident) indicates that Warrnambool lies midpoint between the Port Fairy and Portland allocation of public space.

Warrnambool has a land budget which contains a 10 year supply of vacant land for future residential, commercial or industrial expansion. For the Period 2006 through 2011 (Table 3) 1,223 private dwelling were constructed in Warrnambool

Table 3: Dwelling Structure in Warrnambool 2006- 2011. Source:(City of Warrnambool 2010).

Dwelling structure							
Warrnambool City	2011			2006			Change
Dwelling type	Number	%	Regional VIC	Number	%	Regional VIC	2006 to 2011
Separate house	11,150	80.0	87.8	9,887	77.8	87.8	+1,263
Medium density	2,468	17.7	10.4	2,501	19.7	10.3	-33
High density	130	0.9	0.3	88	0.7	0.2	+42
Caravans, cabin, houseboat	114	0.8	1.0	82	0.6	1.1	+32
Other	69	0.5	0.4	96	0.8	0.6	-27
Not stated	0	0.0	0.1	54	0.4	0.0	-54
Total Private Dwellings	13,931	100.	100.0	12,708	100.	100.0	+1,223

Figure 2 shows the growth in the Warrnambool residential housing market from 2006 through 2011.

The preferred residential option in Warrnambool is the separate house which played the dominant role in residential expansion from 2006 through 2011.

The Warrnambool land budget for the period 2011 through 2016 predicts a deficiency of 847 lots. This figure represents the number of new lots that need to be created to meet the additional residential demand.

Historic Economics Development Patterns

The employment and industrial characteristics of South West Victoria have been recorded by the Australian government since 1901. The employment characteristics and pattern of a region reflect the land use activities which are conducted in the area.

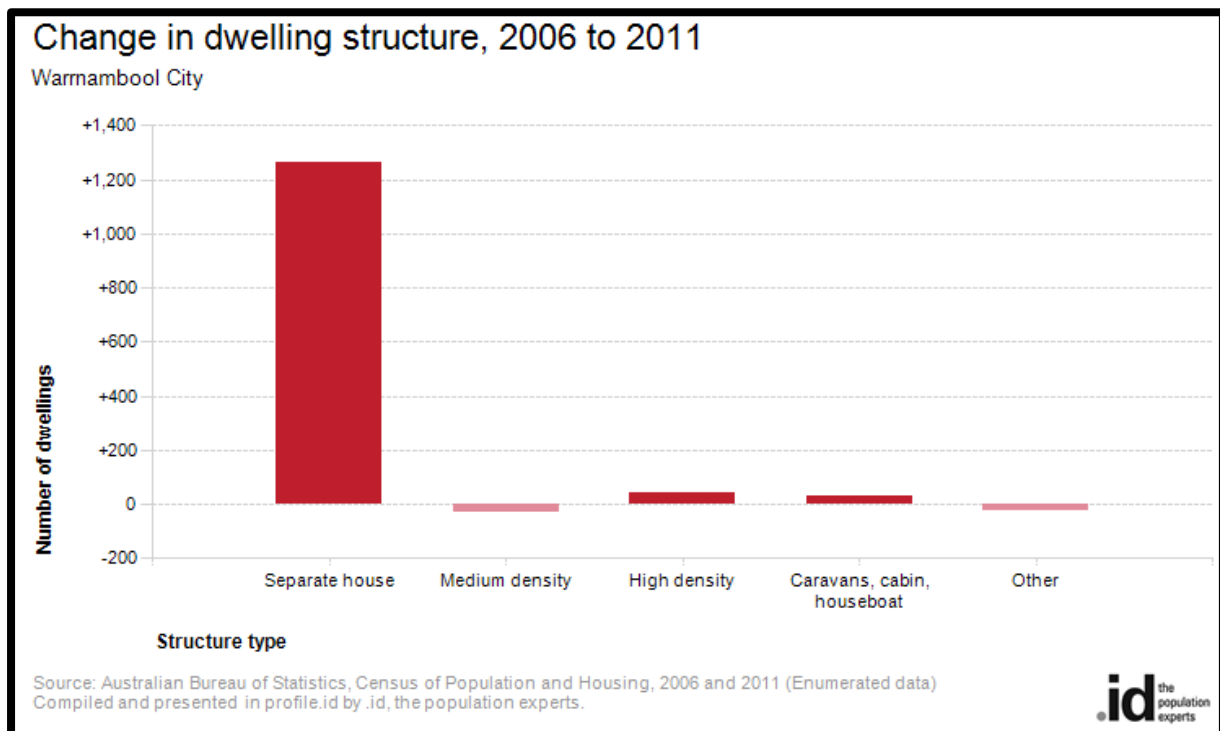


Figure 1: Growth Pattern in Warrnambool Residential Dwelling Market 2006-2011. Source:(ID Consulting 2013).

In 1947 The ABS has 12 categories (i.e.) Primary Production; (7 sub-classes) Mining; Manufacturing (5 sub-classes); Building and Construction (7 sub-classes); Transport; Communication; Finance and Property; Commerce; Public Authority; Amusement / Hotels Personal services etc; and two categories for industry which are not contained in the preceding nine categories.

The 2010 census has 20 categories (i.e.) Agriculture, Forestry and Fishing; Mining; Manufacturing; Electricity, Gas, Water and Water Services; Construction; Wholesale Trade; Retail Trade; Accommodation and Food Service; Transport; Information Media and Telecommunication; Financial and Insurance Services; Rental Hiring and Insurance Services; Professional, Scientific and Technical Services; Administrative and Support Services; Public Administration and Safety; Education and Training; Health Care and Social Assistance; Arts and Recreation Services; Other Services and one category which consolidates all non identified industrial or service categories.)

The different number of industrial and service categories i.e. 12 in 1947 and 20 in 2010 makes a comparative analysis difficult. To do a comparative analysis between 1947 though 2010 nine categories from the 2010 census were transposed and included into the most likely 1947 categories. The transpositions were:

2010	To 1947
Education and training	Public authority (N.E.I.) and Professional Activities
Public Safety and Safety	Public authority (N.E.I.) and Professional Activities
Health Care and Social Assistance	Public authority (N.E.I.) and Professional Activities
Professional , Scientific and Technical Services	Public authority (N.E.I.) and Professional Activities
Electricity Gas, Water and Water Services	Manufacturing
Retail & Wholesale Services	Commerce
Rental hiring	Commerce
Arts& Recreational services	Amusement, Hotels, Personal Services
Administrative & Support Services	Amusement, Hotels, Personal Services

Table 4 is a comparison of labour employment rates over thirteen industry categories. The results include total and percentage increases in 12 employment categories including primary production in Warrnambool. As stated earlier Warrnambool is an agricultural centre and the rise in employment is contrasted with the net reduction in Australia for workers in primary industry.

In 1947 the Warrnambool area had a 27.0 % female labour participation rate (1134 /4198) as opposed to the 1947 Victorian female labour participation rate of 18% (i.e. 217,425 out of a working population of 1,207,830). The overall Victorian female participation in the labour force recorded an annual 6.99% growth rate over the 63 year period (1947-2010).

In 1947, the overall Australian female labour participation rate was 22.41% (717,132 out of a working population of 3,200,351). The overall Australian female participation in the labour force recorded an annual 8.79% growth rate over the 63 year period (1947-2010).

The 2010 overall female participation rate for study Warrnambool is 47.15% of the labour force as compared with 46.65% for Victoria and 46.64% for Australia.

The employment category with the great growth in employee numbers and percentage was the Public authority and Professional Activities sector.

Table 4: Warrnambool Employment Classes 1947-2010. Source:(Australian Bureau of Statistics 1947, 2010).

	1947	2010	Dif	%	1947	2010	Diff	%
	Australia	Australia			W'bool	W'bool		
Primary Production	498,019	249,829	-248,190	-49.84%	142	263	121	85.21%
Mining	54,391	176,562	122,171	224.62%	3	55	52	1733.33%
Manufacturing	829,800	1,018,440	188,640	22.73%	1388	1587	199	14.34%
Building and Construction	232,433	828,910	596,477	256.62%	409	1195	786	192.18%
Transportation and Storage	246,376	479,182	232,806	94.49%	246	495	249	101.22%
Communications	49,191	178,189	128,998	262.24%	58	166	108	186.21%
Finance and Property	73,711	536,204	462,493	627.44%	108	483	375	347.22%
Commerce	405,519	1,461,111	1,055,592	260.31%	5015	2888	-2127	-42.41%
Public Authority and Professional Activities	429,811	3,543,619	3,113,808	724.46%	400	4561	4161	1040.25%
Amusement, hotels, cafes Personal Services	225,566	974,117	748,551	331.85%	406	1236	830	204.43%
Other and Inadequately Defined Industries	108,175	378,277	270,102	249.69%	123	475	352	286.18%
Industry not Stated	124,439	233,885	109,446	87.95%	211	317	106	50.24%
Persons not in Work Force			0			0	0	
Total	3,277,431	10,058,325	6,780,894	206.90%	8509	13,721	5212	61.25%

The economic growth of the study area was subjected to a Shift Share Analysis (Barff, 2008). Shift Share analysis decomposes employment growth (or decline) in a region over a given time period into three components:

1. an Australian growth effect, which is that part of the change in total employment in the study area ascribed to the rate of growth of employment in Australia as a whole,
2. an industry mix effect, which is the amount of change the study area would have experienced had each of its industries grown at the Australian rate, less the Australian growth effect, and
3. a regional shift, which is the difference between the actual change in employment and the employment change to be expected if each industrial sector grew at the Australian rate.

The mathematical formula to describe Shift Share analysis is (Source Wikipedia 2013):

$$e_i^{t+n} - e_i^t = \text{share change} + \text{mix change} + \text{shift change}$$

$$e_i^{t+n} - e_i^t = e_i^t \left[\frac{E^{t+n}}{E^t} - 1 \right] + e_i^t \left[\frac{E_i^{t+n}}{E_i^t} - \frac{E^{t+n}}{E^t} \right] + e_i^t \left[\frac{e_i^{t+n}}{e_i^t} - \frac{E_i^{t+n}}{E_i^t} \right]$$

The same twenty industries were compared from 2000 through 2010. Table 5 shows the employment growth by major industry group in the study area from 2000 through 2010. Under the heading Actual Growth are two columns that report percentage and net change in total number of jobs for each industry category. Over the period 2000-2010 a net total of 1409 jobs were added to the study area economy, amounting to an increase of 11.44%. They show the changes in the study area economy that would have occurred over 2000-2010 had each industry grown at the same rate

as its Australian counterpart. The standardized “percent” growth column identifies the growth rate for each industry on an Australian basis, while the standardized “net” growth simulates the result net changes in employment in the study area. The data not only allows one to directly compare the study area with Australian industry employment growth rates, they also translate Australian industry growth rates into hypothetically comparable changes in employment in the study area. (Smith, 2009)

Standardized Employment for 2010 is the resulting level of employment in each industry for the study area had each grown at the same rate as its Australia counterpart since 2000. This presents a hypothetical profile of the industry composition and level of local employment that would have occurred had the study area directly followed Australian industry trends. (Smith, 2009)

The Australian growth component in the first source of change is the growth or contraction in the Australian economy, During the time period 2000 to 2010, Australia grew by 21.2% (i.e. Australia employment in 2001 and 2010 was 8.298 million and 10.058 million, respectively. The growth rate is therefore $(10.058 - 8.298) / 8.298 = 21.2\%$.

This growth rate is listed in Table 5 as the Australian growth component. The effect of the Australian growth component is felt most acutely during the peaks and valleys of the business cycle, i.e. during recessions and boom times.

The Industrial Mix Component which is the second aspect of Shift Share analysis provides an insight into these growing sectors. This component is found by calculating the percent growth rate for an economic sector at the Australian level and subtracting from it the Australian growth component. The industrial mix component measures how well an industry has grown, net of effects from the business cycle.

The third and final component of Shift Share Analysis is called the Regional Shift. It is the remaining employment change that is left over after accounting for the Australian and industrial mix components. If a sector’s competitive share is positive, then the sector has a local advantage in promoting employment growth

Results for the study area may be highlighted as the following:

Study Area Growth =	Australian Growth +	Industrial Mix -	Regional Shift
1409 jobs	2611 jobs	-969 jobs	-232 jobs

The industries in the study area that are shown to have a local advantage are:

▪ Construction	▪ Electricity, gas water & waste services	▪ Transport
▪ Health Care	▪ Accommodation & food Services	▪ Education
▪ Rental	▪ Public Administration	▪ Technical Services

Table 5: Warrnambool Shift Sear Analysis 2001-2010. Source:(Australian Bureau of Statistics 2000, 2010).

	2001-2010	Warrnambool		Warrnambool		Australia		Australia		Warrnambool		Total	Expected	Differential (local)	Industry mix
	Australian Growth Rate	Employment	Employment	Employment	Employment	Employment	Employment	Employment	Employment	Employment	Employment	Employment	Employment	Effect	Effect
		2001	2010	Change %	2001	2010	Change %	2001	2010	Change %	2001	2010	Change %		
Agriculture, forestry & fishing	21.20%	354	263	-91	-25.71%	330782	249828	-80954	-24.47%	429	-166	267	-4	-162	
Mining	21.20%	12	55	43	358.33%	75178	176563	101385	134.86%	15	40	28	27	14	
Manufacturing	21.20%	1577	1385	-192	-12.18%	1010179	902829	-107350	-10.63%	1911	-526	1409	-24	-502	
Electricity, gas, water & waste services	21.20%	93	202	109	117.20%	60692	115611	54919	90.49%	113	89	177	25	64	
Construction	21.20%	918	1196	278	30.28%	558582	828910	270328	48.40%	1113	83	1362	-166	250	
Wholesale trade	21.20%	644	527	-117	-18.17%	437134	403801	-33333	-7.63%	781	-254	595	-68	-186	
Retail trade	21.20%	2341	1878	-463	-19.78%	1211332	1057310	-154022	-12.72%	2837	-959	2043	-165	-794	
Accommodation & food services	21.20%	755	1236	481	63.71%	410589	650397	239808	58.41%	915	321	1196	40	281	
Transport, postal & warehousing	21.20%	355	495	140	39.44%	355874	479181	123307	34.65%	430	65	478	17	48	
Information media & telecommunications	21.20%	113	166	53	46.90%	148480	178190	29710	20.01%	137	29	136	30	-1	
Financial & insurance services	21.20%	294	310	16	5.44%	312396	377352	64956	20.79%	356	-46	355	-45	-1	
Rental, hiring & real estate services	21.20%	290	173	-117	-40.34%	120556	158853	38297	31.77%	351	-178	382	-209	31	
Professional, scientific & technical services	21.20%	291	528	237	81.44%	554055	730062	176007	31.77%	353	175	383	145	31	
Administrative & support services	21.20%	291	362	71	24.40%	245721	323779	78058	31.77%	353	9	383	-21	31	
Public administration & safety	21.20%	346	684	338	97.69%	369855	689931	320076	86.54%	419	265	645	39	226	
Education and training	21.20%	1082	1268	186	17.19%	595398	804418	209020	35.11%	1311	-43	1462	-194	150	
Health care & social assistance	21.20%	1613	2081	468	29.01%	806171	1167634	361463	44.84%	1955	126	2336	-255	381	
Arts & recreation services	21.20%	245	209	-36	-14.69%	202456	151574	-50882	-25.13%	297	-88	183	26	-114	
Other services	21.20%	433	475	42	9.70%	300658	378217	77559	25.80%	525	-50	545	-70	20	
Inadequately described	21.20%	265	228	-37	-13.96%	192519	233885	41366	21.49%	321	-93	322	-94	1	
Total		12312	13721	1409	11.44%	8298607	10058325	1759718	21.20%	14922	-1201	14923	-969	-232	

Part 2 How Sustainable is Warrnambool

A series of scenarios was developed to test the how sustainable the Warrnambool is. The scenarios involved:

- Forecasting future population growth and its impact on land and water supply, urban and open space density;
- The resulting increase or decrease in CO2 emissions generated by human activity; and
- Forecasting the changing economic and employment environment.

Scenario 1

Population increases

The state government has developed population forecasts for the period 2011 through to 2031 (i.e. 2011, 2016, 2021, 2026 and 2031).

Table 6: Forecast Population increases for Warrnambool. Source:(Victorian Department of Planning and Community Development 2012).

Town	Era	Forecast population increase	Year	Total Population	Increase
Warrnambool	2011-2016	8.17%	2016	36,988	2795
	2016-2021	6.56%	2021	39,416	2428
	2021-2026	5.90%	2026	41,740	2324
	2026-2031	5.26%	2031	43,934	2194

Land use and future land requirements

The Warrnambool land budget contains a 10 year supply of vacant land for future residential, commercial or industrial expansion. Table 3 indicates the number current of vacant lots per city; the number of lots needed to house the expected increase in population by area and the number of additional lots that will be required by 2031.

Table 7: Land Budget for expected housing growth. Source:(Herron 2012; Herron Murray 2013).

Location	Era	Expected Households	Lots Required for increased population	Surplus or Deficit of lots	Number of new lots required or created
Warrnambool	2011-2016	14,664	1285	Deficit	847
	2016-2021	15,904	1240	Deficit	2087
	2021-2026	17,063	1159	Deficit	3246
	2026-2031	18,158	1090	Deficit	4336

Warrnambool Sustainability

As shown in Table 3 Warrnambool has a chronic residential land shortage needing a predicted 4,400 lots to meet the expected population increase by 2031. To resolve this issue Warrnambool has several options at its disposal:

1. Developing more residential land by rezoning the last agricultural land in the city;
2. Decreasing lot size and increasing urban density; and/or
3. Working with the surrounding municipality to co-develop new residential areas adjoining Warrnambool and Port Fairy

Warrnambool is not sustainable in its current form. Residential density will increase from 913 individuals per square kilometre to 1253.82 in 2031 while open space density will decrease from 0.04 Ha per individual to 0.0346 Ha per individual. The density issue will need to take into consideration that the fastest growing segment in the Warrnambool population the 45+ and 65+ age groups.

Warrnambool consumed 475 ML of its total water allotment of 750ML in 2010 (i.e. 62%). The current water consumption per dwelling is 166 kilolitres per dwelling per year, using this figure and extrapolating it forward to 2031 water consumption would go up to 3,014,228 Kiloliters or 3014.228

ML which is over four times the entire current water allotment. This factor again brings into consideration whether or not Warrnambool is sustainable.

There is a solution Warrnambool currently has 4674 ML of recycled water at its disposal and to date has used not one drop of this resource, Warrnambool uses only 8.70% of its total water resources.

The Warrnambool Public Transport and bus system has the ability to expand to carry additional passenger and additional routes.

The Victorian State government believes the current and future economic growth of Warrnambool will

“focus on key industries where new investment is anticipated including dairying, energy and tourism with significant opportunities for further value-adding in major industries.”

“By 2031 the largest sectors in the economy are projected to be healthcare, agriculture, manufacturing and construction. Other high growth sectors will include retail trade, financial, professional and scientific services and accommodation. This highlights a shift from primary production to a more service-based economy and will require workforce changes and services to support skills development and productivity improvements. Employment in manufacturing is expected to decline between 2011 and 2031, with healthcare, retail trade, accommodation and food being the largest employers by 2031.” (Victorian Department of Planning and Community Development 2012, 2013)

Limiting this scenario is the ability to manage competing demands for agricultural land, particularly in the corridor from Warrnambool to Portland, including limiting urban encroachment into highly productive agricultural areas. The reduction of agricultural land for housing will impact on future agricultural production and overall economic returns.

With the forecast expansion of Warrnambool population CO2 emissions have been forecast to double by 2050. This factor will be compounded by the effects of Climate Change on the Warrnambool coastline and land scape. Warrnambool has developed an environmental strategy that focuses on coastal management, waterways and wetlands, pest plants and animals, flora and fauna protection, parks, reserves and public open space development , community awareness and involvement, water and energy efficiency, recycling and accountability. The question is will this program be sufficient to ensure that Warrnambool will still be sustainable and as liveable as it is today?

Summary

The continued sustainability of the three cities hinges on factors which are controlled by the cities themselves.

In Warrnambool’s case higher density limits and the use recycled water will ensure a sustainable future. For Port Fairy the major issue is flooding and coastal erosion both of which can be mitigated through coastal management.

Portland faces issues of economic sustainability and is the most vulnerable of the three settlements. Portland must foster and develop other industries beside the smelter and the economic exploitation of natural resources for its future prosperity.

The proposed water redevelopments will add to the landscape diversity for each of the three cities. The question of whether these developments will assist in improving the sustainability of these communities is still undecided

Appendix A: Inventory of Key Coastal Planning Dissertations

Abeyirigunawardena, DS 2010, 'Climate Variability and Change Impacts on Coastal Environmental Variables in British Columbia Canada', PhD thesis, University of Victoria.

Ahmad, SR 2009, 'GIS Based Analysis and Modelling with Empirical and Remotely-Sensed Data on Coastline Advance and Retreat ', PhD thesis, University of Windsor.

Alkema, R 2010, 'The rising tide: Adaptation to sea-level rise in Charlottetown, Prince Edward Island', Msc thesis, University of Guelph.

Allen, JS 2005, 'Policy and methodological implications of a coastal urban growth prediction model', PhD thesis, Clemson University.

Baccardax, AD 2010, 'Incorporating concerns of coastal stakeholders in planning and management: The case of St. Margaret's Bay', MA thesis, Dalhousie University

Batish, S 2010, 'Use of Landsat for Managing Coastal Ecosystems of the USVI ', PhD thesis, Ohio State University.

Belfiore, S 2005, ' Using Indicators for Improving the Performance of Integrated Coastal Management Efforts towards a Common Frameworks ', PhD thesis, University of Delaware.

Berke, PR 1981, 'Shoreline Resources Planning in the United States ', PhD thesis, Texas A & M University.

Bernhardt, SP 2010, 'Evaluating Florida's Coastal Protected Areas: A Model for coastal Management Plan Evaluation ', PhD thesis, Texas A & M University.

Charles, JD 2005, 'Perspectives on integrated coastal management in Halifax Regional Municipality', MA thesis, Dalhousie University.

Davis, B 2003, 'Area-based management frameworks in the United States coastal zone', PhD thesis, University of Rhode Island

Dos Santos Azevedo, MA 2000, 'A decision support system for Brevard County's barrier island system', PhD thesis, Florida Institute of Technology

Ex, L 2010, 'The State of Integrated Open Space Planning towards Landscape Integrity', MA thesis, Utah State University.

Gardiner, PC 1974, 'The Application of Decision Technology and Monte Carlo Simulation to Multiple Objective Policy Making A case in California Coastal zone Management', PhD thesis, USC.

Gray, AC 2009, 'Assessing coastal evolution by using GIS and remote sensing to model shoreline changes in Galveston over time and intense storm events', Msc thesis, Stephen F Austin University

Hardy, MH 2001, 'Simplified Integrated Transportation and Land Use Modelling to Support Metropolitan Planning Decisions: An Application and Assessment', PhD thesis, George Mason University.

Hart, DA 2000, 'Building a horizontally and vertically integrated coastal GIS using local government spatial data the case of coastal erosion hazards of the Lake Michigan coast of Wisconsin', PhD thesis, University of Wisconsin.

Hundley, CC 2008, 'A Comparative Assessment of Shoreline Change Policy Options in the United States ', PhD thesis, Clemson University.

Kaya, LG 2006, 'Critical Barriers to Rational Planning Processes for the Coastal Zone Management: the Case Study of Antalya, Turkey', PhD thesis, State University of New York

Kudu, R 2009, 'Multi-objective optimization model for macroscopic land allocation', PhD thesis, University of Colorado / Denver

Loucks, LA 2005, 'Coastal community based decision-making: Values for sustainable coastal zone management', MA thesis, St, Marys University.

Lovelace, PS 2009, 'Making decisions in coastal ecosystems', PhD thesis, East Carolina University.

Lu, KS 2001, 'A parcel GIS-based multinomial logistic model for destination land use prediction', Clemson University.

Moss, ML 1974, 'Urban Coastal Resource Management: Public Ownership and Leasing as a Development ', PhD thesis, USC.

Norris-Raynbird, C 2006, ' Capacity Building: An Inquiry into the Local Coastal Program Component of Coastal Zone Management in Louisiana ', PhD thesis, Texas A & M University

Norton, RK 2001, 'Consensus and commitment: Reconciling state and local growth management goals for North Carolina's coastal commons', PhD thesis, University of North Carolina.

Pettit, C 2002, 'Land Use Planning Scenarios For Urban Growth: A Case Study Approach ', PhD thesis, University of Queensland.

Portman, ME 2007, 'From land to sea: The application of land protection tools to the marine environment', PhD thesis, University of Massachusetts

Ru, Y 2001, 'Web-based GIS for coastal zone management in New Brunswick', Msc thesis, University of New Brunswick.

Soule, J 2010, 'An Analysis of Stakeholder Preferences on a Complex Waterfront: Land Uses and Planning Processes in Chelsea, MA ', PhD thesis, Tufts University

Sylver, SM 2009, 'Getting it Right: Planning to Protect Cape Cod's Sensitive Coastal Resources ', MA thesis, Tufts University

Wood, IL 2009, 'Planning for Coastal Community Resiliency: A Case Study Analysis of South Carolina Beachfront Communities ', MA thesis, Clemson University.

Wright, TSA 1998, 'Investigating community-based coastal zone management in Queensland, Australia', MA thesis, Dalhousie University.

Youngs, MA 1998, 'The impact of Michigan's coastal zone management programs on property values', MA thesis, Michigan State University.

References

Australian Bureau of Statistics 1954, 'Population Census'.

Australian Bureau of Statistics 1966, 'Population Census'.

Australian Bureau of Statistics 1971, 'Population Census'.

Australian Bureau of Statistics 1976, 'Population Census'.

Australian Bureau of Statistics 1981, 'Population Census'.

Australian Bureau of Statistics 1986, 'Population Census'.

Australian Bureau of Statistics 1991, 'Population Census'.

Australian Bureau of Statistics 1996, 'Population Census'.

Australian Bureau of Statistics 1947, 'Population Census', <<http://www.abs.gov.au/AUSSTATS/abs@.nsf/ProductsbyCatalogue/CE58BF186D2A18BDCA25784C007FA8D5?OpenDocument>>.

Australian Bureau of Statistics 1961, 'Population Census'.

Australian Bureau of Statistics 2000, *Population Census*, ABS, <<http://www.abs.gov.au/websitedbs/censushome.nsf/home/historicaldata2001?opendocument&nvpos=280>>.

Australian Bureau of Statistics 2006, *Population Census*, ABS, <<http://www.abs.gov.au/websitedbs/censushome.nsf/home/historicaldata2006?opendocument&n avpos=280>>.

Australian Bureau of Statistics 2010, *Census*, ABS, <<http://www.abs.gov.au/websitedbs/censushome.nsf/home/data?opendocument#from-banner=LN>>.

Australian Bureau of Statistics 2012, *Community Profiles*, ABS, <<http://www.abs.gov.au/websitedbs/censushome.nsf/home/communityprofiles?opendocument&n avpos=230>>.

City of Warrnambool 2010, *Warrnambool 2010*, Warrnambool.

Google Earth 2012, *Google Earth*.

Herron, M 2012, 'Looking for Sanity in Coastal Planning Deliberations', Ph.D. thesis, Deakin

Herron M 2013, 'Sanity in Coastal Planning Decisions', PhD thesis, Deakin University.

Home, R 1997, *Of Planting and Planning: the Making of British Colonial Cities*, E & F.N. Spon, London.

ID Consulting 2013, 'Warrnambool Profile', <Error! Hyperlink reference not valid..>

Victorian Department of Planning and Community Development 2012, *Victorian Population Projections*, Melbourne, Vic.

Victorian Department of Planning and Community Development 2012, *Populaton Projections*, Melbourne.

Victorian Department of Planning and Community Development 2013, *Great South West Coast Draft Regional growth Plan*, Melbourne, Vic.

Wikipedia 2013, Shift Share Analysis, Wikipedia2013, <http://en.wikipedia.org/wiki/Shift-share_analysis>.