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**Quantifying the potential impacts of increasing
agricultural fragmentation on land value**

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1.0 Introduction

Societal expectations from rural lands have traditionally been focussed on the production of food and fibre. Yet the perception of rural areas is changing and they are now seen in many instances to be capable of delivering multiple functions or non-commodity outputs including land conservation and the preservation of biodiversity, contributing to the sustainable management of renewable natural resources and enhancing the socio-economic viability of many areas (OECD, 2001). The overall multifunctionality is constrained or favoured by biophysical and socio-economic drivers. As these types of drivers vary spatially and temporally, so does the functionality of the landscape and heterogeneous patterns emerge. Associated with multiple functions at a single location are a variety of pressures which can manifest themselves as conflict between interacting land uses (Gimona and van der Horst, 2007; Willemsen et al., 2010). One such conflict in rural zones is that between agricultural use and residential use.

Rural areas are increasingly seen as attractive areas to live in, yet residential use and agricultural use are not always compatible when in close proximity. In an area where residential use is a relatively new component of the landscape issues such as excessive noise and odour, and the application of certain chemicals can become problematic. Attempting to control and mitigate these issues can infringe on the continuing operation of primary producers and right to farm issues can arise. These types of issues are not only limited to amenity value and there is also a spatial component. As more dwellings are constructed in rural areas there is ultimately less space left for agricultural activity. While the spatial requirements for productive agriculture have obvious implications, the spatial arrangement of rural areas also impacts upon their degree of functionality. Urban sprawl and the peripheral nature of growth radiating out from existing built up areas in a loosely contiguous fashion is arguably most people's understanding of the impact of residential use on rural areas. However, the loss of arable land is not only confined to cities extending their 'footprint'. Fragmentation and development of agricultural land beyond city limits is now recognised as a potential impediment to

agricultural production and is the focus of both research (Brabec and Smith, 2002; Van Hung et al., 2007; Kawasaki, 2010) and planning efforts (Parson Brinckerhoff, 2007 and 2010).

The State of Victoria is Australia's biggest exporter of food and fibre, producing an estimated AU\$ 9 billion of agricultural goods contributing 26% of the national total (DPI, 2008 Future Farming Strategy). This is achieved despite having just 3% of Australia's arable land. Therefore the sustainable use of this land is an important component of any strategic planning at a regional level or above. Historically the association of the farmhouse dwelling with the working farm has been the principal reason for the development of housing in rural areas (Murphy et al., 2009). In the context of Victoria this dynamic has changed substantially over the last half a century under the influence of a host of economic and social drivers. In Victoria rural land is often developed by those seeking a lifestyle change, with areas of high amenity in close proximity to urban infrastructure and major transport routes being candidates for ad hoc conversion from primary production to rural residential use (Murphy et al., 2009). This ad hoc conversion is at odds with some key objectives of the *Planning and Environment Act 1987* which is the piece of legislation that defines the objectives of planning in Victoria. The Act sets out to '*provide for the fair, orderly, economic and sustainable use, and development of land*' and '*to balance the present and future interests of all Victorians*'. In a practical sense applied to rural areas, the unplanned conversion of agricultural land to residential use presents farmers with spatial and economic barriers.

Farm consolidation in Victoria is increasing as farmers face declining terms of trade, climatic pressures (Murphy et al., 2009) and changes in technology and the efficient scale of production. In 2003-04 the average farm size was 430 ha compared to 296 ha in 1976-77 (Taylor et al., 2006). Larger numbers of lifestyle blocks interspersed throughout rural areas clearly present challenges to farmers trying to consolidate their holding to increase return on investment in capital, spread the risks associated with operating in a global market and respond to changing consumer demands (Murphy et al., 2009). This spatial aspect can also be exacerbated by the changing economic status of the remaining arable land. While farm values in remote areas are primarily driven by the profitability of

agriculture, in areas close to cities values are influenced by the potential for subdivision and sale for other uses (Murphy et al., 2009). In rural areas proximate to cities economic growth can generate employment, attract workers, increase per capita income and result in demand for larger residential parcels (Bradshaw and Muller, 1998). This scenario can influence the spatial and economic configuration of rural areas.

Economic theory provides a framework for the optimal allocation of scarce resources, such as land. This theory suggests that land, like all scarce resources, should be allocated to its highest value use. Figure 1 illustrates the comparison of the marginal net benefits of land for agricultural (MB_{Ag}) and residential use (MB_{Res}). The horizontal axis represents the land parcel size and the vertical axis the market value of the land per square metre. It is assumed that for smaller land parcel sizes agricultural production will not be viable, hence the residential value of the land is higher than the agricultural value. Conversely for larger parcels of land the residential value of the land is lower than the agricultural value. Theoretically, an optimal allocation for society is when land parcels below size A are used for residential use and those larger than A are used for agricultural use. In essence, the marginal benefit of the smaller land parcels is greater for residential uses than agricultural uses hence any allocation of land parcels smaller than A from agricultural to residential use increases total welfare to society. In a functioning land market, this change will occur without intervention as farmers realise the market value of their land and subdivide traditional agricultural land.

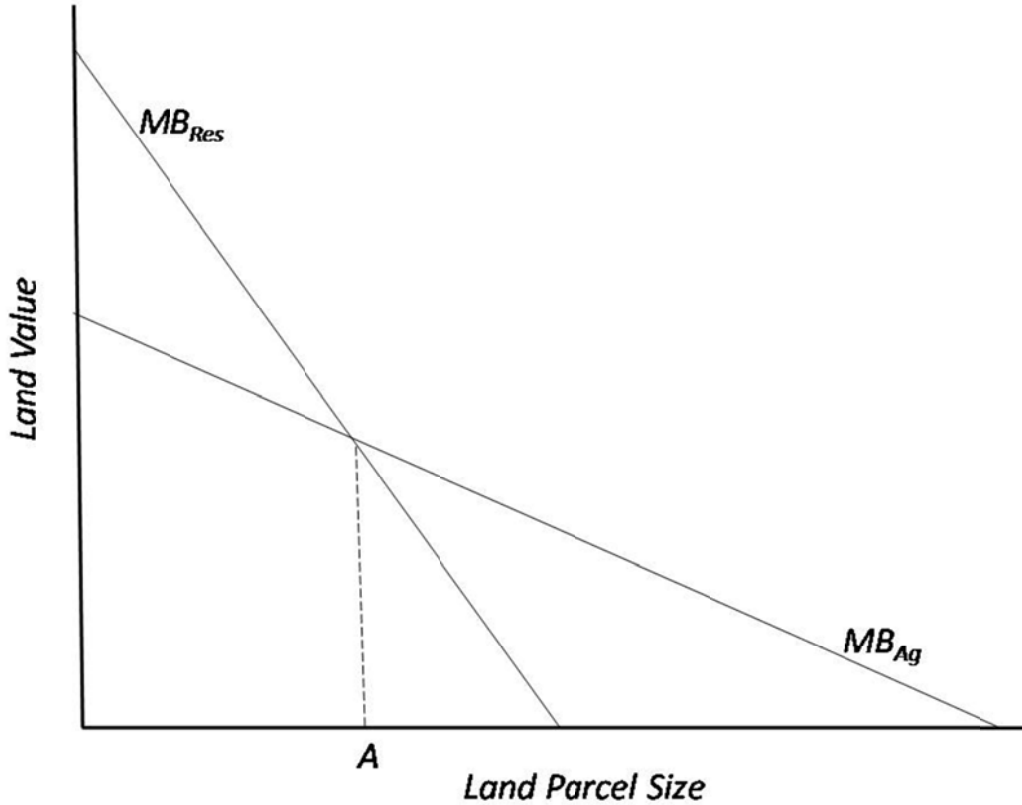


Figure 1. Theoretical market model indicating the efficient allocation of land.

MB_{Res} = Marginal Benefit for residential land; MB_{Ag} = Marginal Benefit for Agricultural land.

Warrnambool City Council (WCC) is a Local Government Area (LGA) in southwest Victoria where the debate surrounding the best use of rural land is currently topical. In a region where agriculture has historically been the mainstay of the economy there is some resistance to unplanned conversion of land to residential use. Despite concerns and much strategy being discussed it appears an investigation quantifying the impacts of either planned or potential unplanned conversions is yet to be done. The purpose of this research is threefold. Firstly we spatially quantify the planned loss of farmland proposed by the WCC by applying the proposed growth boundaries and examining a cross-tabulation matrix. Secondly we investigate the potential for the unplanned conversion of farmland. This is carried out by applying a novel method of assessing the change in value of farming areas that uses the

current Planning Scheme and 2010 council land valuations to develop a predictive equation. Finally, we outline and discuss the economic theoretical framework for the optimal allocation of land in the context of the study area and elaborate on the limitations of a theoretical approach, thereby identifying future research that will improve the capacity of economic modelling to contribute to land use planning. Although the outcomes of this research are based upon a case study, the methods used and developed will also have applicability to other regions. The rural/residential interface and associated planning decisions are highly topical as policy-makers make decisions that potentially will have cumulative impacts well beyond their local jurisdiction when considering global challenges such as food security.

2.0 Methods

2.1 Description of the study area

Situated in southwest Victoria, Australia, Warrnambool City Council (WCC) is the region's major population centre with an estimated 32,712 residential population in 2008. Covering an area of 12,072 ha, the extent of the study area includes parts of the townships of Bushfield and Woodford in the north and Allansford in the east, and extends just beyond the Merri River and Dennington in the west (Figure 2). The southern boundary of WCC is the Southern Ocean.

Since European colonisation in 1847 when the first land sales were made growth of the city has undergone cycles influenced by different drivers. Early land use was mainly grazing, with growth during the 1850s attributed to its rise as a prominent sea port. Further growth during the 1870s to 1890s coincided with the development of railway infrastructure connecting it to Melbourne. The population had reached 7,700 in the 1920s, and the postwar period saw the population double from 10,000 in 1945 to 20,000 by 1974.

Experiencing a Mediterranean climate influenced by proximity to the ocean, the mean summer maximum temperature is 22 °C and the mean winter temperature is 14 °C. Mean annual rainfall for the area is 740 mm. The major industries include dairy, retail, tourism, health, meat processing and construction. In the wider context of south west Victoria, the dairy industry is the largest single

contributor to the economy generating 21 % of the regions output and providing 13.7 % of the region's employment (O'Toole et al., 2010). Numerous agribusinesses that support this industry are based within the Warrnambool City Council area.

2.2 Planned conversion – Cross-tabulation matrix

The *Warrnambool Land Use Strategy* (Parsons Brinckerhoff, 2004) has been adopted by council as the strategic plan to shape Warrnambool's future land use and development. Four areas have been identified as major residential growth corridors for immediate development to satisfy the estimated 1950 lots required over the forthcoming 15 years (Figure 2). Assessment of zoning transitions was based upon a cross-tabulation matrix using the planning zone information from 1999 (t_1) and the proposed planning zones of 2009 including the proposed growth boundaries (t_2). To accommodate this analysis, planning zones were reclassified into four major zone groups: urban; flood/water; conservation and farmland. Specific zones were not used as the development of the growth areas are at different stages and the zones have not been finalised. Nonetheless, as these areas have been identified by Parsons Brinckerhoff (2004) and adopted by council, the eventual fate of these areas is for conversion to urban use in one form or another.

Landscape changes were summarised in terms of swap and net change, and gain and loss, following the detailed methodology of Pontius et al. (2004). This approach distinguishes important patterns of landscape change distinct from the high level of persistence common to most investigations (Wear and Bolstad, 1998; Geoghegan et al., 2001; Schneider and Pontius, 2001). Swap is defined as the change in location of a land cover between t_1 and t_2 , which derives from simultaneous gross gain and gross loss. Net change is the difference in area of a land cover between t_1 and t_2 . Gain refers to the increase in area of a land cover, while loss refers to a decrease in area of a land cover between t_1 and t_2 . The measures of swap, gain and loss have typically been used in the past to assess changes that have already occurred (Pontius et al., 2004 etc). This is a new application of this methodology that allows a future assessment in the change of zoning, which is effectively a change in land use.

2.3 Unplanned conversion - Parcel analysis

The rates database populated with the 2010 valuations was supplied by WCC. All the rateable parcels in the Farming Zone were extracted in ArcGIS 9.3. On the advice of council employees parcels currently in the Farming Zone but covered by the proposed growth boundaries were removed from the analysis (Figure 2). When compared to the parcel data in VicMap it was apparent there was a proportion of parcels not present in the WCC rates database. The explanation provided by the WCC was the missing parcels were currently the subject of sale, subdivision or other planning processes and were unavailable. The final analysis was carried out on the 349 available parcels which covered 84.56% of the Farming Zone.

Australian dollar value/m² was calculated using the current site values and areas for each parcel. Descriptive statistics relating to area and value were generated for the parcels by applying two types of categorisation: (1) by the Australian Valuation Property Classification Code (AVPCC); and (2) by the Sub-Market Group (SMG). The AVPCCs are intended as an aid to property valuers and are a three-digit number based upon a hierarchy of primary, secondary and tertiary representation of a property's classification and were applied Victoria-wide for the 2010 council revaluation. The SMGs are a localised categorisation used to group properties of similar use and other attributes such as size and location. While there was some agreement between the two methods there were some discrepancies that justified using both categorisations.

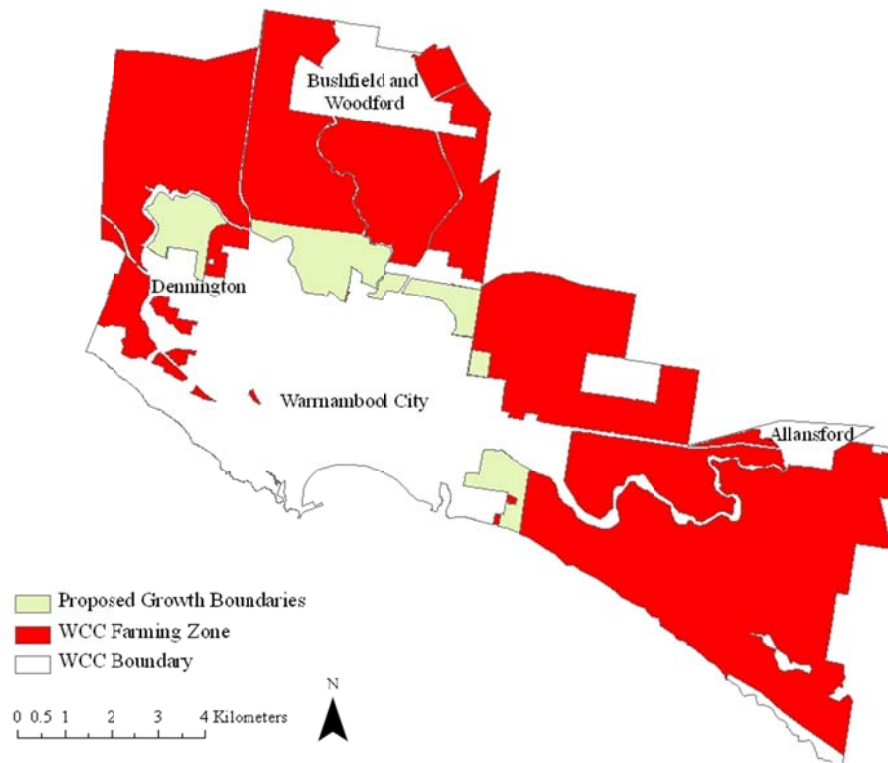


Figure 2. The Warrnambool City Council study area showing localities of the city and surrounding townships. The Farming Zone is the focus of the analyses. The proposed growth boundaries are for illustrative purposes. All areas in white comprise zoning and overlays other than Farming Zone.

Assessment of the relationship between parcel size and parcel value was performed using linear regression. Raw data values were transformed (natural log) to meet the assumptions of the regression analyses. The regression analyses were performed for the entire data set and also for the residential parcels and farming parcels using both the AVPCC and SMG categorisation. The coefficients generated were used to predict the change in value of the land under the scenario of increased subdivision. Currently the Schedule for the Farming Zone in the WCC allows subdivision to a minimum lot size of 15 ha and construction of a dwelling without a permit on lots of the same size in the absence of any other relevant overlays¹. Candidates for further subdivision were parcels exceeding 30 ha (i.e. $>30 < 45$ ha could become $2 \times \geq 15$ ha; $>45 < 60$ ha could become $3 \times \geq 15$ ha; etc) (Figure 3).

¹ This can be contrasted with a minimum lot size of 40 ha in Victorian state legislation and neighbouring shires.

Using these selection criteria the size of the new parcels were calculated and their new values calculated using the empirical relationships developed with the regression analyses.

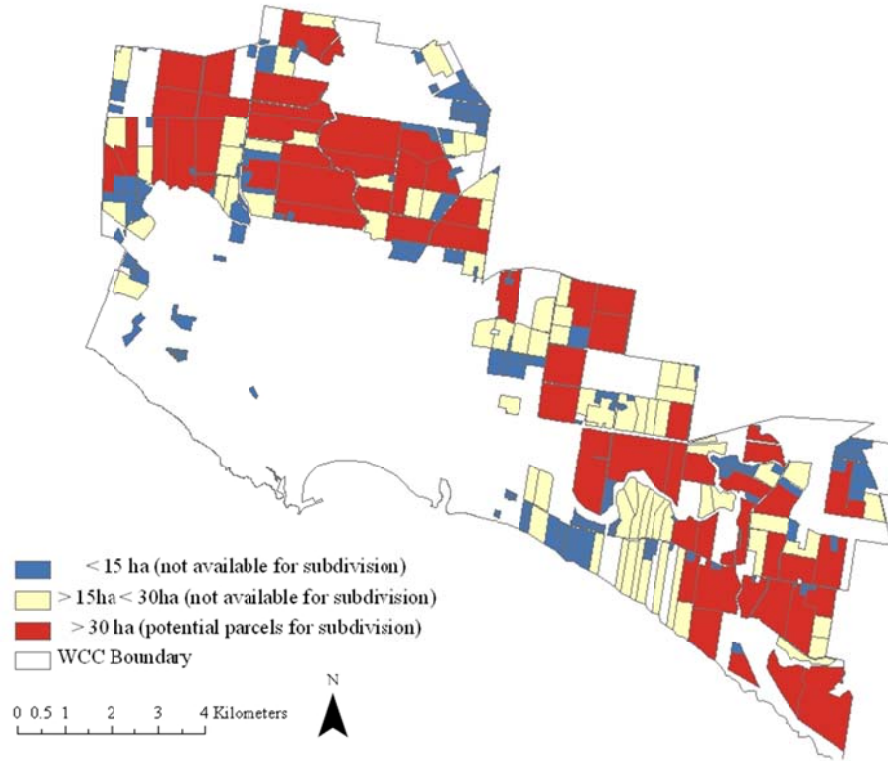


Figure 3. Current parcel sizes within the WCC. Parcels greater than 30 ha are potential candidates for subdivision according to prevailing Farming Zone Schedule.

3.0 Results

Planned conversion

The cross-tabulation transition matrix shows Farmland and Urban zones covered the greatest area in the WCC, with 58.54% and 29.63% persisting between t_1 and t_2 respectively (Table 1). Urban land use is set to have the largest gain following the implementation of growth boundaries in t_2 . This is almost entirely at the expense of Farmland, which is set to have the largest loss in area. Flood/Water and Conservation land uses registered 0.01% and 0.00% of Absolute Value of Net Change respectively, indicating the predominate land use transition is Farmland to Urban (Table 2).

Table 1. Cross-tabulation zone transition matrix for 1999 (t_1) and Planned Conversion >2009 (t_2).

Persistence of the zones can be read along the diagonal. All values are percentages.

	Urban	Flood/Water	Conservation	Farmland	Total 1999
Urban	29.63	0.05	0.00	0.03	29.72
Flood/Water	0.17	2.64	0.00	0.02	2.83
Conservation	0.01	0.00	3.22	0.02	3.25
Farmland	5.52	0.12	0.03	58.54	64.20
Planned Conversion >2009	35.32	2.82	3.25	58.61	

Table 2. Summary of zone transitions for 1999 (t_1) and Planned Conversion >2009 (t_2).

All values are percentages.

	Gain	Loss	Total Change	Swap	Absolute Value of Net Change
Urban	5.69	0.09	5.78	0.17	5.61
Flood/Water	0.17	0.19	0.36	0.35	0.01
Conservation	0.03	0.03	0.06	0.06	0.00
Farmland	0.07	5.66	5.74	0.15	5.59
Total	5.97	5.97	11.94	0.73	11.21

3.1 Unplanned conversion – Parcel analysis

Summary statistics for the 349 parcels analysed were completed after dividing the data into Australian Valuation Property Classification Codes (AVPCC) (Table 3) and Submarket Groups (SMG) (Table 4). Numerically AVPCCs 110 and 530 were the largest contributors to the Farm Zone with 171 and 148 parcels respectively. AVPCC tertiary codes beginning with ‘1’ are classed as residential and ‘5’ as primary production. By pooling residential (100, 110, 151, $n = 177$) and primary production (525, 530, 561, $n = 151$) codes a comparison between median area and median land value of these groups was carried out using a Mann-Whitney U test. Residential land was significantly smaller in area than primary production land ($z = -15.345$, $p < 0.001$) and was significantly higher in value/m² ($z = -14.176$, $p < 0.001$). AVPCCs 243 and 561 do not contribute in a major way numerically (total $n=2$) or in area (total area = 22.25 ha) to the Farming Zone. Similarly, AVPCC 525 numerically did not have a major presence in the landscape, yet did cover an area of 204.99 ha.

The SMG data were numerically dominated by categories from the 1300 ($n = 177$) and 1400 ($n = 151$) market groups (Table 4). Mann-Whitney U tests were used to assess statistical differences between the area and land values of these groups. Residential use in the Farming Zone occurred on smaller areas ($z = -15.150$, $p < 0.001$) but were characterised by a higher value/m² ($z = -13.813$, $p < 0.001$). SMGs 905 and 908 comprised 17 parcels and had an overall area of 67.05 ha.

The consistent statistical difference between parcel size and land value between residential use and primary production use when examining the data in AVPCC or SMG categories suggest there are at least two distinct land ‘uses’ occurring in the Farming Zone. To assess the relationship between land area and land value in these two uses linear regression was applied.

Table 3. Summary statistics of parcel data categorised by AVPCC

AVPCC	Description	No. of Parcels	Mean Area ha (Std Dev.)	Mean Value/m ² (Std Dev.)
100	Vacant Residential Home Site/Surveyed Lot	25	4.73 (6.42)	14.39 (14.60)
110*	Detached Home	171	2.98 (3.92)	19.34 (15.77)
151	Miscellaneous Building on Residential Rural Land	1	1.06	21.97
243	Member Club Facility	1	4.73	6.23
525	Livestock Production-Dairy Cattle	2	102.49 (50.39)	1.56 (0.32)
530	Mixed Farming and Grazing	148	32.69 (24.72)	3.55 (2.21)
561	Vineyard	1	17.52	3.08

*Outlier of 84 ha removed from analysis.

Table 4. Summary statistics of parcel data categorised by sub-market group

SMG	Description*	No. of Parcels	Mean Area ha (Std Dev.)	Mean Value/m ² (Std Dev.)
905	High value river/sea view properties	6	0.938 (0.241)	45.38 (7.18)
908	High value river/sea view properties	11	5.583 (6.63)	13.30 (9.29)
1301*	Rural residential properties with land areas up to 10 ha (Woodford, Bushfield)	46	2.47 (1.85)	18.21 (18.43)
1302	Rural residential properties with land areas up to 10 ha (Warnambool)	57	3.28 (3.28)	20.79 (15.22)
1303	Rural residential properties with land areas up to 10 ha (Dennington)	19	4.44 (2.95)	10.85 (7.83)
1304	Rural residential properties with land areas up to 10 ha (Allansford)	55	2.50 (1.43)	18.36 (14.34)
1401	Rural classified properties over 5 ha consisting mainly stand alone dairy properties or broad acreage grazing properties (Warnambool, Woodford, Bushfield)	104	31.62 (27.18)	3.96 (2.97)
1402	Rural classified properties over 5 ha consisting mainly stand alone dairy properties or broad acreage grazing properties (Allansford)	51	35.66 (27.75)	3.11 (1.91)

*Outlier of 84 ha removed from analysis.

3.2 The relationship between parcel size and land value

Linear regression was used to estimate the relationship between land area and land value. To satisfy the assumptions of this statistical test a natural log transformation was carried out on both the independent (land area) and dependent (land value) variables. Across the study area using all the parcel data there was a significant negative relationship between land parcel size and land value per square metre (Table 5). This pattern was also evident when analysing subsets of the data (Table 5). Relationships were stronger when analysing the residential models compared to the primary production models. Furthermore, β -values for the residential models (-0.802 and -0.814) were always significantly steeper than the primary production models (-0.555 and -0.584) ($t = 5.21, p < 0.001$ and $t = 5.16, p < 0.001$ respectively).

Table 5. Summary of regression equations

Data categories	Variable	β (std error)	T -value (sig)	F -value (sig)	Adjusted $R^2(n)$
All	Constant	8.980 (0.139)	64.419 (<0.001)	2588.01 (<0.001)	0.881 (349)
	ln(area)	-0.636 (0.013)	-50.872 (<0.001)		
100; 110; 151 (Residential)	Constant	10.569 (0.215)	49.260 (0.001)	1385.644 (<0.001)	0.877 (197)
	ln(area)	-0.802 (0.022)	-37.224 (0.001)		
525, 530, 561 (Farming)	Constant	8.046 (0.527)	15.281 (<0.001)	173.784 (<0.001)	0.535 (151)
	ln(area)	-0.555 (0.042)	-13.183 (0.001)		
1301; 1302; 1303; 1304 (Residential)	Constant	10.675 (0.207)	51.614 (<0.001)	1534.851 (<0.001)	0.898 (177)
	ln(area)	-0.817 (0.021)	-39.177 (<0.001)		
1401; 1402 (Farming)	Constant	8.417 (0.504)	16.689 (0.001)	208.902 (<0.001)	0.574 (155)
	ln(area)	-0.584 (0.040)	-14.453 (0.001)		

3.3 Examining the potential influence of subdivision on the value of the Farming Zone

The assumption of these analyses is land that is subdivided will be converted from farming to residential use. These analyses also do not make any assumptions about the provision of services or geological suitability for dwelling construction, although existing public road access passes all parcels to be divided. Of the 349 parcels, 58 exceeded 30 ha and in the event they were subdivided to their full potential (i.e. divided into ≥ 15 ha parcels) the 58 parcels would become 201 parcels. The current site value of the 58 parcels is AU\$66,343,000. Applying the coefficients of the two residential models (100; 110; 151 and 1301; 1302; 1303; 1304) as a predictive model indicates the value of the land area

following subdivision would increase to AU\$84,975,000 and AU\$78,855,000 respectively or 28% and 19% depending on the model applied. Essentially this process is converting parcels with AVPCCs of 525, 530 and 561 to AVPCCs of 100, 110 and 151, and converting parcels of SMGs 1401 and 1402 to SMGs of 1301, 1302, 1303 and 1304. Hence, this analysis suggests that the currently unrealized potential gain from land conversion within the current planning provisions is between \$18.6 and \$12.5 million.

While this analysis considers potential subdivision within the existing planning provisions, these models can also be used to estimate the land parcel size that would optimise the allocation of land between residential and agricultural uses from a purely theoretical economic perspective. Simultaneously solving for two unknowns (y) in the residential and farming equations, indicates that for the AVPCC model the marginal value of land parcel size is greater for residential use than farming use for parcel sizes below 2.730 ha and for the SMG model for parcel sizes below 1.617ha (Figure 4). This analysis, which is not without limitations as discussed below, suggests that there are potential welfare gains to be made allowing subdivisions below the current 15ha minimum lot size.

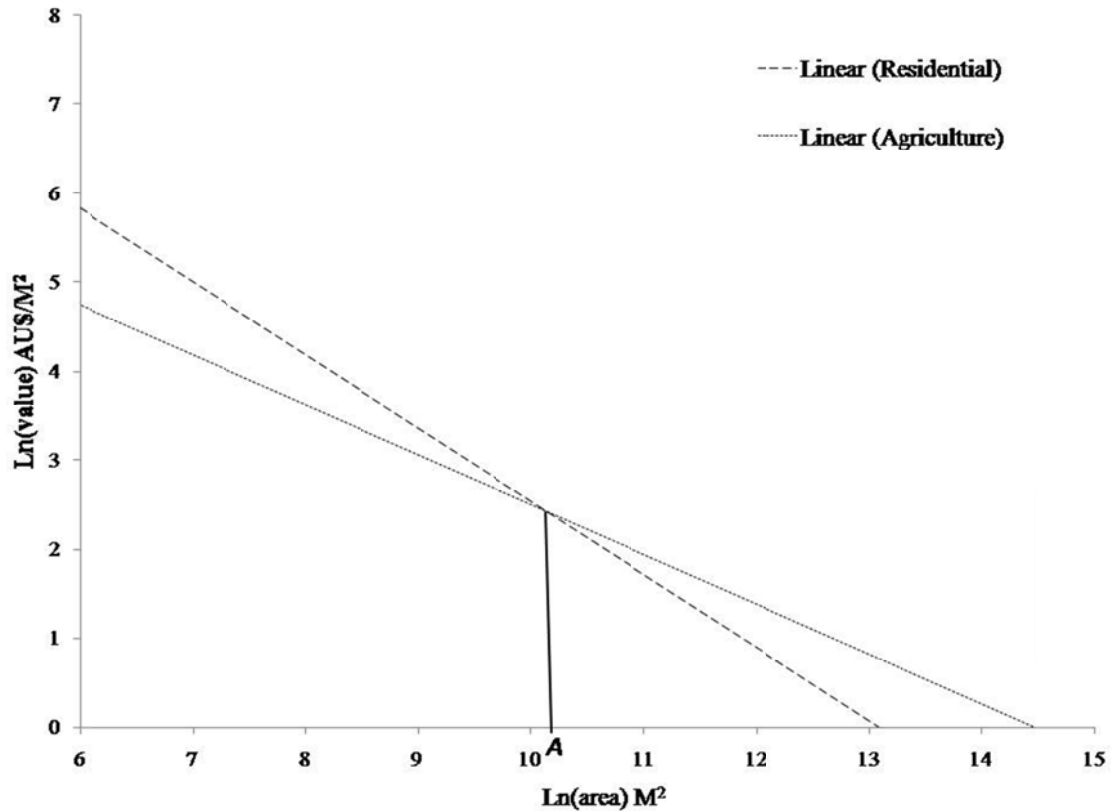


Figure 4. The efficient allocation ($A=10.215=2.730$ ha) of land based upon classification of parcels using AVPCCs.

4.0 Discussion

Applying the AVPCC and SMG categories was done as these groupings, despite having seemingly analogous categories, did not always contain the same parcels even when lumped into residential and agricultural uses for the purpose of regression modelling. There were two conspicuous discrepancies that were evident when examining the parcel data. Firstly, despite southwest Victoria forecast to supply 23% of Australia's milk output in 2008/09 and dairy farms being a prominent feature of the landscape surrounding Warrnambool, just two of the 349 parcels analysed here were classified as AVPCC 525 *Livestock production – Dairy cattle*. When examining the parcels using the SMG categories there were 155 parcels in SMGs 1401 and 1402 which included parcels >5 ha in the Farming Zone that are stand alone dairy properties or broad acre grazing properties. The other notable observation was no parcels were classified as 117 *Residential Rural/Rural Lifestyle*. Properties

described under this AVPCC include single dwellings on a larger allotment (>1 ha and <20 ha) in a rural, semi rural or bushland setting where primary production uses and associated improvements are secondary to the value of the residential home site use and associated residential improvements (land.vic.gov.au).

Currently there is no available information on the proportion of lifestyle properties in the study area. It is required, if for no other reason, to assess if the Farming Zone as a whole is delivering what the planning scheme intends. Future work quantifying this land use will be of assistance to strategic planners and policy-makers. We do not believe this would entail a large investment to deliver this outcome as the framework for this classification already exists. Other potential uses for this type of data could be to inform planners where lifestyle activity is greatest and designated zones may be created to cater for this land use. This strategic approach could minimise conflict in rural zones between residential and farming uses by reducing unplanned encroachment.

Although this analysis is at a local scale, the extent to which regional planning impacts on state and national food production is also an important consideration of future land use planning. The dairy industry is Victoria's largest export earner and 13% of the dairy products traded globally originate from the State. Within Victorian there are three dairying regions; (1) Northern Victoria and Riverina, (2) Gippsland, and (3) Western Victoria. The Northern Victoria and Riverina is part of the Murray-Darling Basin and is largely reliant upon irrigation allocations. During years of low rainfall and low water allocations, dependence upon bought-in supplementary feeds increases and this seriously undermines the profitability of dairy enterprises in this region. Much of the last decade has seen drastically reduced rainfall in the Murray-Darling Basin. This limitation coupled with the more recent milk price drop associated with falling commodity prices during the Global Financial Crisis has meant many dairy farmers in the Northern Victoria and Riverina dairy area face an uncertain future. In Western Victoria and Gippsland, the situation is much different, despite not being immune to the milk price drop. Although there is limited irrigation activity in Gippsland (Macalister Irrigation District),

much of the strength of the Western Victoria and Gippsland region stems from their dryland pasture base and relatively mild and reliable seasonal climate. The ability to provide stock with on-farm grown pasture and reduce reliance on bought-in supplementary feeds provides these areas with a substantial cost saving and competitive advantage. Longer term it is likely that proportionally more of Victoria's milk supply will come from Gippsland and Western Victoria.

This paper considers two important aspects of the debate surrounding land fragmentation in one specific local government area. The first is the issue of the unplanned conversion of farmland to residential use. In areas where farming is considered to deliver important social, economic and environmental goods, strategic planners through policy-makers often attempt to protect these areas from what is considered inappropriate use (i.e. unplanned conversion to other uses). Although the unplanned conversion from agricultural to residential use is viewed as an undesirable outcome, there is rarely an examination of what the potential increase in land value may be. This research quantifies the market driver for unplanned land conversion from agricultural to residential in the study area and indicates that potential land value gains of between 19-28% are to be accessed from land fragmentation. It achieves this in a cost-effective manner by accessing current land value databases and the prevailing planning scheme. These types of data are available Victoria-wide meaning the method is applicable at a broader scale. The analysis is limited as it does not include the external costs and benefits of both residential and farm land use in regional Australia. Further limitations include the omission of the cost of infrastructure, and possible inconsistencies in the valuation data sets. Nevertheless, it provides a valuable estimate of the market pressure facing a regional council and suggests that without amendments to current planning provisions in the region, unplanned conversions will continue to increase land fragmentation.

The second question which the paper addresses is the relationship between land parcel size and land value. In the study there was an obvious trend for smaller parcels to have higher values. This is reflected in the summary statistics of the data categorised either by AVPCC or SMG (Tables 3 and 4) and the relationship quantified using linear regression (Table 5). This analysis clearly quantifies the

conflicting pressures for the use of farmland between residential and agricultural use and suggests that parcels below approximately two hectares are the critical land parcels where residential value exceeds agricultural value. This reflects empirical observation regarding the size of lifestyle properties. Hence, theoretically in determining optimal land use the analysis suggests potential welfare gains for the community from changes in land use. This analysis excludes the externalities associated with both residential and agricultural land use and factors such as the irreversible nature of land fragmentation. Nevertheless, in the absence of measuring the external costs and benefits there is no evidence that a historically driven minimum subdivision size of 15 hectares provides a more optimal allocation of land than a market driven subdivision size of approximately two hectares would provide.

References

- Brabec, E. and Smith, C., 2002 Agricultural Land Fragmentation: The Spatial Effects of Three Land Protection Strategies in the Eastern United States, *Landscape and Urban Planning*, Vol 58, pp 255–268.
- Bradshaw, T., Muller, B., 1998 Impacts of Rapid Urban Growth on Farmland Conversion: Application of New Regional Land Use Policy Models and Geographical Information Systems, *Rural Sociology* Vol 63:1, pp 1–25.
- Department of Primary Industries (DPI), 2008 *Future Farming Strategy: Productive, Competitive and Sustainable*. Melbourne, Victoria, Australia.
- Geoghegan, J., Villar, S., Klepeis, P., Mendoza, P., Ogneva-Himmelberger, Y., Chowdhury, R., Turner, B., and Vance, C., 2001 Modelling Tropical Deforestation in the Southern Yucatan Peninsula Region: Comparing Survey and Satellite Data., *Agriculture, Ecosystems and Environment*, Vol 85, pp 25–46.
- Gimona, A. and van der Horst, D., 2007 Mapping Hotspots of Multiple Landscape Functions: A Case Study on Farmland Afforestation in Scotland, *Landscape Ecology*, Vol 22:12, pp55–1264.
- Kawasaki, K., 2010 The Costs and Benefits of Land Fragmentation of Rice Farms in Japan, *The Australian Journal of Agricultural and Resource Economics*, Vol 54, pp 509-526.
- Murphy, M., Beilin, R., Brewin, D., McGuinness, S., Gibb, I. And Milner, R., 2009 *Future Farming Improving Rural Land Use*, Rural Planning Group – Independent Report to the Minister for Planning. Victorian Government.
- OECD, 2001 *Multifunctionality: Towards an Analytical Framework*, Paris.

- O'Toole, K. and Keneley, M. 2010 Forgotten Outcomes for Rural Areas in Central Policy-Making: The Case of Blue Gums in Australia, *The Australian Journal of Public Administration*, Vol. 69:2, pp. 1–12.
- Parsons Brinckerhoff, 2004 *Warrnambool Land Use Strategy*, Victoria, Australia.
- Parsons Brinckerhoff, 2007 *City of Greater Geelong – Rural Land Use Strategy*, Bendigo, Australia.
- Parsons Brinckerhoff, 2010 *Ballarat Rural Land Use Strategy*, Southbank, Australia.
- Pontius, R., Shusas, E., and McEachern, M., 2004, Detecting Important Categorical Land Changes While Accounting for Persistence, *Agriculture, Ecosystems and Environment*, Vol 101, pp251–268.
- Schneider, L., Pontius, R., 2001 Modelling Land-Use Change in the Ipswich Watershed, Massachusetts, USA. *Agriculture, Ecosystems and Environment*, Vol 85, pp 83–94.
- Taylor, M., Ha, A. and Fisher, B. 2006 *Trends in Victorian Agriculture*. Department of Primary Industries, Melbourne, Victoria, Australia.
- Van Hung, P., MacAulay, T. and Marsh, S, 2007 The Economics of Land Fragmentation in the North of Vietnam, *Australian Journal of Agricultural and Resource Economics*, Vol. 51, No. 2, pp. 195–211.
- Wear, D. and Bolstad, P., 1998 Land-use Changes in Southern Appalachian Landscapes: Spatial Analysis and Forecast Evaluation, *Ecosystems*, Vol1, pp575–594.
- Willemen, L., Hein, L., van Mensvoort, M. and Verburg, P. 2010 Space for people, plants, and livestock? Quantifying interactions among multiple landscape functions in a Dutch rural region *Ecological Indicators* 10:1, 62–73