

THE PROPERTY WEALTH METRIC AS A MEASURE OF SOCIO-ECONOMIC STATUS

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ABSTRACT:

Neighbourhood socio-economic status (SES) is linked with poor health outcomes (Auchincloss et al., 2007; Adams et al., 2009; Chichlowska et al., 2009; Kavanagh et al., 2010; Williams et al., 2010). One of the more common Australian data sources for analysing social disadvantage is the Australian Bureau of Statistics (ABS) Socio-Economic Indicators for Areas (SEIFA) index of Advantage\Disadvantage (Australian Bureau of Statistics, 2006). As SEIFA is aggregated to predetermined spatial units the index masks variation and impacts on epidemiological studies at the local level. This research investigated the potential to use the South Australian Fiscal Cadastre as a surrogate socio economic indicator in the investigation of community health at the property level to supplement the more traditionally used SEIFA index. A Relative Location Factor metric (RLF) is developed by comparing the relative locational merit of each property to the global average for the study area and comparing this with the 2006 SEIFA index of disadvantage-advantage. This paper presents the results from this first step. Further research will examine the relationship between RLF, health survey data, the underlying census socio-economic characteristics and SEIFA.

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INTRODUCTION:

The relationship between poor health and socio-economic status (SES) has a long history and early work, such as Booth's 1898-99 maps of poverty in London highlighted the links. However, despite the many studies researching health and SES, the lack of an understanding about the spatial distribution of SES is still a major challenge in the implementation of informed public health policy. The traditional approach relies on socio economic data which is typically presented as some sort of average within an arbitrarily aggregated spatial unit to preserve confidentiality. This introduces Ecological Fallacy (Robinson, 1950) and Modifiable Areal Unit Problem (MAUP) (Openshaw, 1984) into the analysis as well as masking any variation within these spatial units potentially hindering the successful intervention of any resulting public health policy. These issues raises the question as to which spatial unit is the most appropriate when analysis results may be different depending on the choice made.

The objective of this paper is to use a derived relative location factor (RLF) based on property value as a proxy for SES at an individual property level and make initial comparisons with the more traditionally used Australian Bureau of Statistics (ABS) Socio-Economic Index for Areas (SEIFA) index. Property may well be the most valuable asset owned by many individuals and as such it can provide the basis for a property based wealth indicator reflecting SES. The derivation of the RLF uses a hedonic global ordinary least squares (OLS) regression model constructed using property characteristics as independent variables that describe the dwelling and not its location. The deliberate omitted variable bias may then be attributed to location and expressed as a RLF value surface which can be assigned to each property. This allows analysis to be potentially free of the MAUP and provide a better understanding of any local spatial variation that may be occurring within the traditionally presented spatial units thus enhancing public health policy.

The literature has established the link between public health and SES and there is an emerging literature on the relationship between property values and SES (Vernez Moudon et al., 2011). The scope of this paper is to establish a RLF surface and compare it to the traditional SEIFA index of advantage-disadvantage and identify some of the differences and discuss how the RLF could contribute to enhanced public health outcomes. This is the first step in understanding the contribution that RLF can make to SES and health research. The limitations of this study were the property data availability and its ability to represent the current market at a particular point in time. The strength of the RLF is that it can be easily constructed at any point in time and could therefore provide an understanding of changing SES between the quinquennial Australian Census of Population and Housing.

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BACKGROUND

The relationship between socio economic status (SES), social disadvantage and poorer health outcomes is well documented and has a long history with Louis-Rene Villerme (Julia and Valleron, 2011), Rudolf Virchow's (Waitzkin, 2006), Charles Booth (Völker and Kistemann, 2011) and John Snow (Newsom, 2006) in the 19th Century, and numerous studies since, see for example (Kawachi, 2003; Marmot and Wilkinson, 2006; Cabrera et al., 2007; Chaix et al., 2007; Aldabe et al., 2010; Brownell et al., 2010; Kavanagh et al., 2010; Kestens and Daniel, 2010; McDonough et al., 2010; Wilson et al., 2010). In Australian studies, socio-economic status is usually analysed using the five yearly ABS Census and the SEIFA index (Australian Bureau of Statistics, 2006). The latest Census was recently collected (2011), but presently the most up-to-date census is 2006. Due to the confidentiality provisions associated with the ABS, data are not released that would enable the identification of any individual or household. To protect confidentiality when releasing data, the ABS randomise cell values of less than three (to either 0 or 3) and aggregate data outputs to predetermined spatial units. The ABS spatial units are set prior to each census and released as the Australian Standard Geographic Classification ¹(ASGC) (Australian Bureau of Statistics, 2006). The 2006 ASGC provides spatial units which cover all of Australia without overlap or omission starting with the smallest unit, the collection district (CD), through to statistical local areas (SLA), local government areas (LGA), statistical sub-division (SSD), statistical divisions (SD), state (SA) and nation. The smallest spatial unit the CD is typically 160-200 households (Australian Bureau of Statistics, 2006) and while this provides a small unit in urban areas, it can be very large in rural or remote areas. Consequently, data aggregated to provide outputs for the census geographies may not be suitable when attempting to understand local variations within these larger spatial units. This paper presents the results from the first step which examined the construction of a relative location factor (RLF) based on property values as a potential enhancement to the more traditional SES indicators of social disadvantage by providing a breakdown of the local variation to the property level. Further research will examine the relationship between RLF, health survey data, the underlying census socio-economic characteristics and SEIFA.

The objective of this study was to take the established nexus between property value and SES and show how the potential property market structure may help explain local variations beyond that possible using aggregated SES data. A similar study used a similar measure to test the relationship between obesity, a property specific wealth metric and area level SES in Seattle (Vernez Moudon et al., 2011). The results from the Seattle study concluded that the property level measure was more predictive than area-level SES in identifying fair or poor health status (Vernez Moudon et al., 2011). Australian studies have shown how the variation in socio economic indicators is correlated with the variation in median house price movement when aggregated to the same spatial unit (Reed, 2001; Jackson et al., 2007).

Location is generally recognised as a most important determinant of property value. As (Bourassa et al., 2003) stated, the three most important contributors to property value are "location, location, location" is not just a tired dictum; location does matter and therefore its associated geography does matter. Social geography can not only describe the composition of a geography (Shevky and Bell, 1955) but perhaps more importantly can show the associated spatial variation of that geography across a study area.

The property may well be the most valuable asset owned by many individuals. As it accounts for a significant proportion of an economy's GDP (Gibb and Hoesli, 2003) the importance to society generally can be appreciated. Therefore to manage the development and affordability of this asset and its association with health, through informed government policy requires insight to the housing market structure and the spatial variation associated with it. The importance of this understanding was expressed by (Rothenberg et al., 1991) as being "to understand that which fundamentally influences the wellbeing of most citizens".

One of the most important attributes of housing as a traded commodity is its immovability. This provides the basis of making location a prime value determinant (Galster, 1996). Therefore as well as an economic equilibrium expressed in terms of supply and demand, property can also be expressed in terms of a spatial equilibrium as proximity to various places of interest as influencing price (Thrall, 2002).

The question as to how best represent the changing nature of the residential value surface becomes of interest in understanding the property market's perception of where the more desirable and less desirable locations may be as this may be related to an interpretation of property location as an indication of SES. The existence of the

¹ 2011 will be the final version of the ASGC as the ABS has redesigned the spatial geography of Australia and the new source document will be the Australian Statistical Geography Standard (ASGS).

housing market composed of a number of interrelated sub markets has long been acknowledged, but discussion is still prevalent in the literature as to the best methodology to determine these sub markets (Watkins, 2001).

The issues that emerge from the literature involve the recognition that submarkets are best defined simultaneously in terms of both spatial and structural identifiers (Watkins 2001) and should be derived from the data itself rather than on the basis of some a priori definition such as suburbs or postcodes (Adair et al., 1996). The data should reflect the underlying residential real estate structure of the study area and not rely on selected property characteristics alone (Maclennan and Tu, 1996; Bourassa et al., 1999; Bourassa et al., 2003). However, it is insufficient to identify the underlying structure and geography only, as submarket definition requires expression in terms of the marketplace in order to give it an economic entity status (Pryce, 2004). To identify all attributes contributing to the underlying market structure is not a trivial exercise as the quantity of locational attributes alone are almost limitless (Orford, 1999). As locational attributes often serve as a 'proxy' for the numerous unobserved attributes (Pavlov, 2000) a methodology described by (Gallimore et al., 1996) isolating the effects of location to the error term of an hedonic model describing price in terms of observable property characteristics and remaining deliberately 'blind' to location may be an appropriate methodology in determining a residential location factor (RLF).

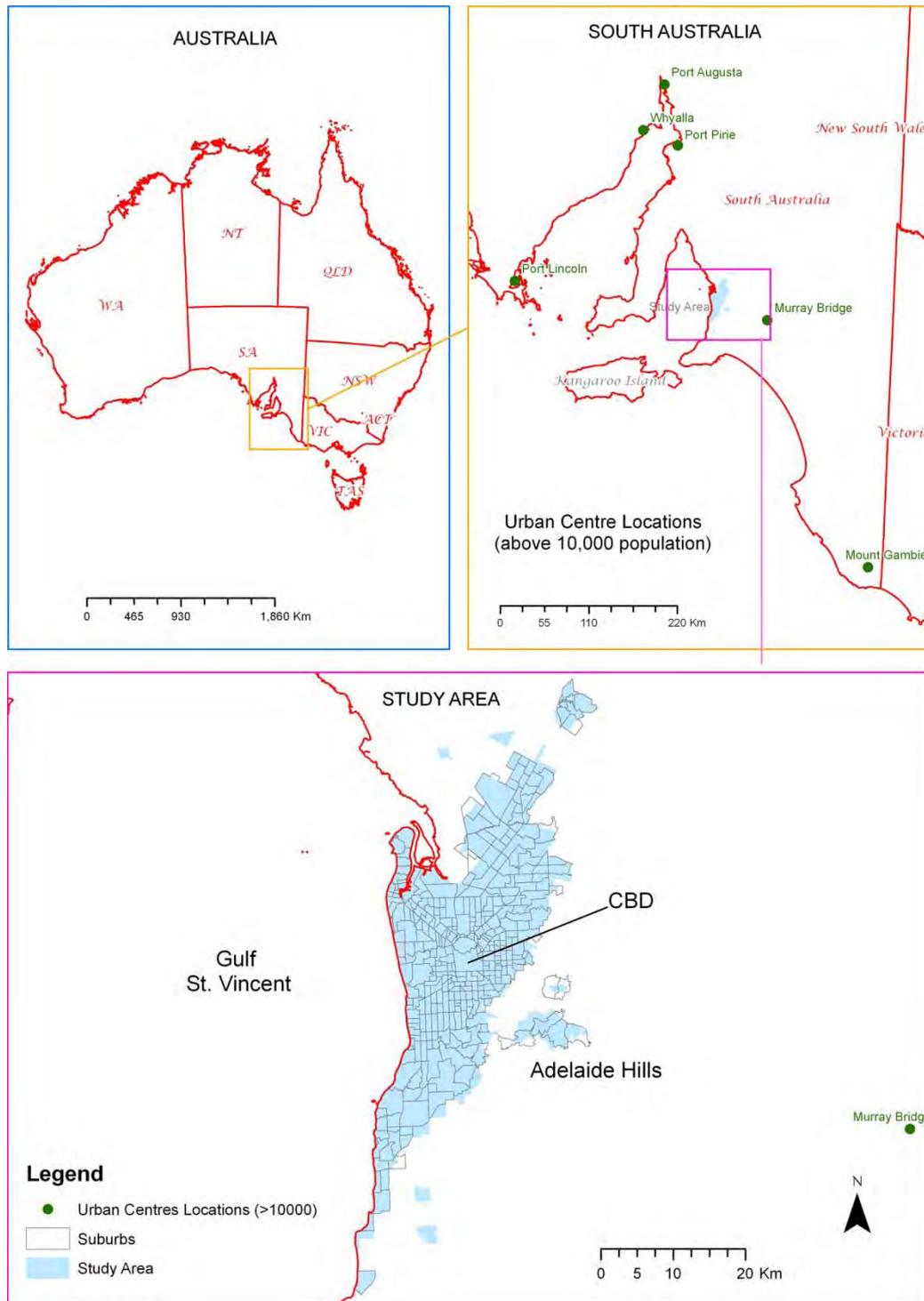
The methodology in this study was divided into two stages. The first stage was to express property values in terms of a household specific wealth indicator providing another view of SES that could complement the more traditionally employed ABS SEIFA index. It is not the intention to replace or compete with such a long established index, but rather to contribute by expressing the importance of property wealth as a complementary SES metric. SEIFA is calculated using a combination of census social and demographic variables collected every five years and as such does not directly include property wealth as part of the index. This research suggests one way of achieving this may be to construct a continuous raster surface depicting the residential market structure at an individual property level. Following (Gallimore et al., 1996) this was achieved through constructing a global hedonic ordinary least squares model that was deliberately "blind" to location. There is an assumption that the error term is due to the value attributes describing location and used as the input to construct a Residential Location Surface (RLF) as the ratio of Sale Price to the estimated Value from the "blind" model. The second stage was to compare the traditionally used ABS SEIFA index of advantage-disadvantage at the CD level and compare this to the RLF aggregated to the CD level. It was not necessarily expected that the two should be closely aligned across the whole study area as the SEIFA index was constructed as a relative index between a particular CD and the whole of the state whereas the RLF is a metropolitan specific model. In part this may be where the RLF can contribute to a better understanding of locations of social advantage-disadvantage as it is derived by study area specific data and expressed at the property level thereby capturing local variations not possible with more global metrics.

This is very much an exploratory study that may ultimately lead to a better understanding between location and SES.

STUDY AREA:

The study area for this research was the urban area of the Adelaide Metropolitan Area as displayed in Figure 1. Adelaide is used for this study as there were excellent detailed spatial data for property, property sales and a comprehensive longitudinal health survey available for further analyses.

Figure 1: Study Area.



DATA:

In adopting the global hedonic OLS model approach, the data used were taken from the 2006 Sales History data of the South Australian Valuer General. The data used in this study are summarised in Table 1.

TABLE 1: Ordinary Least Squares Model Input Data.

VARIABLE	TYPE	DESCRIPTION
Coordinate values	continuous	X,Y coordinate - false eastings and northings using GDA_1994_MGA_Zone_54 obtained from the South Australian Government
Sale Price (SP)	continuous	Sale Price in dollars obtained from the South Australian Government
Dwelling size (DS)	continuous	Equivalent main area in square metres (source: South Australian Valuer General).
Dwelling age (DA)	continuous	Age in years obtained (source: South Australian Valuer General)
Dwelling land area (LA)	continuous	Area in square metres taken from the digital cadastre (source: South Australian Valuer General)
Dwelling style(DT)	Dummy	If “South Australian Housing Trust style” or “poor conventional” dummy = 1 else 0 (source: South Australian Valuer General)
Dwelling quality(DQ)	Dummy	If high quality based on housing style i.e. “high quality contemporary”; or “high quality conventional” or “high quality ranch” or “mansion” or “architectural design“ dummy = 1 else 0 (source: South Australian Valuer General)

The raw data described above were cleaned as follows:

- all sales not representing market value were removed;
- no adjustments were made for time as the market was deemed stable over this time period;
- there was no screening of sales data on the basis of ‘outliers’ to make the resulting model as unbiased as possible from a valuation perspective; and
- only sales that were part of the study area were included.

This resulted in a sales data set of 6,800 sales.

METHODOLOGY:

The methodology adopted used the improved property market sale transactions to establish an interpolated continual raster surface of relative location factors (RLF) at a given point in time. This was achieved through the analysis of completed property transactions captured when the transfer of ownership is registered with the relevant government authority, in the case of Australian jurisdictions, the Registrar General, which is a State Government responsibility. In this study sale transactions occurring between May and October 2006 were captured and used as evidence of market value as at 30th June 2006. The methodology was carried out in two stages. Stage 1 involves creating a RLF value for each residential dwelling in the study area. Stage 2 compares this to traditionally used SES indicators to establish the efficacy of using the RLF as a surrogate SES indicator.

Stage 1:

Only independent variables describing the property (i.e. dwelling characteristics) and assuming the error associated with predicting the sale price is due to omitted variables, in this case “location” were used to predict the **sale price** (shown in Equation 1). A raw RLF (rRLF) was derived from the sales sample by dividing the **sale price** by the **predicted value** as shown in Equation 2.

$$SP_i = B_0 + B_1DS_i + B_2DA_i + B_3LA_i + B_4DT_i + B_5DQ_i + \text{error} \quad \text{Equation 1}$$

$$rRLF_i = SP_i / (B_0 + B_1DS_i + B_2DA_i + B_3LA_i + B_4DT_i + B_5DQ_i) \quad \text{Equation 2}$$

where:

- SP_i = the sale price of the ith property
- rRLF_i = the estimated location factor for the ith property
- LF_i = the derived location factor for the ith property from the value surface
- B₀ to B₅ = the parameter estimates
- DS_i = the dwelling size for the ith property.
- DA_i = the dwelling age for the ith property.
- LA_i = the Land Area for the ith property.
- DT_i = dummy variable for poor style for the ith property
- DQ_i = dummy variable for the high quality style for the ith property

This led to an interpretation that an rRLF greater than 1.0 means, that compared with the average, there was money paid for the dwelling over and above the dwelling itself, namely location. Conversely, a RLF of less than 1.0 would indicate that less was paid for the property that indicated by the dwelling alone and relative to the average of a rRLF of 1.0 is a less desirable location. The next part of stage one was to establish if the derived rRLF was randomly distributed across the geographic study area or was there a spatial pattern that leads to the conclusion that location (represented through the rRLF) had spatial significance. A global Moran's I statistic was calculated to summarize the pattern of the rRLF across the study area to determine if the distribution could have been formed randomly.

A non-deterministic interpolated surface was then formed from the rRLF using ordinary kriging as it was deemed that a smoother surface more accurately represents a relative location factor. This surface of interpolated rRLF factors (from equation 2) produces the RLF surface from which individual RLF scores can be assigned to individual properties. A 25 metre cell size was adopted in the production of the RLF as this would more closely approximate a true RLF value at the individual property level.

Stage 2:

This stage of the methodology created an individual dwelling point representation of the RLF surface and a CD average RLF value. The RLF surface values were extracted to the 2006 individual dwelling points using the ArcMap toolbox, Spatial Analyst Tools, Extraction, Extract values to Points tool. The result provided a property level expression of the RLF surface generated in stage 1 and the means for highlighting the within CD variation of the RLF.

The CD RLF was generated using the ArcMap toolbox, Spatial Analyst Tools, Zonal, Zonal Statistics as Table and the resulting table joined to the CD spatial layer using the CD Code. This function uses a CD layer to calculate the minimum, maximum, average, standard deviation and variance of the RLF surface for each CD. The ABS SEIFA scores were presented as deciles, therefore to provide a standard basis for comparison, RLF decile values were calculated for the CD RLF layer. The resulting layers and values are presented in the results section below.

RESULTS:

Stage 1:

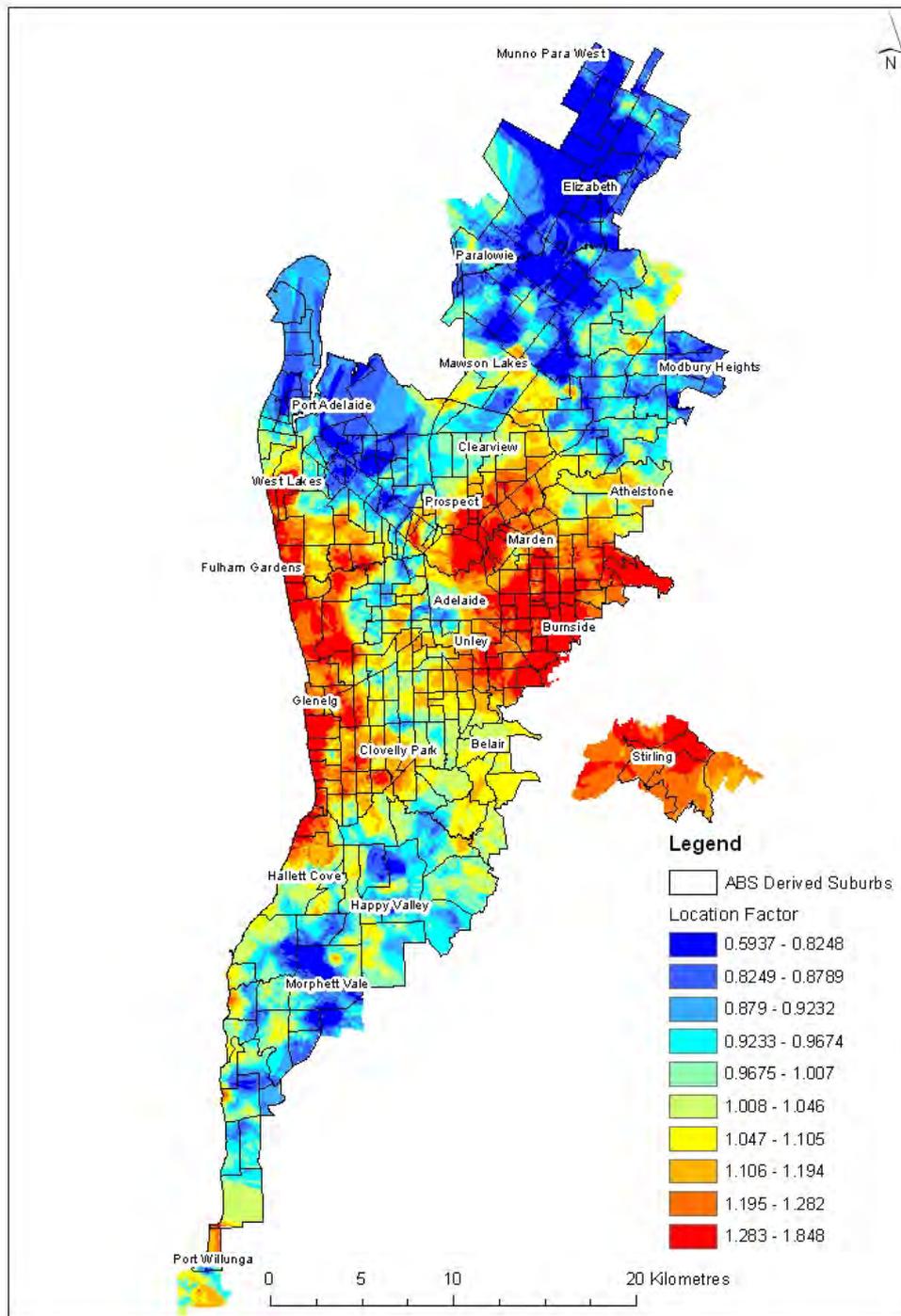
The global OLS regression model specified in Equation 1 was calibrated using the above described sales data set containing 6,800 sales and presented in Table 2 below.

Variable	Coefficient	t stat	Prob
Intercept	-83466	-16.83	0
DS	2095	81.06	0
DT	-43568	-11.98	0
DQ	80546	14.59	0
LA	1.34	0.267	0.79
DA	2261	47.61	0

An adjusted R squared statistic of 0.59 was obtained. This was an expected result as bias in the form of the deliberately omitted location variables can be seen.

The global Moran's Index of 0.23 with a Z-score of 194.9 (p-value of 0.000000) was obtained indicating a less than 1% likelihood that the clustered pattern of the derived rRLF could be a result of random chance. The interpolated raster surface was then generated giving the RLF as shown in Figure 2.

Figure 2: Relative Location Factor Surface.

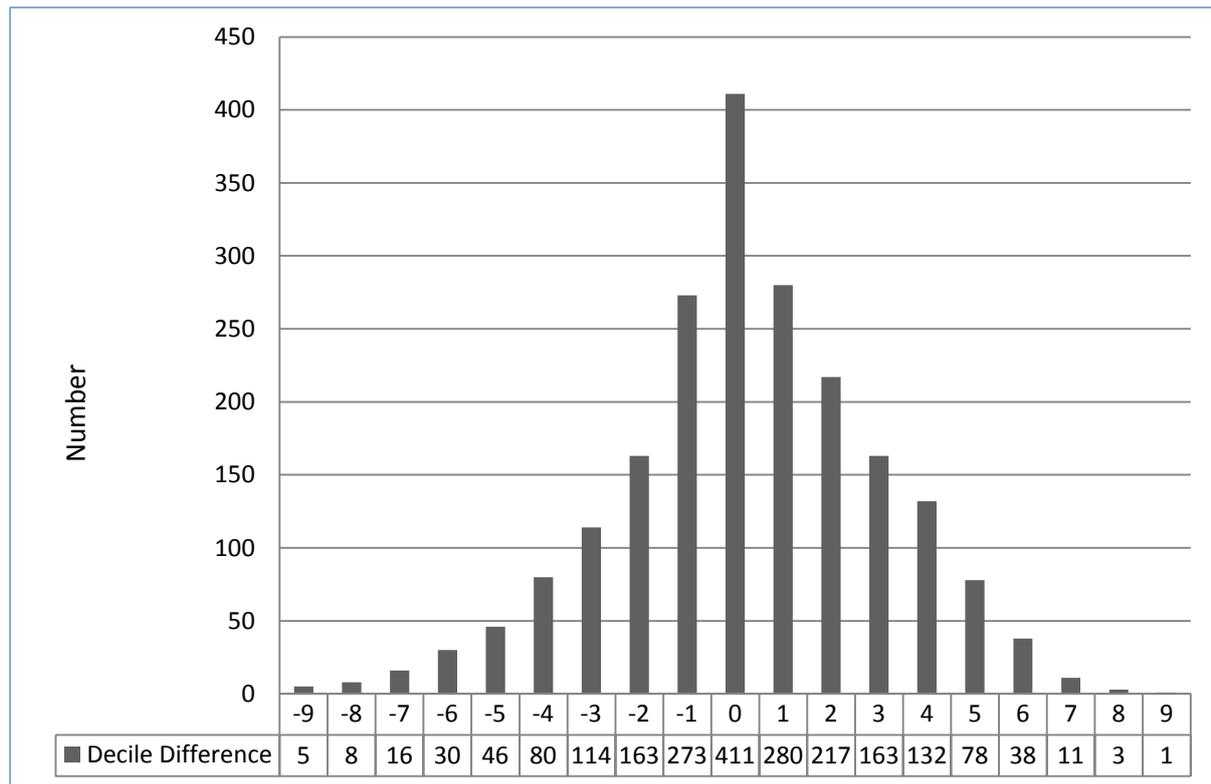


Stage 2:

As stated earlier, the results were not expected to provide an exact correlation with SEIFA, but a metric that could be used to supplement SEIFA, highlight the within CD (or other spatial unit) variation and provide a measure that could be matched to individuals at the property level. The correlation coefficient for the SEIFA state based decile ranking and the RLF decile ranking was 0.55. This is clearly indicative of a relationship without providing a measure that is an exact match and therefore of limited value above using SEIFA.

The difference in decile values is displayed in Figure 3. The difference was calculated as the RLF decile minus the SEIFA decile and a positive results indicates cases where the RLF is greater than the SEIFA decile a negative occurs when the RLF is less than the SEIFA decile.

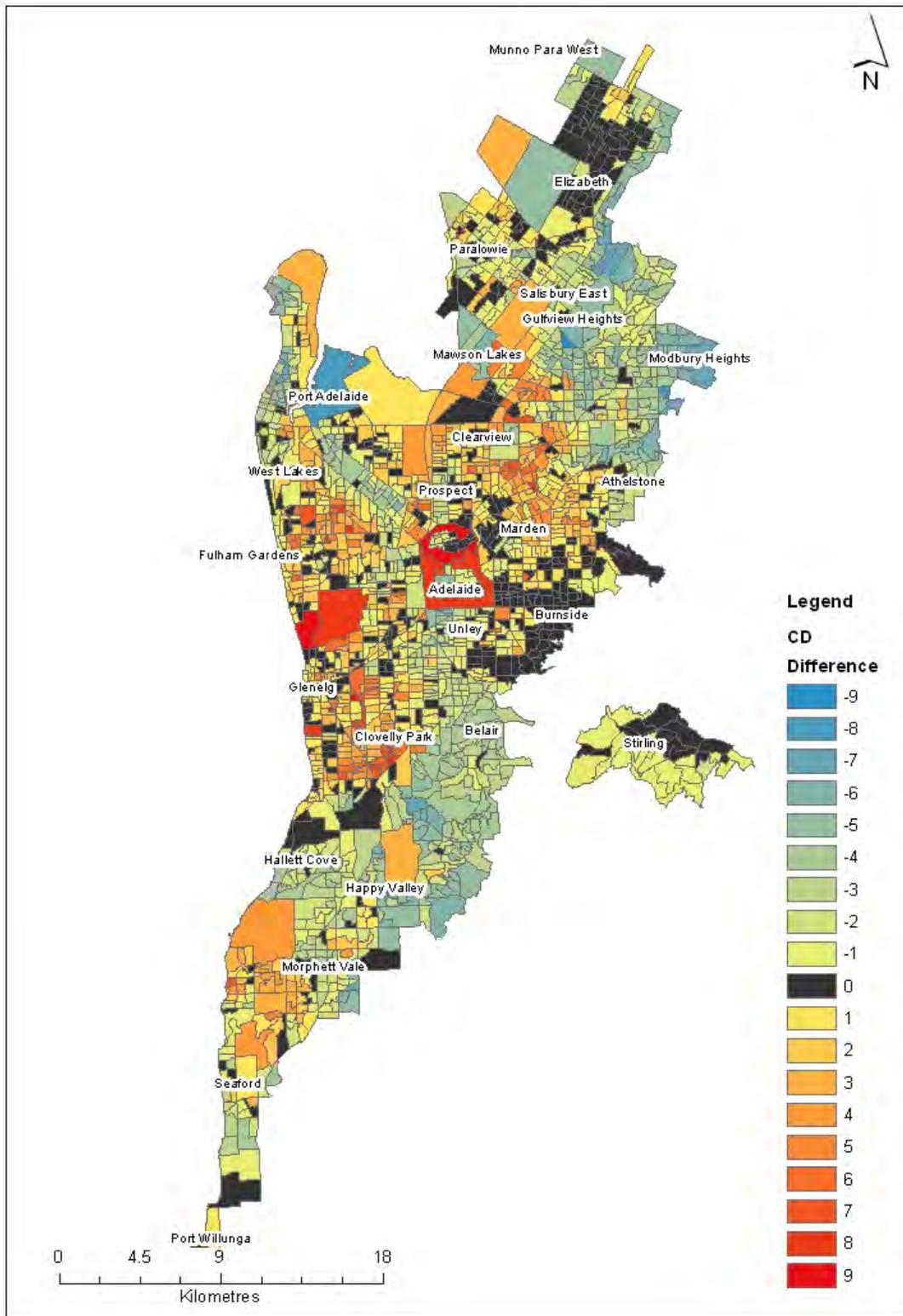
Figure 3: Difference Between RLF Decile and ABS SEIFA Decile.



The difference between the SEIFA decile values appeared normally distributed with 47 percent between ± 1 decile difference and 65 percent between ± 2 deciles different. While the distribution does indicate a relationship is present between the two measures it is not such that the RLF would not have any utility above and beyond using SEIFA. It is important to report a relationship at the aggregate level as this supports the utility of the property level RLF and the added value this will provide for research at a more detailed level.

In addition to the decile difference as displayed in Figure 3, the difference was mapped to visually identify any spatial associations (see Figure 4). Spatially, the differences did not appear visually clustered and occurred across the study area in areas that include high, low and all decile levels in between. It is important to note that the RLF and SEIFA both identify the extremes of disadvantage (Elizabeth area, lowest RLF and lowest SEIFA) and advantage (Burnside, highest RLF and SEIFA).

Figure 4: Spatial Distribution of RLF Decile and SEIFA Decile Difference.

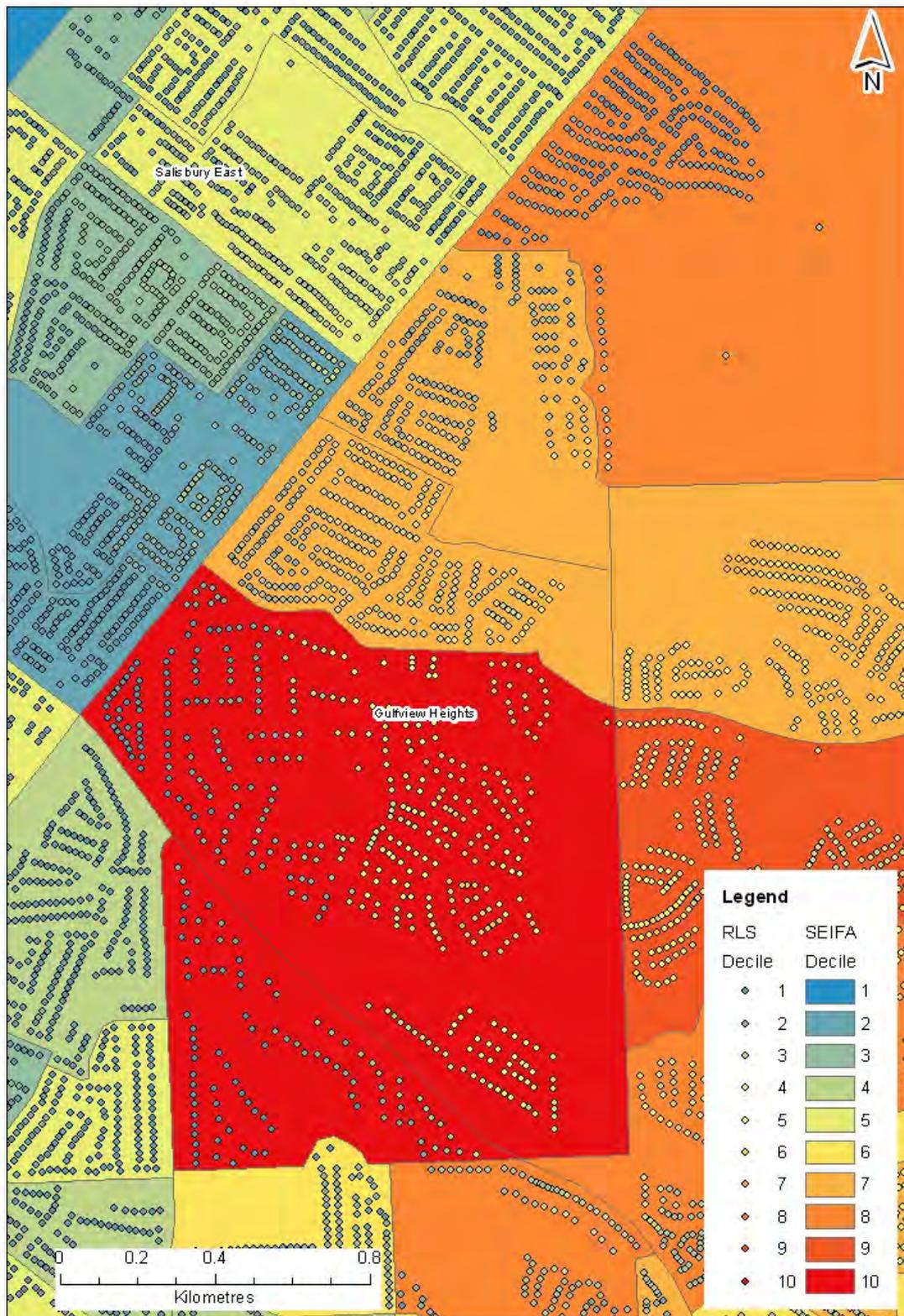


DISCUSSION:

Building upon the work of (Vernez Moudon et al., 2011) these results provide enough to suggest that the RLF as constructed provides an additional SES measure for research into health and SES. One of the aims of this research was to provide a property level SES measure that would work with the more traditionally calculated area level measure but enable the within area variation to be included. The property level RLF decile value is overlain on the CD SEIFA decile value to illustrate the variation that occurs within spatial units (Figure 5). Figure 5 is zoomed to the Gulfview Heights and Salisbury East area approximately 15 kilometres to the North of Adelaide City. This area was selected because the property based RLF decile values display a gradient moving across the area from the west to the east, with lower SES (as indicated by the RLF) in the west to higher values in the east. Compared with the CD based SEIFA decile value which would indicate an area of advantage. In this example, any association with poor SES would not be identified using the aggregate SEIFA measure. Figure 5 highlights a number of areas of difference to pursue this line of research and with the inclusion of census variables and individual level health data will provide the basis to test if the area level data returns a statistically valid relationship with the RLF and whether the property based RLF provides a stronger relationship that enables within area SES variance to be included.

Given that much of the earlier work used to report on the health and SES relationship were based on aggregate spatial units and yet still reported a clear relationship suggests that a property based measure will provide a more locally based expression of SES. It should be noted that the methodology utilised in this research, through the use of surfacing methodology takes into account the influence of neighbouring when used to create the sales value surface. This was a factor which (Vernez Moudon et al., 2011) identified as a strength of their work in the Seattle paper.

Figure 5: Property Level RLF and CD level SEIFA.



CONCLUSION:

The association between poorer health and SES has a long association and in Australian research the ABS SEIFA measures are used via predetermined geographies to model social and health relationships with SES. The ABS is bound by strict confidentiality conditions and does not release unit record data or any data that could potentially identify an individual. Consequently, all analysis using SEIFA is built upon models which incorporate SES based upon an aggregated spatial unit and therefore represent an averaged outcome. This is increasingly evident in the health and place research and is managed using multi-level statistical models to allow both individual data and aggregate to be analysed. In an attempt to improve the SES, health and place research, the objective of this research was to derive a supplementary SES indicator that could be used at the household level.

This was achieved by deriving a RLF and running initial comparisons with the traditionally used SEIFA index. Future research will look at the benefits that might be gained in using the RLF in conjunction with SES indicators. The initial indication is that RLF could potentially enhance the traditional SES indicators through making comparisons that fell into two broad groups. Firstly, the comparison between RLF and aggregate spatial units such as the CD may highlight locations where the CD SEIFA scores were not supported based upon the RLF value variation. This poses the question as to appropriateness of the SEIFA index when compared to a more locally derived metric. Perhaps the RLF identifies the local differences that could be masked using SEIFA and a broader national average. Secondly, and perhaps more importantly, RLF provides within group variation which cannot be identified by SEIFA. This helps address the MAUP issue, assists in the accuracy of resulting research and consequent intervention policy. As the RLF is a dwelling measure and is expressed at each property the variation and association relationships may result in the identification of areas of similarity for research that are more meaningful and more closely reflect the true social structure of the study area.

Future research will investigate the link between RLF, census and individual measures of SES indicators with the SEIFA index to establish if the more locally derived indicators are more closely aligned with the RLF. Future research will investigate the potential to more appropriately identify spatial SES boundaries. The limitation of the RLF is the inability to recognise the underlying elements of the social structure which can be seen through interpretation in conjunction with SES indicators.

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