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Mass Appraisal Certification Standards – The Spatial Dimension

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Abstract

The mass appraisal process is used to determine property values in many jurisdictions around the world as a basis for taxation and has been for a considerable time. The need to be able to transparently demonstrate the fairness and equity of this process is of prime importance to both government and the taxpayer. Currently this is primarily achieved in Australia and New Zealand through a series of assessment ratio studies based on standards established by the International Association of Assessing Officers (IAAO). Both United States and Australasian jurisdictions have started to spatially represent aspects of their mass appraisal process in order to improve the auditing function which leads to the certification for use as a taxation base. Against the broad background of international practice this paper investigates the spatial interpolation of the sales price to the assessed value ratio as a way of contributing to the quality control and assurance of the fiscal cadastre. This is considered through a case study of the metropolitan area of Adelaide, South Australia.

Key Words

Mass Appraisal, Standards, GIS

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INTRODUCTION:

With many jurisdictions around the world relying on the efficacy of the fiscal cadastre for the fair and equitable distribution of the property tax burden, it is becoming increasingly important that this process is able to demonstrate the accuracy of the resulting values in a transparent and accountable manner. Stakeholder confidence is reliant upon a clear demonstration that both the level and the comparability of the resulting assessment of value is fair and equitable to all taxpayers.

The challenge in the auditing of the mass appraisal process for fairness and equity is similar to that faced in the undertaking of the mass appraisal process itself, namely accounting for variation due to location.

It is generally acknowledged within the literature that the real estate market is made up of a number of interrelated submarkets (Adair, Berry et al. 1996; Goodman and Thibodeau 2003) but somewhat less consensus exists as to where the boundaries of such submarkets may be (Watkins 2001; McCluskey, Deddis et al. 2002). Watkins (2001) further argues that such submarket definition may be composed of both spatial and or structural attributes.

Currently, in recognition of the submarket concept various stratifications of the market are normally constructed*, a priori*, within which the auditing process can be undertaken. Currently, within Australian jurisdictions auditing practice centres around the sales ratio studies outlined in the IAAO standards. The level of the assessment is measured by observing how close, on average, the ratio of the Assessed Value (A) is to the Sale Price (S). This is termed the A/S Ratio and has been adopted as the basic building block of assessment accuracy studies. It is also referred to as the Mean Value Ratio (MVP). The uniformity of the assessment is measured by various statistics looking at the dispersion of this same ratio, namely the coefficient of variation (COV) or coefficient of dispersion (COD) as explained in Eckert (1990). As well as the "horizontal equity", it is equally necessary to consider the "vertical equity" which, conceptually, looks at the difference in the A/S Ratio between the high and the low value properties to see if all levels of value are being treated equally. The statistic normally used to investigate this is the price related differential (PRD).

Each Australian jurisdiction and New Zealand has its own set of standards through which both horizontal and vertical equity is achieved, with the Australian Property Institute (API) currently drafting a minimum set of national requirements. The current standards are largely based on statistical interpretation of the IAAO sales ratio studies that have been used in the USA for the last 2 to 3 decades (Eckert 1990). These statistics are based on the ratio of the assessed values to analysed sale prices. This is predicated on the assumption that the sale price represents the market and therefore the difference between the two is the extent to which the assessment does not represent that market. Using enough sales, this provides an intuitively simple and concise measure of the current assessment in terms of the current market. Tolerances for the difference are set, against which the accuracy of the assessment is either accepted or not. Broadly, these statistics address both the level of the assessment and the uniformity of the assessment.

Across Australian jurisdictions and New Zealand there are variations on what is essentially this same theme. In some jurisdictions, instead of sale prices, 'benchmark' valuations are determined as a proxy for market value. There are advantages and disadvantages in adopting this approach but essentially it achieves the same goal. Other statistics, again measuring a difference between the market and the assessment, may be used to indicate the accuracy of the overall assessment. These include the 'hit rate' (number of properties sold with a sale price and assessment within a predefined tolerance) and the MAPE (Mean Absolute Percentage Error). In each case the same concept is adopted, namely understanding the level and the uniformity of the assessment in terms of the market.

The broad objective of this paper is to demonstrate how spatial analysis undertaken within an integrated Geographic Information System (GIS) environment may contribute to the quality and transparency of the certification and auditing of the mass appraisal process both in terms of assessment level and assessment uniformity. Specifically, the paper seeks to achieve this by creating two interpolated surfaces across the study area as follows.

The first is the interpolated surface of the A/S Ratio enabling potential locations of unacceptably high and low sales ratios to be identified for further investigation and potential correction. It is this overall variation that is identified in the COV and COD sales ratio statistics. This interpolated surface can show how this overall variation is distributed providing an opportunity to address any problem and so reduce (improve) the overall COV and COD statistics enhancing the fairness and equity in the resulting property tax base.

The second is the interpolation of the Sale Price created to show geographic location of the top and bottom 10% of properties by Sale Price so that analysis can be undertaken of the sales ratio statistics in these locations to determine any bias between these property groups. It is this overall bias that is depicted in the PRD statistic. This interpolated surface can again demonstrate where such bias may be occurring, presenting the opportunity for revision and thus improving any vertical inequality that might otherwise have been present in the resulting assessment. The top 10% was an arbitrary choice for this study. It is acknowledged that, in practice, this categorisation may well be broader. However, for this study it is the methodology that is the focus.

The findings of this paper suggest that the A/S Ratio analysis statistics and standards, promulgated by the IAAO and to varying degrees adopted by Australian and New Zealand jurisdictions, may be usefully represented spatially using interpolated continuous surfaces. The validity of such interpolation relies on Tobler's First Law (Tobler 1970) suggesting that one location may exhibit similarity more likely to be in common with locations that are closer than further apart. It is considered appropriate as the data conforms with this theory and hence interpolation would be a suitable analytical tool.

This paper therefore attempts to take the overall concept embedded in the A/S Ratio studies one step further by investigating not only what the differences are but where, in geographical space, these differences are occurring without making any *a priori* assumptions as to spatial segmentation. This highlights the importance of location and questions whether it should be incorporated into mainstream assessment ratio studies as part of the Australasian standard.

Currently, the jurisdictions investigated in Australasia acknowledge this importance and have begun implementing some form of spatial analysis but acknowledge they are only in the early stages of developing this important spatial dimension as part of the auditing process.

LITERATURE REVIEW

Central to the demonstration of fairness and equity in the process is a robust and rigorous means of measurement. The literature on such means of measurement is extensive and largely focused on issues arising out of IAAO standards implementation.

The primary statistical tool recommended for use to measure assessment performance is an assessment sales ratio study (A/S Ratio Study) (IAAO 2010). It has evolved over decades of practice and research and emanated from early efforts in the 1930's in the USA that identified 3 key areas that were associated with assessment performance evaluation:

- a single, summary measure was desired instead of a series of different ratios across different property groups;
- an indication of the significance of the differences or biases was desired so that one would be confident the results did not reflect the vagaries of sampling; and
- a separation of assessment bias from random errors was desired (IAAO, 1977).

Since that time there has been a plethora of research related to the various statistical tests that form part of an A/S Ratio study and notable contributions have included:

- Sample size requirements (Gloudemans 1994 and Steiner 1994);
- The necessary conditions for sale prices and assessed values to be included in the study (Gloudemans 1999);
- The use of jurisdiction stratification as a technique for improving the evaluation of an assessment (Bourassa et.al. 1999 and Bourassa 2003);
- The need for a robust estimator for the level of the assessment (Young 1989, Birch et.al. 1999, Tomberlin 2001 and Denne et.al. 2005);
- The determination of Confidence Intervals for the Coefficient of Dispersion (COD) (Gloudemans 2001 and BenMaMoun 2006);
- The appropriateness of tests for identifying vertical inequities (Paglin et.al 1972, Cheng 1974, Kochin et.al. 1982a, Kochin et.al. 1982b, Bell 1984, Cannaday et.al. 1987, Sunderman et.al 1990, Clapp 1990, Sirmans et.al. 1995 and Jensen 2009);
- The appropriateness of tests for identifying inequities across different property groups (Gold 2007 and Moore 2008).

Predominantly the focus has been on the robustness and appropriateness of the various tests used to measure the accuracy and uniformity of a property's assessed value as related to its actual market value (as represented by most practitioners as the sale price but by some as an expertly derived market value).

Notably, there has been little research on the use or practice of GIS as a tool for enhancing the evaluation of the performance of an assessment. The use of GIS in mass appraisal is now widespread and reporting on its use in the literature has been dominated by:

- thematic mapping of assessment value (McCluskey et al. 1997).
- mass appraisal system design (Longhorn 1998, Thomas 2000);
- GIS's ability to enhance valuation model building particularly with respect to sub market delineation and accounting for location (Rosiers et al. 2000);
- It's ability to assist in data capture for valuation model building (Marano 2000); and,
- GIS's capabilities in relation to comparable sale selection and identification (Hardester 2002).

To date the advantages of GIS to mass appraisal in quality control have been identified as its ability to spatially identify A/S Ratio and assessment value outliers and the identification of spatial patterns in assessment error through mapping and visual interpretation (Wadsworth 2006, O'Connor 2008) but, to date, these visual thematic improvements haven't led to any new performance measures to which tolerances and benchmarks can be assigned. A suggested list of activities that could be facilitated and improved through GIS support was discussed by Wadworth (2006). That list included the quality control and assurance of the fiscal cadastre and it is that this paper seeks to develop further through the application of spatial analysis and interpolated surfaces as tools for enhancing the quality control and assurance process.

RESEARCH METHODOLOGY

This paper uses Adelaide, capital city of the Australian state of South Australia as the study area. The veracity of the 2009 annual assessment of capital value for residential properties was adopted as a case study to investigate. The IAAO sales ratio analysis standards were used as the basis of the analysis. The total study area incorporates approximately 370,000 residential properties and covers approximately 980 sq. kms. As well as using the study area as a whole, it was spatially segregated, *a priori*, into two smaller spatial units, namely a local government area and a suburb, by way of example of current practice within Australian jurisdictions so that the results may be compared.

The methodology is divided into two stages.

<u>Stage 1</u> involves deriving the generally adopted statistics for measuring standard of assessment across selected Australian jurisdictions (Table 1).

The statistics calculated were, as outlined by Eckert (1990):

1. the ratio of the Assessed Capital Value (A) to the Sale Price (S) (A/S Ratio).
2. The Coefficient of Variation (COV) is expressed as a percentage of the standard deviation divided by the mean A/S Ratio.
3. The Coefficient of Dispersion (COD)
   COD = (100(AAD))/ median A/S Ratio in which AAD is the average absolute deviation from the median of each of the A/S ratios calculated for each of the 10,300 sales in the data set.
4. The Price Related Differential (PRD)
   PRD = The mean A/S Ratio divided by the Weighted Mean A/S Ratio.

Each of these statistics were calculated at three different spatial market stratifications reflecting the general current practice. In this study these stratifications comprised the whole metropolitan area, a selected local government area (LGA) and a selected suburb within that LGA. Stratification on property characteristics was not taken any further than the single residential dwellings which is represented by the sales used in this study. In the conventional way these statistics were calculated for each spatial unit and presented in table form (Table 1) in the results.

The tolerance of the mean A/S Ratio of between 0.9 and 1.10 was considered acceptable with variation tolerances of the COV being less than 17.0 or the COD less than 13.0 as a minimum benchmark (Rossini and Kershaw 2008).

Stage 2 then builds upon these results to understand whether a spatial view of these statistics could contribute to a more equitable outcome.

To view the A/S Ratio statistic and the associated dispersion, the calculated A/S Ratio was interpolated across the whole study area using an Inverse Distance Weighted (IDW) interpolator. In this way the methodology shows how the A/S Ratio varies across geographical space thus demonstrating the dispersion of the ratio as well as the level. The Global *Moran's I* spatial statistic was calculated to demonstrate the probability of such distribution being clustered or arising as a result of chance (Maguire, Batty et al. 2005; Mitchell 2005). The interpolation of the A/S Ratio statistic is visually examined to identify locations of high and low A/S Ratio statistics as potential targets for investigation and improvement. If these can not be identified then, at least in this study the spatial dimension of sales ratio studies adds nothing.

The question of spatial representation of the PRD was addressed by representing visually the essence of what the PRD is trying to show. The objective of the PRD is to highlight any vertical inequity that may exist in the area being studied. This is referred to as *regressive* assessment if the PRD value is larger than 1, indicating that the high valued properties are being under assessed (weighted mean is less than the mean) and conversely, less than 1, referred to as *progressive* assessment, indicating the high valued properties are being over assessed (weighted mean above the mean). Because the weighted mean is weighted by the value of the properties it is all about over or under assessing in relation to high valued properties. Therefore, this methodology, observes how the high and low valued properties are spatially represented and within these groups of high and low valued properties the A/S Ratios are summarised in order to determine if there is a significant difference in the A/S Ratios. In essence, the question is whether the Ratios may indicate that there is an over or under assessment of properties based on their value category. The value categories were adopted on the basis of those properties in approximately the top or bottom 10% of the properties in the study area. Again, an interpolated surface was calculated across the whole study area using an Inverse Distance Weighted (IDW) interpolator of the sale prices, indicating market value, identifying the location of these top and bottom 10% of properties. The A/S Ratios between these groups were analysed to establish if any significant difference exists in the A/S Ratio indicating potential progressitivity or regressitivity between these geographic areas of high and low valued properties.

A data set comprising approximately 10,300 residential sale transactions from the six month period from October 2008 to April 2009 was created to represent market values as at the date of valuation, which, in this case, was January 1st 2009. These sales were obtained from the state government and were analysed by the Office of Valuer General as being representative of market value at the time of sale. As analysis of price movement over the time period showed a stable market, no time adjustment was made to the sale price. The capital value is the market value of the unencumbered estate in fee simple and therefore in theory should be close to the market as indicated by the sales selected. The data attributes of the sales transactions were simply the Sale Date, Sale Price and Assessed Capital Value. This data was integrated with the Valuation Cadastre which represents the taxable property boundaries to which the assessed capital value applies giving spatial reference within a GIS environment.

RESULTS and DISSCUSSION:

Stage 1:

The results of applying the above methodology to the data set above described is summarised in Table 1.

Statistic/Area	Whole Study Area 369,842 properties 10,332 sales	LGA Marion 29,085 properties 885 sales	Suburb of Mitchell Park 1,687 properties 47 sales
Mean A/S Ratio	0.91	0.91	0.92
Median A/S Ratio	0.89	0.91	0.92
COD	9.17	8.53	5.90
COV	13.38	12.34	7.44
PRD	1.01	1.01	1.00

Source: Authors **Table 1 Summary of IAAO statistical output**

Discussion

Although acceptable tolerance may well vary from jurisdiction to jurisdiction and from one market stratification to another, a conventional interpretation of these results may suggest that the overall assessment, over the whole study area, may be acceptable adopting a tolerance between 0.9 and 1.1 (Table 1), but in the most important aspect of uniformity it appears quite acceptable with the COV and the COD of 13.4 and 9.17 respectively. This is below the absolute minimum tolerances of 17 & 13 and close to reasonable tolerances of less than 13 and 10 respectively suggested by Rossini and Kershaw (2008) and shown for the whole study area in Table 1. This conclusion is reinforced within the *a priori* smaller spatial segmentation of the study area in terms of LGA and suburb level, again as shown in Table 1. The PRD results suggesting the potential presence of *regressitivity or progressitivity* in the assessment indicate that the assessment was acceptable in all three spatial stratifications with the PRD statistic being within the acceptable range 0.98 to 1.03 (Eckert 1990).

Stage 2:

However, when the A/S Ratio variation is spatially represented for the whole study area, as shown in Figure 1, the same discussion, while accepting that overall the variation may be within tolerances, can focus on locations where the level of the assessment is out of line with the market. Specific locations are shown where potential over and under assessments are likely to occur (light and dark areas respectively in Figure 1). The interpolated surface does not offer precise locations of definite problem areas. Using different interpolators can produce differing surfaces, but overall the proximity of the highs and the lows will generally be in the same locations. The question as to the most appropriate interpolator for this type of analysis will require separate research and is beyond the scope of this study. However, even this relatively simplistic interpolated surface provides opportunities to enhance the quality of the assessment still further through the allocation of scarce resources to specific potential problem areas. This is predicated on the assumption that the distribution shown in Figure 1 not just a random distribution that has occurred by chance alone. Therefore the Global Moran's I statistical test was undertaken indicating a less than 1% probability of this distribution being random (Maguire, Batty et al. 2005; Mitchell 2005). This same test revealed a less than 1% and less than 5% probability at the LGA and suburb spatial stratification respectively as shown in Figure 2. The sales used to generate this interpolated surface appear reasonably well distributed across the study area as is shown in Figure 4.

The results for the mean A/S Ratio level for the LGA of Marion overall was 0.91 (Table 1) which, although may be the low side depending on the tolerances set by the respective jurisdiction, when looking at the spatial distribution of this ratio in Figure 2 it can be appreciated that some suburbs within this LGA are high while others are low which, on average, may generate an overall misleadingly better result than the spatial distribution reveals. The suburbs of Sturt (southwest of Mitchell Park) and Ascot Park (immediately north of Mitchell Park) appear over assessed while parts of Parkholme (adjacent Ascot Park) and Hallett Cove (southern part of the LGA) appear under assessed. Within the suburb of Mitchell Park an overall A/S Ratio of 0.92 (Table 1) was calculated. On observing the spatial distribution (Figure 2), the northern and southern areas within the suburb appears to be higher than the middle again leading to an overall average within the suburb that may be considered acceptable. The influences that may be causing the disparity within the suburb or LGA may be better understood with reference to surrounding areas. This can be seen in Figure 2 where the influence of Ascot Park (a suburb just to the north of Mitchell Park) may be affecting Mitchell Park. This may help to understand the local problem that, without the more holistic approach provided by the interpolated surface, may not be possible.

Further stratification by property characteristics may find that certain properties are inappropriately classified or the valuation process is breaking down for certain property types. This enables the data to be amended and/or the valuation problem to be addressed.

In suburbs (or any spatial stratification) where there are not enough sales to determine meaningful A/S Ratios in their own right, using the interpolated surface from the whole (or a larger) spatial unit can provide a solution based on information from that broader area thus providing evidence where there previously may have been none.

The Price Related Differential PRD) was spatially represented by plotting the location of approximately the top and bottom 10% of properties in the study area together with a summary of the A/S Ratio statistics in each. The first group contains all ratios for the whole study area (10,332). The second group contains the high valued property area (darker shade area in Figure 3) that represented 7.4% of the total, whereas the third group contains the low valued property area and represented 15.6% of the total. These results were examined to determine if these 3 groups were significantly different to one another. If there is no significant difference then the A/S Ratio is not favouring either the high or low valued properties in comparison to the overall Ratio. The non parametric Kruskal-Wallis test was adopted to test the following hypothesis

H_0: The three groups are assessed at the same percentage of market value.
H_1: The three groups are assessed at different percentages of market value.

The p-value indicated that the null hypothesis be rejected at the 99% confidence level.
Given that $p<0.01$ we can reject the null hypothesis and accept the alternative hypothesis that the A/S Ratio means are different across the different value groups. Although this does not require spatial analysis to achieve , it can be seen that in this example it may be an assistance for the valuers to see where the likely locations are of the relevant groups so that further investigation can be undertaken. These results tend to show that the high valued areas along the coast, in some inner eastern and southern suburbs may be under assessed in relation to some lower valued northern and in southern suburbs. This regressitivity is evident even though the overall PRD statistic indicated an acceptable tolerance level of 1.01. Again, without this spatial segregation it would be much harder to identify locations that are most likely to require a review by valuers to ensure the highest degree of fairness and equity in the final assessment as is possible. A general feature of achieving improvements in the quality of the mass appraisal process is that it usually incurs greater cost. These improvements can be gained with little or no cost as it is about managing the same data and the same resources with a more effective methodology.

CONCLUSION

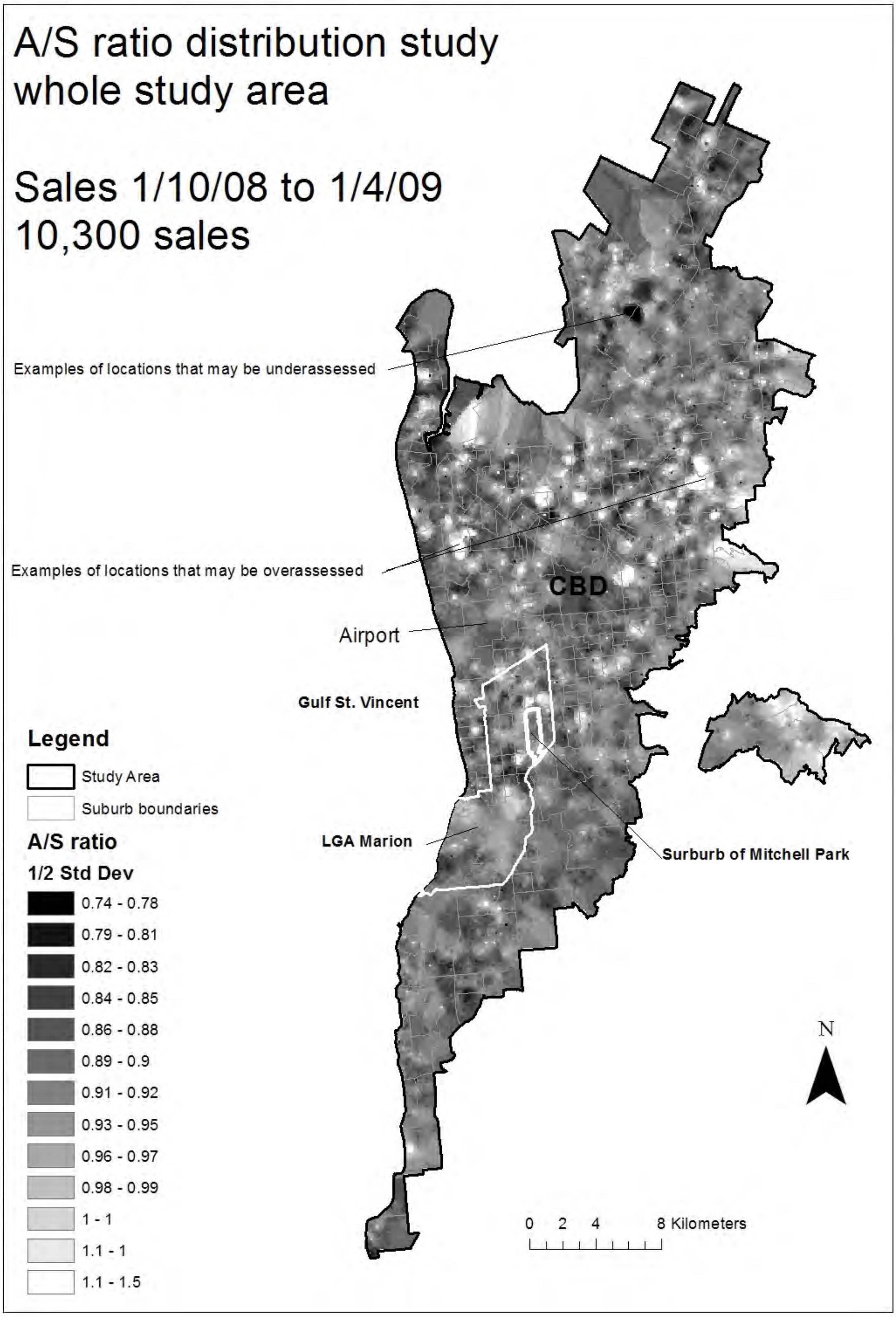
The objective of using interpolated surfaces to visually examine the spatial distribution of various statistics conventionally used to determine the accuracy of a mass appraisal has been achieved. Even though the conventional statistics indicated acceptable results, visual interpretation of the spatial surfaces suggested locations where the assessment may be improved. This is generally not possible otherwise. Hence, the spatial dimension of the traditionally adopted A/S Ratio should be able to contribute to the overall fairness and equity of the property taxation base through identification of potential problem areas not revealed using the conventional suite of available statistics.

This study does not suggest that highlighted locations will automatically be problematic, but rather provides an efficient and effective methodology for deploying scarce resources for further investigation. Any errors corrected will enhance the accuracy of the assessment through improvement in the uniformity that may not otherwise have been detected. This may in turn enable lower COD and COV to be expected as well as lowering the likelihood of vertical inequities. This could allow an increase in the level of the assessment (closer to that of the market) without necessarily incurring a greater number of taxpayer objections. This would provide a more equitable distribution of the tax burden.

With sales samples representing relatively few of the total number of properties, interpolation can provide a holistic aspect of the A/S Ratio distribution. This may then demonstrate not only what the difference is between the assessment and the market but, arguably more importantly, where such differences may exist. This can help identify potential problem areas enabling valuable resources to be efficiently allocated to address them with little or no extra cost.

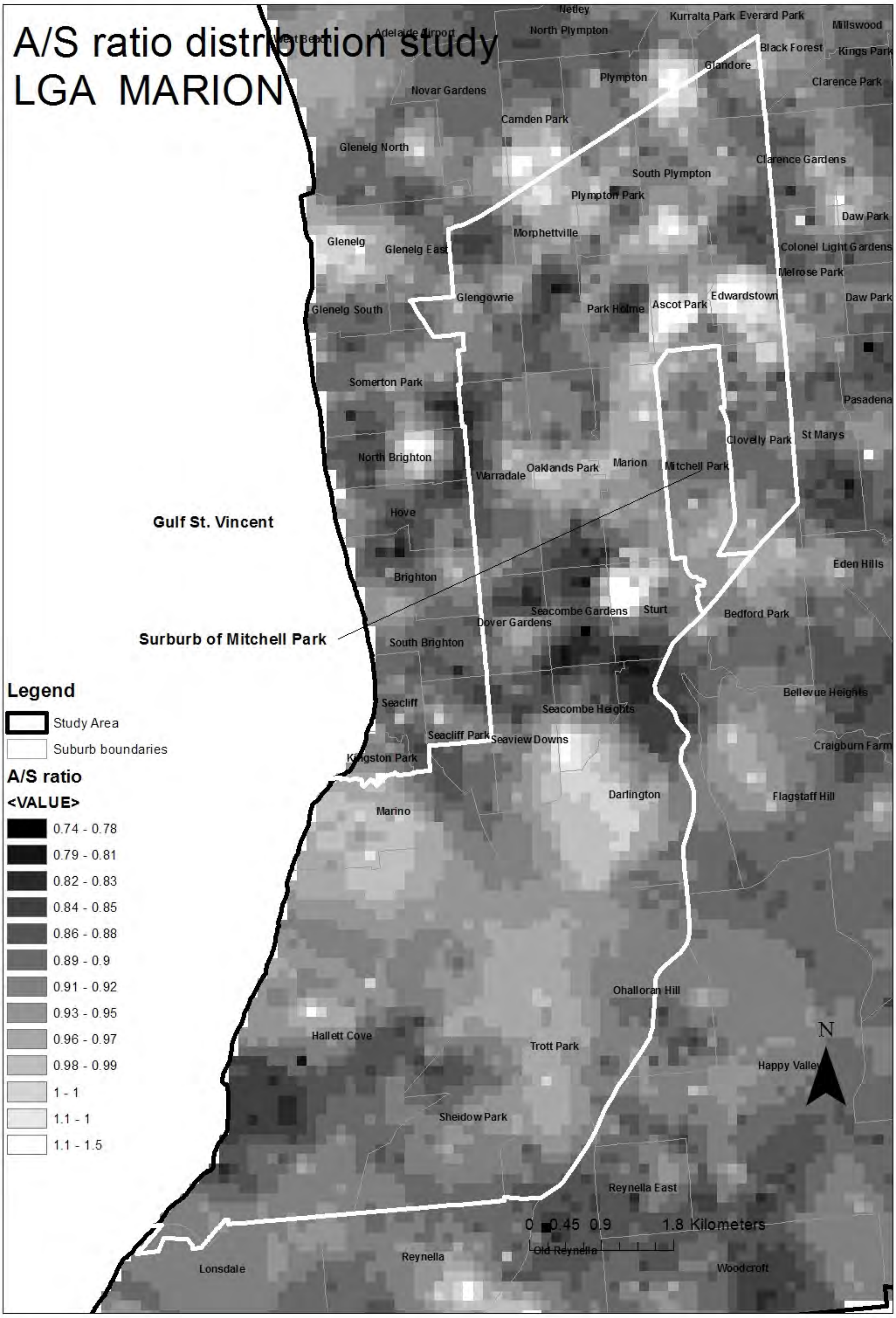
Further areas of research would need to be undertaken to fully realise this potential. The first is that of the choice of interpolation to display the A/S Ratio distribution. There are many types of interpolation to investigate and the most appropriate choice would only enhance this preliminary investigation that has used the simple, but easily understood IDW methodology. Secondly, field evidence that such methodology can highlight problematic areas in an efficient and effective manner needs a study to be undertaken.

With the increasing need to offer stakeholders a transparent auditing process describing the fairness and equity in the mass appraisal process the inclusion of spatial analysis incorporating such interpolated surfaces may offer considerable assistance.

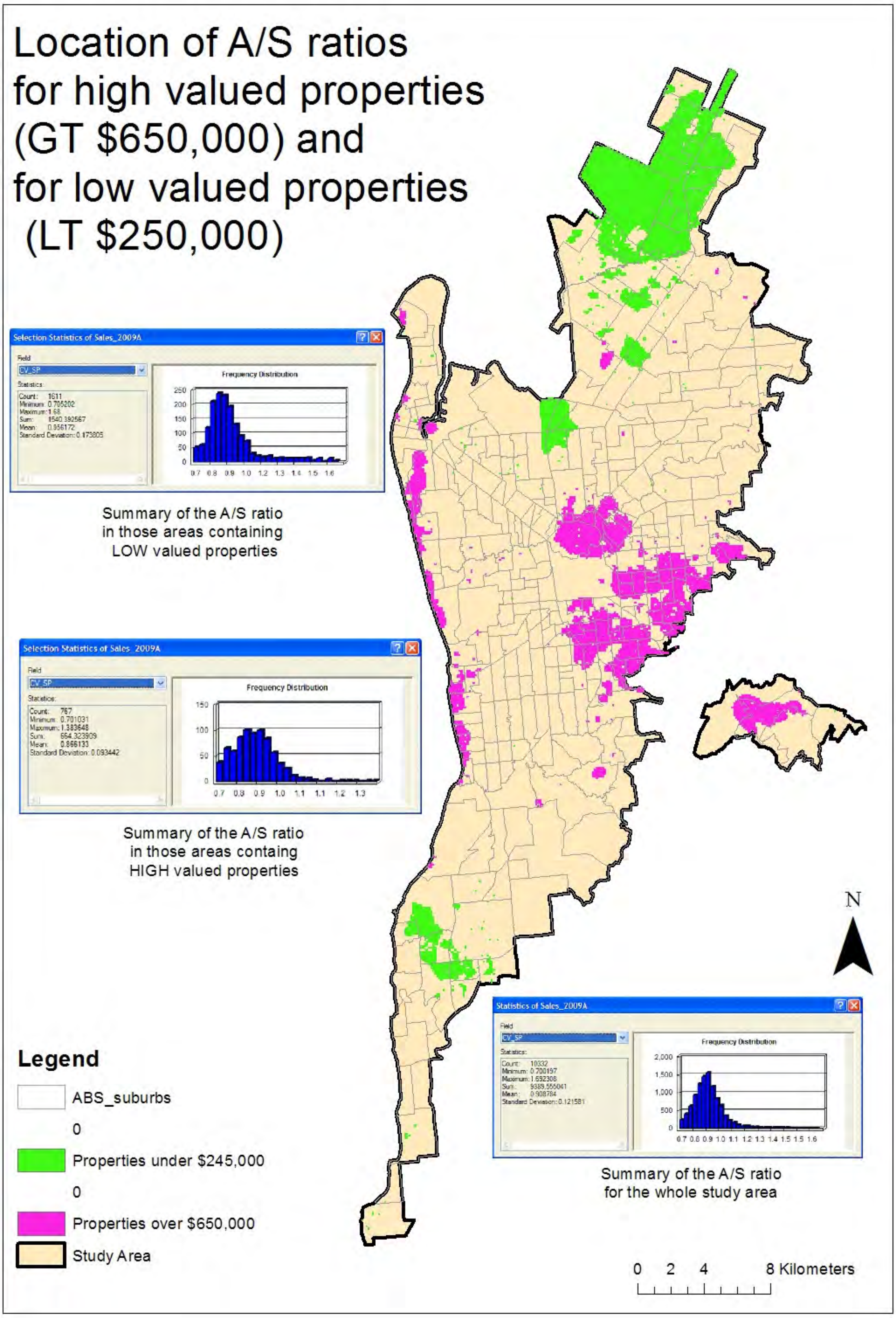


Source: Authors

Figure 1 A/S Ratio distribution over the whole study area

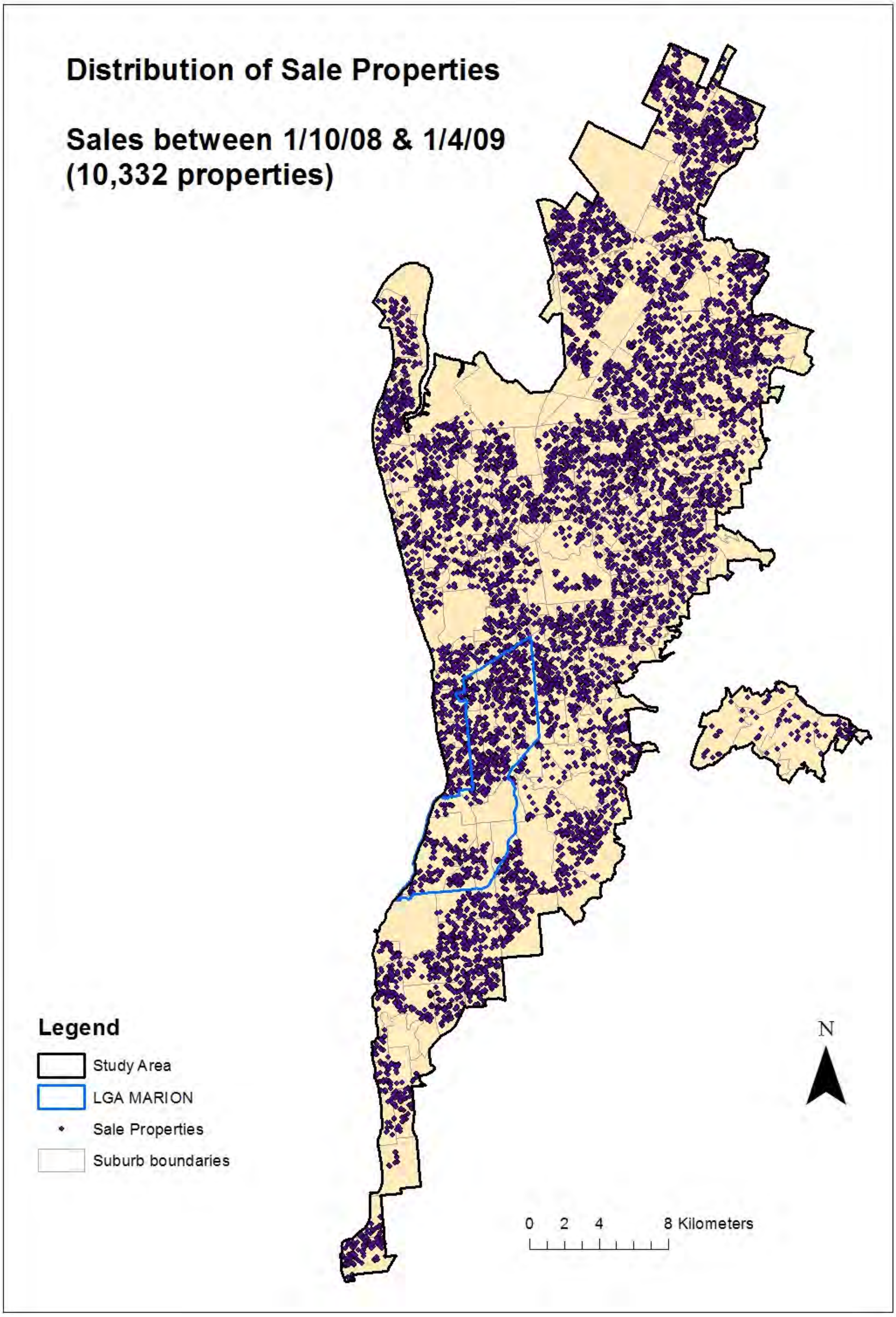


Source: Authors Figure 2 A/S Ratio distribution over the LGA of Marion



Source: Authors

Figure 3. Location of high and low valued properties



Source: Authors

Figure 4 Distribution of sales used across the study area

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