Modeling the Value of View in Real Estate Valuation: A 3-D GIS Approach

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Abstract

Views, being a qualitative and subjective variable, are difficult to measure and quantify for valuation purposes. To quantify view in a variable, there is a need to reflect the influence of surrounding buildings' height, the surrounding topography, as well as the height and orientation of the subject property itself. Such influences could only be captured using 3-D modeling techniques. Few studies have explored the use of 3-D modeling for valuation and mass appraisal purposes. This paper demonstrates the use of 3-D GIS and regression analysis to estimate the value of a view in an urban housing market. It focuses on the valuation of sea view in private high-rise residential properties located near the eastern coast of Singapore. Our results show that an unobstructed sea view will add an average premium of 15% to the house price. In addition, we further illustrate the application of our model in a simulation exercise to maximize the seaview of a redevelopment project in the same neighbourhood. The paper further suggests implication of pricing strategies of private developers in pre-construction sales.

Key words: view, valuation, 3-D GIS

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1. Introduction

Real estate valuation is concerned with the determination of the value of an interest in a parcel of real estate at a specific point in time. This value can be expressed as a market value, the value in use or in other perspectives, such as depreciated replacement cost. In arriving at this value, the focus has been on the analysis of the factors with regards to the market as well as the subject property itself. Generally, the factors affecting the value of a property can be categorized into those which are quantifiable and those which tend to be subjective and therefore not easily quantifiable. The location of the property, for instance, while could be defined in terms of distances from amenities and facilities, is difficult to be quantified as a single factor (Lusht, 1997). The orientation and view of a property, especially in high-rise buildings, are also difficult to be quantified. In assessing such factors, proxies and dummy variables are often used to mitigate the subjectivity of the factors.

In Singapore, the high density and high-rise nature of properties has also led to significant differences in the view and orientation of properties in these buildings. These characteristics do influence value as buyers generally would pay more for apartments with a good view and a favourable orientation. However, the amount of premium for such properties is difficult to determine unless a 3-D visualization of transacted properties with different views and orientation could be plotted to account for the differences. Furthermore, as more and more tall buildings are being constructed, properties with existing views might be obstructed by the taller new buildings. 3-D visualization can also be used to simulate how views and orientation of existing properties could be affected with new developments. However, few studies have explored the use of 3-D modeling techniques for valuation and mass appraisal purposes.

This paper attempts to develop a methodology to quantify view with the aim of enhancing valuation judgment. In this paper, we demonstrate the use of 3-D GIS and regression analysis to estimate the value of a view of residential properties. Specifically, the paper focuses on the valuation of sea view in private high-rise residential apartments located near the eastern coast of Singapore. In addition, we further illustrate the application of our model in a simulation exercise to maximize the seaview of a redevelopment project in that area. We further suggest the implication of such view maximization on the pricing strategies of private developers in pre-construction sales.

The paper is organized as follows. A brief review of past studies on real estate valuation of views is given following the introduction. A description of the data and the proposed methodology is then given in the following section. Section 4 provides the estimation results and analysis. Section 5 illustrates the application of our model to a potential development. The last section concludes with some applications of this study and recommendations for developers.

2. Literature Review

Views, being a qualitative and subjective variable, are difficult to measure and quantify for valuation purposes. Early studies on real estate valuation used single dummy variables to account for the view effect on prices. McLeod (1984) utilizes dummy variables to indicate the presence of a river view in suburbs around the Swan River in Perth, Australia. Kulshreshtha and Gilles (1993) adopted the same approach to estimate the value of a view of the South Saskatchewan River. Seiler, Bond and Seiler (2001) and Bond, Seiler and Seiler (2002) both found that water views add substantial value to a property using dummy variables. Seiler, Bond and Seiler (2001) concludes from the analysis of appraisal-based data around Lake Erie that lake view adds 56% to home values whereas Bond, Seiler and Seiler (2002) using transaction-based data around the same Lake found that lake view adds an 89.9% premium to a house.

Some recent studies began to use several dummy variables to measure different types and quality of views. Benson *et al* (1998) examine the impact of views in Bellingham, Washington using dummy variables. They use four levels of ocean view (full, superior partial, good partial, and poor partial), two levels of lake view (view from a lakefront property and view from a non-lakefront property), and whether or not the property has a mountain view. Bourassa, Hoesli, Sun (2003) analyze the mutli-dimensional feature of view (type of view, scope of view, distance to coast, and quality of surrounding improvements) and empirically test the impact of views using dummy variables. The results indicate that aesthetic externalities have a substantial impact on residential property values.

Views are found to have substantial impact on property values in most studies (Darling, 1973; Plattner and Campbell, 1978; Gillard, 1981; Rodriguez and Sirmans, 1994; Bond, Seiler and Seiler, 2002) although some studies have also reported insignificant impacts (Davies, 1974; Brown and Pollakowski, 1977; Correll *et al*., 1978; Paterson and Boyle, 2002). There is therefore no general consensus amongst these studies on whether views have a significant impact on prices.

However in these studies, the existence of view is determined by site inspection. This process could be time-consuming depending on the number of properties in the sample. In addition, the categorization of views requires subjective interpretation that may not be consistent across properties or observers. These shortcomings could be obviated through the use of GIS data.

Lake *et al* (1998, 2000a and 2000b), being the first to utilize GIS to analyze the visibility of properties in Glasgow, Scotland, use the viewshed function in GIS to calculate view scores based on what is visible from the property and then weight cells by their distance from the observer. In their analyses, they consider the heights of surrounding buildings as impediments to visibility. Their results indicate the views of roads, railways and industrial estates have a negative impact on property prices. However, the authors did not manage to detect any positive significant impacts of views arising from parkland, water features and vegetation. In addition, in Lake *et al* (1998), the view of a road from the back of a property is found to have a positive impact whereas the view of a road from the front has a negative impact, a result that is counter-intuitive.

More recently, Paterson and Boyle (2002) use GIS data to develop variables representing the visibility of surrounding land use/cover features in a hedonic model of suburban/rural residential housing market. The visibility variables measure the percentage of the land visible overall within one kilometer of a property, as well as the percentage of visible land in each land use/cover category. Four types of land use/category are examined: development, agriculture, forests and surface water. Three hedonic models are then estimated to determine if views affect property prices and further if omission of visibility variables leads to omitted variable biases. The results illustrate that the visibility measures are important determinants of price and their exclusions may lead to incorrect conclusions regarding the significance and signs of other environmental variables. Bourassa, Hoesli, Sun (2003) provide a more complete review of previous studies of the impact of views on property prices.

3. Data and Methodology

The main technique that we have developed in attempting to quantify the measurement of view is to construct a Viewshed Index. What is visible from a location is an important element in determining the value of real estate. Our purpose in this study is to quantify the effect of view on property prices. To quantify the effect of view on property values, we need to create some form of index or variable which will capture the extent and quality of the view. The variables should reflect the effects of:

a) the observer's orientation;
b) the observer's height elevation;
c) the height of surrounding buildings;
d) the surrounding topography; and,
e) the type of view – sea, city, nature reserve.

Based on these considerations, we find that there is a need to analyze such effects in three-dimensional space. A suitable commercialized software for such purposes would be the ArcGIS 3-D Analyst. The software not only allows us to visualize the urban landscape in three dimensional space but also allows us to perform visibility analysis.

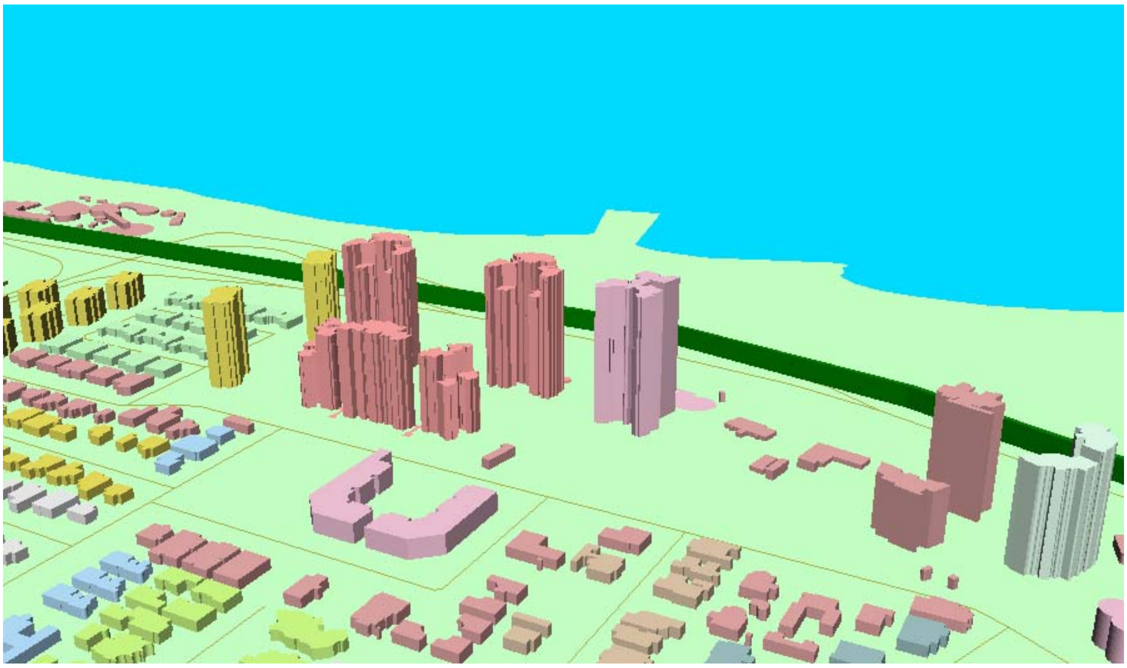
In this study, it was decided that we split the view effect into two variables, one capturing the type of view and another capturing the extent of the view. The first variable would be a dummy variable (seaview in our context) indicating whether a particular view (like seaview) is visible from the observation point. The second variable (viewshed) is a continuous variable capturing the range and extent of the dominant view. Both variables are constructed with the assistance of ArcGIS 3-D Analyst.

The first stage in defining the visual impact measures for each property is to generate a Digital Elevation Model (DEM) of the study area. The second stage would involve the conduct of viewshed operations to identify the land uses visible from each property. The last stage would create some form of indices to capture the visibility of each property.

A DEM is a 3-D model of the urban landscape containing the land height and building height information (see Figures 1, 2). In this case, since the land is relatively flat in our study area, we suppressed the effect of land height on visibility. The most time consuming part of creating the DEM is to record the heights of all buildings in the study area. To simplify the problem, we assume that all the buildings in the area have a similar floor-to-floor height of 3 meters. The number of storey in each building is then obtained from project brochures, property guides or where information is not available, from a simple external inspection of the building. With the building height information and building shape files (in 2-D format), we proceed to create the DEM in 3-D space by using the add-on 3-D analyst functions in ArcView. To facilitate the visibility operations, we had to convert the DEM into grid format containing the information of all the land and building height in the study area.

Figure 1: 3-D visualization of a section of the study area

Figure 2: 3-D visualization of the Makena Condominium and its surrounding terrain



The visibility analysis is then carried out via the ArcView software. Although the details of the intervisibility computation algorithm used by ArcView are not available in the public domain, we assume that the ArcView's algorithm heuristics do not affect the result of our visibility analysis (ESRI, 2002).

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The visibility function in ArcView requires us to specify the following six sets of parameters for the visibility computation (Figures 3, 4). For most of the parameters, we adopt the specifications from Lake *et al* (2000a) as a guide. The parameters are:

a) SPOT - This is the elevation of the observer. We use the elevation of the observer at the particular storey level as SPOT. As it is time-consuming for us to measure every building's storey height, we assume that the floor-to-floor height is 3 m and compute the elevation height via: Elevation= floor-to-floor height x storey level.

b) OFFSETA, OFFSETB - OFFSETA is the vertical distance in surface units (meters in this case) to be added to the elevation of the observer. OFFSETB is the vertical distance in surface units to be added to the elevation of the target. In this case, we calculate the visibility at eye level and thus we set the OFFSETA as 1.7 m (relating to the average height of an adult in Singapore) and we set the OFFSETB as 0 m.

c) AZIMUTH1, AZIMUTH2 - These are the horizontal angle limits to the scan. The sweep proceeds in a clockwise direction from AZIMUTH1 to AZIMUTH2.

Values are given in degrees from 0^0 to 360^0, with 0^0 oriented to the north. In this case, the visibility is constrained to a maximum of 180^0 sweep and constrained by the sides of the building façade. As a result, we set AZIMUTH1 and AZIMUTH2 according to the angle of the building façade. The parameters are chosen to reflect the approximating angle of view when looking through a balcony.

d) VERT1, VERT2 - These are the vertical angle limits to the scan. The VERT1 and VERT2 are respectively the upper limit and lower limit of the scan. The VERT1 and VERT2 angles are expressed in degrees between 90^0 and -90^0. Positive angles are above the horizontal angle; negative angles are below. The horizontal plane (0^0) is defined by the z value of the observation point plus the value of OFFSETA. In this case, VERT1 = 90^0 and VERT2 = -90^0.

e) RADIUS1, RADIUS2 - RADIUS1 and RADIUS2 are the limits of the search distance when identifying areas visible from each observer. Points beyond the RADIUS2 search distance are not considered as view targets and are thus excluded from the analysis. Targets closer than RADIUS1 search distance are similarly ignored but they can still block the visibility of targets between RADIUS1 and RADIUS2. In this case, RADIUS1 = 0 m and RADIUS2 = 500 m. These limits are chosen because Lake et al (2000) suggest that extending the analysis to 1 or 2 km did not significantly increase the amount of visible land. Furthermore, such distance would lead to extended calculation times.

f) Observers and Targets – These are specified by a Point Theme and the Grid Theme respectively, which in this case are the sets of the fundamental positions of the observer and the DEM respectively. In our analysis of the visibility of residential properties, a residential unit may have many locations (e.g kitchen, bedroom, living room) for constructing the viewshed. To simplify our analysis, we choose the dominant view (balcony view) in the unit to analyse the effect of view on property prices. In our case, the observer is assumed to be positioned at the edge of the balcony.

The last stage is to create an index that captures the visibility extent of the observer. The visibility operations in ArcGIS 3-D Analyst provide us with a viewshed for every property unit. The viewshed is the portion of the terrain surface that is visible to the observer (Figure 5). From the viewshed, we can then know whether a particular unit has seaview, city view or any other type of views. The area of the viewshed would also give us the indication of the extent of the view. We then use the number of cell counts which represents the area in the viewshed as the basis to compute the viewshed index. The computation of the index is as follows:

$$\text{Viewshed Index} = \frac{\text{No of cell counts in the visible area}}{\text{Total cell counts in unobstructed view}}$$

where we normalize the number of cells in the viewshed of the selected observer by the total number of cell counts in the viewshed of an observer having a totally unobstructed view.

Figure 3: Parameters required by the Visibility request in the software ArcView (Side View)

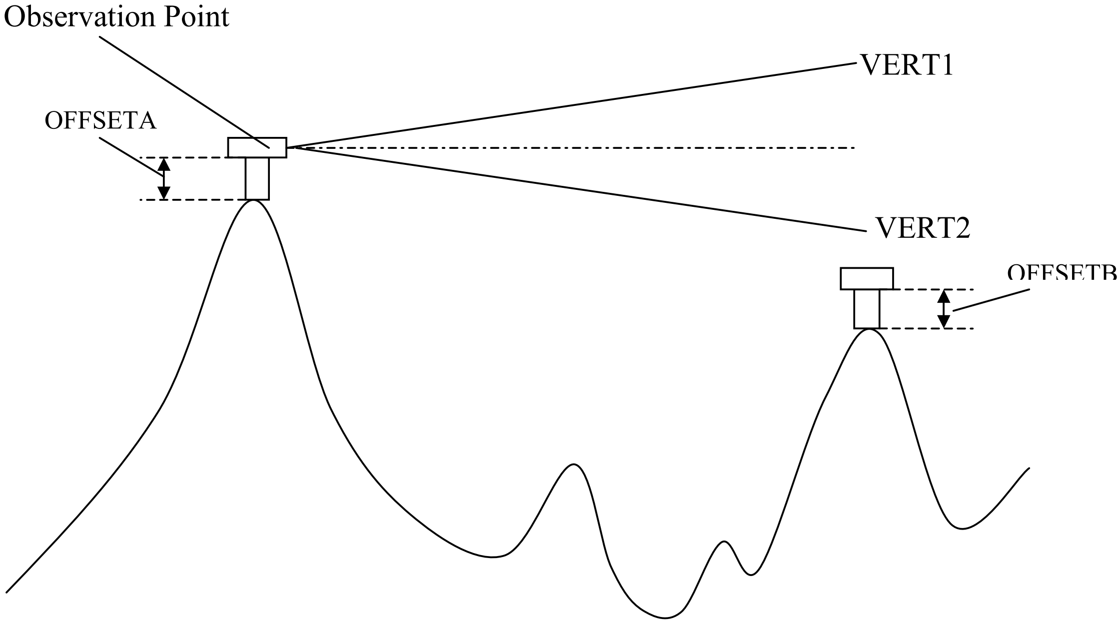


Figure 4: Parameters required by the Visibility request in the software ArcView (Top View)

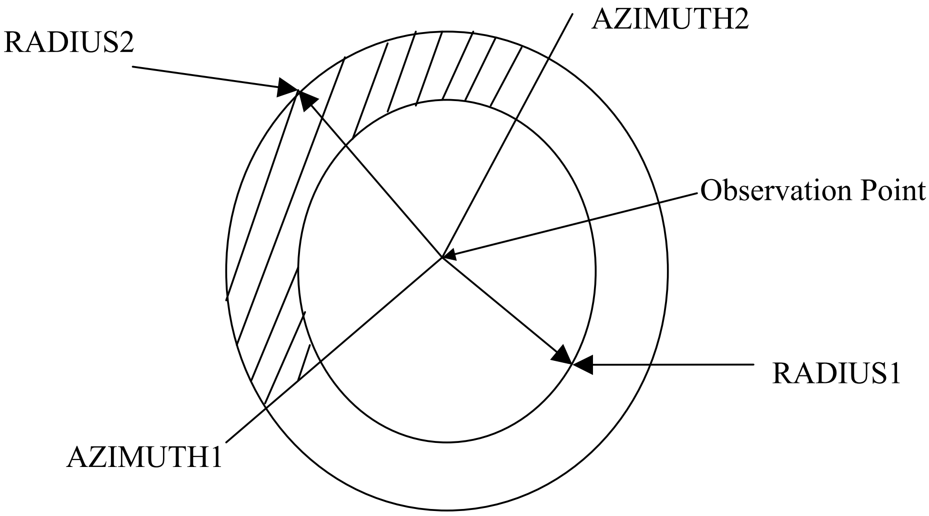
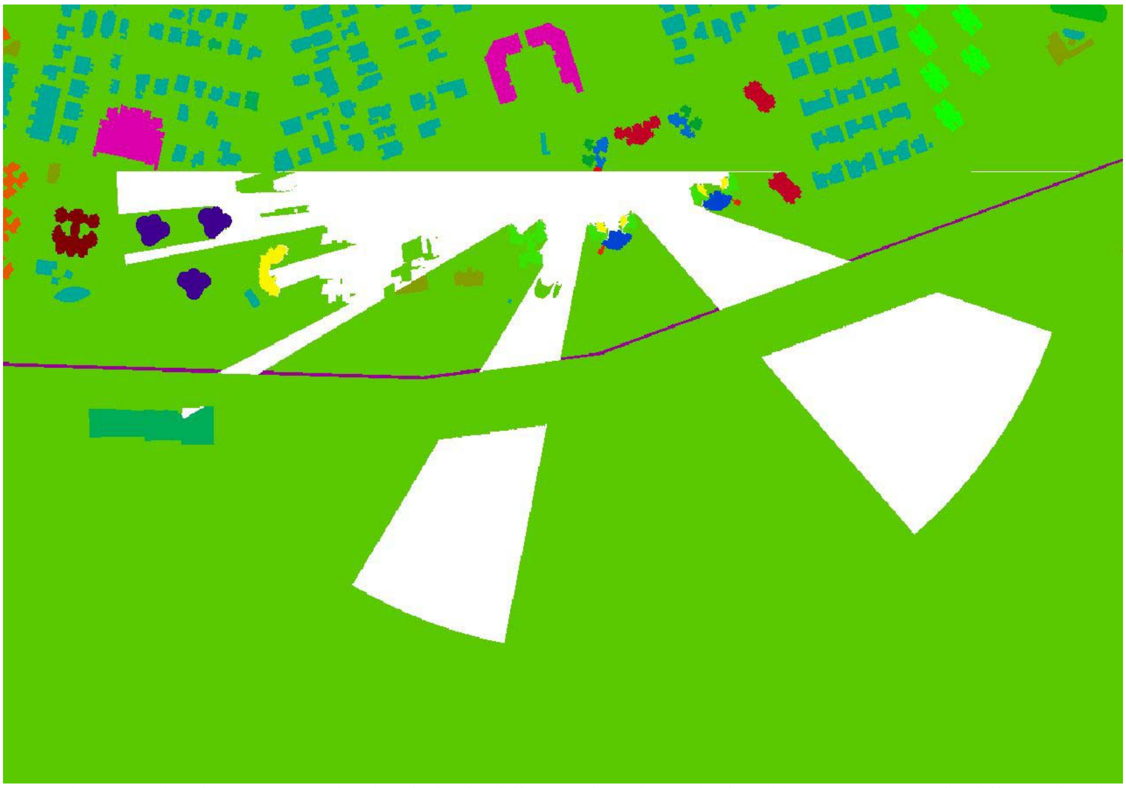


Figure 5: Visualization of viewshed projected from one of the top floor units in the Makena Condominium



Note: The portion in white represents the viewshed. The different color schemes in the grid output represent the different elevation height of the study area.

4. Estimation Results and Analysis

In Yu and Chai (2004), the paper illustrates via an intervention analysis that obstruction of seaview does have a substantial impact on house prices. This implies that the value of view in a hedonic setup should be ascertained using a more objective and reliable approach. Our research attempts to provide such an approach by measuring the value of view via two variables, seaview and viewshed.

As described in section 3, seaview is a dummy variable that indicates whether seaview is visible from the observation point. In the traditional valuation approach, the valuer would have to make a property inspection to determine whether seaview is visible from the property interior. Now, using our viewshed approach, the valuer is able to know whether the property has seaview without having to do any property inspection. With the assistance of ArcGIS 3-D Analyst, we are able to create a viewshed indicating the visible areas in the surrounding. The constructed viewshed would indicate to the valuer whether the sea or any other features in the surrounding is visible to an observer in the property.
The second variable, viewshed, is a continuous variable capturing the range and extent of the dominant view. In the traditional valuation approach, the valuer would have to reply on his/her judgment during the property inspection to ascertain the value of the extent of view. To enhance the value judgment of valuers, our viewshed approach creates a viewshed index, as described in section 3, which measures the extent of view. To explore the applicability of our two variables, we apply the two variables in a hedonic setup to a sample of properties in the Marina Parade Area in Singapore. The subject area was chosen because: firstly, the subject area is located near the east coast of Singapore and several properties in this area enjoy unobstructed view frontage to the sea; secondly, there is a large concentration and a good mix of public and private residential properties in the area; and, thirdly, there is large and ready pool of transaction data, comprising of both public and private housing for our analysis.

From our understanding of the property market in the area, many property buyers are attracted to this area and willing to pay a premium for the attractiveness of the seaview from their property. We believe that in the subject area, buyers are only willing to pay a premium with regards to the quality and extent of the view only if the property enjoys seaview. To test this hypothesis, we used a selected group of private residential properties located near the coast for our analysis. We then split the transaction data of these properties into two groups in which seaview is only visible to the first group of properties while the second group of properties does not enjoy seaview at all. We then conduct two separate regressions on the two sample groups to explore the effect of viewshed on property prices. Table 1 shows the summary of variables used in our hedonic analysis and Table 2 shows the descriptive statistics of the variables.

Table 1: Summary of variables

Coefficients	*Variable*
P	Continuous dependable variable representing the sale price
LOGP	Continuous dependable variable representing the log of the sale price
CASA,	Dummy variable to control location and block effects, equals one if the

EQUAAPT, FIRSTG, HAWAII, MEYERP, PEACHG, ATRIA, SOVER, VIEWPT	property unit is located in the development.
AREA	Continuous variable representing the floor area of the individual unit
LEVEL	Continuous variable representing the floor level of the individual unit
NEW	Dummy variable equals one if the transaction is a developer sales
FOREIGN	Dummy variable equals one if the purchaser is foreigner
COM	Dummy variables equals one if the purchaser is a company
PRIVATE	Dummy variable equals one if the purchaser is a previous private property owner
Q190-Q203	Dummy variables to control temporal market effects, equals one if the transaction takes place in the particular quarter
Viewshed	Continuous variable representing the viewshed index which indicates the extent of the view
Seaview	Dummy variable equals one if the unit has sea view
Seashed	Interaction variable between viewshed and seaview

Table 2: Descriptive Statistics of Private Housing Transaction

	Min	*Mean*	*Max*
P	550000	1512673	4800000
AREA	87	162	517
LVL	1	11	28
NEW	0	0.055	1
FOREIGN	0	0.2699	1
COM	0	0.1486	1
PRIVATE	0	0.805	1
CONDO	0	0.9048	1
Viewshed	0.006	0.3199	0.8926
Sea view	0	0.5862	1
Seashed	0	0.2594	0.8926

No of transactions:	841
No of projects:	10
Sample Period:	1/1/1995-7/11/2003
Source:	URA REALIS

Note: The ten projects used in this analysis are the Viewpoint condo, the Sovereign, the Makena, Atria@Meyer, Peach Garden, Meyer Park, Hawaii Tower, Equatorial Apartments, Casa Meyfort and First Mansion.

Table 3 shows the results of our hedonic analysis using the log-linear model. The log-linear function is chosen because it shows the best fit with the data. Our results show that the variable viewshed is only significant in the sample group that enjoys seaview and insignificant in the sample group that does not have seaview. This supports our hypothesis that the quality and extent of view only matters in the presence of seaview. In other words, buyers are not willing to pay any premium for the any aspect of view in the absence of seaview. In that case, we believe there is a need to reformulate the measurement of view to capture this aspect of our findings. We propose a new variable, seashed, which captures both the presence of seaview and the extent of view. Seashed is specified as:

seashed = seaview x viewshed.

Thus, the variable seashed will be zero if the property does not have any seaview and if the property enjoys partial or full seaview, the variable seashed will range from zero to 1 (not including zero), depending on the extent of the view.

Table 3: Private Residential Regression Results (Log-linear model)

	Sample 1 (With Sea View)				Sample 2 (Without Sea View)			
	Coefficients	Std Error	t	Sig.	Coefficients	Std Error	t	Sig.
Constant	13.721	0.037	373.831	0.000	5.622	0.674	8.348	0.000
AREA	0.003	0.000	16.910	0.000	0.003	0.003	0.806	0.421
LEVEL	0.010	0.002	6.473	0.000	0.061	0.023	2.589	0.010
NEW	-0.054	0.047	-1.136	0.257	-0.065	0.346	-0.188	0.851
FOREIGN	0.002	0.013	0.126	0.900	0.012	0.214	0.058	0.953
COM	0.090	0.021	4.382	0.000	0.065	0.288	0.226	0.822
PRIVATE	-0.013	0.017	-0.766	0.444	-0.125	0.197	-0.634	0.526
VIEWSHED	0.080	0.038	2.080	0.038	-1.425	1.197	-1.191	0.235
No of units	493				348			
R^2	0.926				0.318			
F-Ratio	48.818				2.772			

Note: condo variable is excluded from the regression due to collinearity problems

To test the significance of the newly constructed variable, we amalgamate the two sample group into one and rerun the regression using the variable seashed. In this case, the linear regression function is used instead of the log-linear function due to a higher r-squared statistic. Table 4 shows the regression results of the linear model. The results illustrate that the seashed variable is more significant than the viewshed and this supports our proposition to reformulate the variable. The seashed coefficient also shows that the property will enjoy an enhancement in value of $232,686 if the property has a totally unobstructed seaview. This translates into a premium of 15% of the average house price in the sample.

Table 4:Private Residential Regression Results (Linear Model)

	Coefficients	*Percentage (of Average Price* in the Sample)*	*Std Error*	*t*	*Sig.*
AREA	7579.815	0.50%	283.052	26.779	0.000
LEVEL	9471.537	0.63%	1809.034	5.236	0.000
NEW	-78090.682	-5.16%	40036.863	-1.950	0.052
FOREIGN	19133.619	1.26%	18828.394	1.016	0.310
COM	120247.157	7.95%	27627.138	4.353	0.000
PRIVATE	17190.859	1.14%	21335.085	0.806	0.421
CONDO	-129695.818	-8.57%	129591.220	-1.001	0.317
SEASHED	232686.874	15.38%	47065.725	4.944	0.000

No of units	841
R^2	0.983
F-Ratio	944.49

*The average price of the sample properties is S$1,512,673

5. Application to a Potential Development

In this section we shall illustrate a case study of the application of our model in the pricing of a redevelopment project. In this case study, the chosen redevelopment site for our application and simulation is the Viewpoint Condominium which Keppel Land had bought for redevelopment in 1999. With the release of the new Master Plan, the plot ratio of the site is raised which provides the motivation for redevelopment. However until now, the redevelopment has yet to take off due to the sluggish property market in recent years. Table 5 shows the development characteristics of the Viewpoint Condominium.

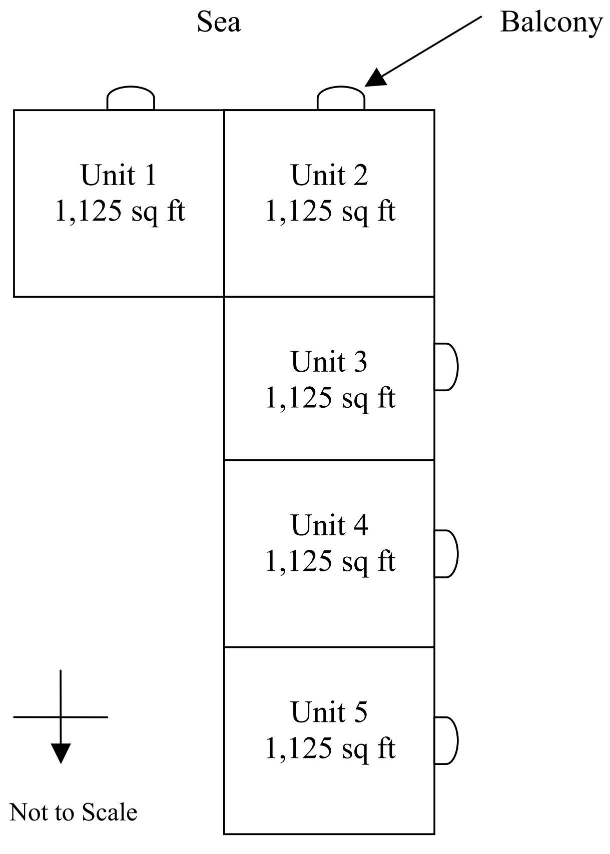
Table 5: Development Parameters of Viewpoint Condominium

	Old Viewpoint	*New Viewpoint*
Site Area	80,684 sq ft	80,684 sq ft
Pot Ratio	1.2	2.8
No of units	72	175
Unit Size	1,312 sq ft	1,125 sq ft

Storey Height	19	36

We simulate the scenario where the Viewpoint is being redeveloped in the third quarter of 2003 and where the gross floor area is maximized to its full potential. Presently, the site is occupied by a 19 storey condominium with 70 apartments and 2 penthouses. The new property is designed for residential developments of up to 36 storeys and with a built-up area of 2.8 times the site area (plot ratio of 2.8). Based on the revised development potential, the new site is to be redeveloped into a new condominium with 170 apartments and 5 penthouses. Through several simulations of different floor layouts and building orientations, we develop a building layout as shown in Figure 6 which seeks to maximize the building's frontage to the sea. Our aim in this simulation exercise is to maximize the seaview in every condominium unit and as a result, the property's value is being enhanced by the view premium.

Figure 6: Simulated Floor Plan of New Viewpoint Condominium



The next step is to construct a new DEM for the new condominium in ArcGIS 3-D Analyst as shown in Figure 7. With the new DEM, we utilize the viewshed function in

ArcGIS 3-D Analyst to construct the viewshed, sea view and seashed variables for every unit using the same methodology as described in Section 3. The viewshed index schedule of the new Viewpoint Condominium is shown in Table 6. Figure 8 shows the comparative analysis of the viewshed index of the old and new Viewpoint Condominiums for the first 19 storeys. The bold lines indicate the viewshed indices of the various units of the old Viewpoint Condominium and the dotted lines display the viewshed indices for the new Viewpoint Condominium. It is apparent that due to our re-orientation of the building, the viewshed indices of the new condominium are higher than that of the old condominium. With the new viewshed index schedule, we are now able to value the new Viewpoint Condominium.

Figure 7: 3-D Visualization of the New Viewpoint Condominium

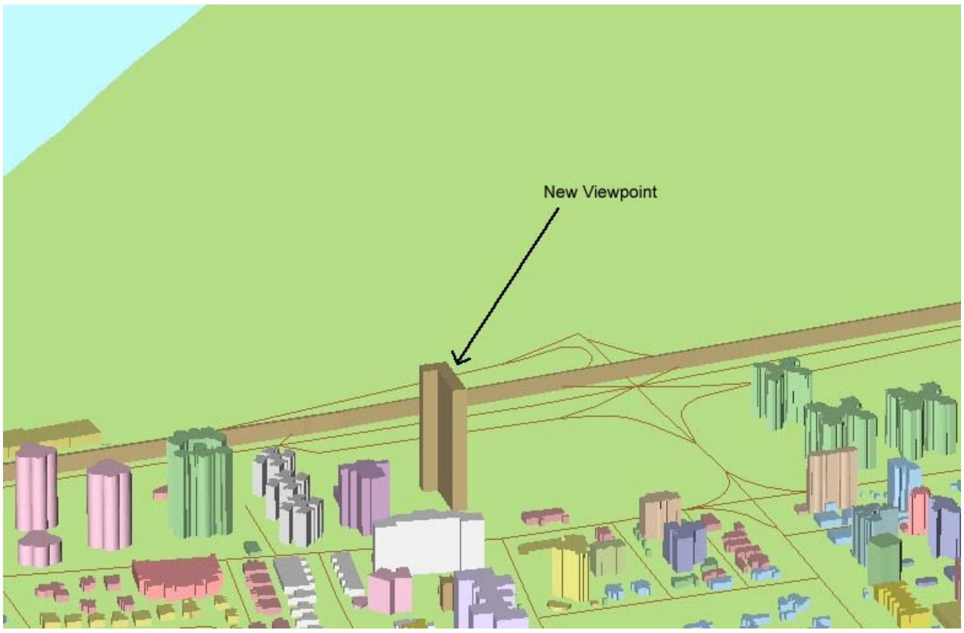


Figure 8: Viewshed Index Distribution of Old and New Viewpoint Condominiums

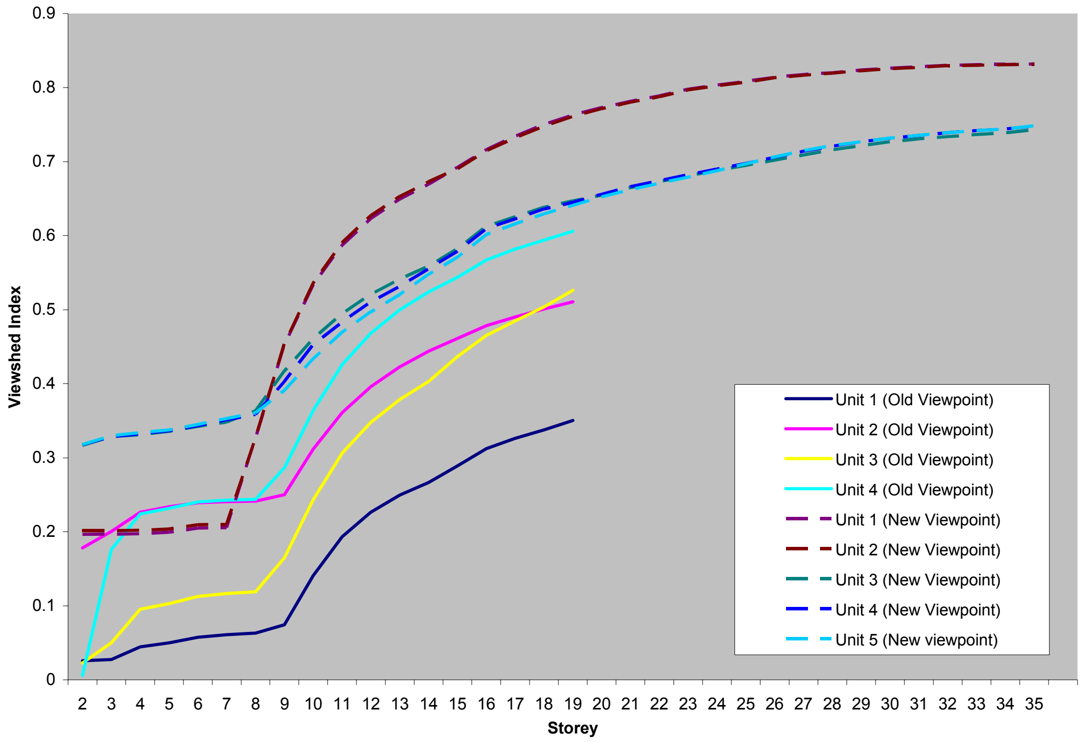


Table 6: Viewshed Indices for the New Viewpoint Condominium

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
1	Communal Area				
2	0.1966	0.2015	0.3167	0.3174	0.3176
3	0.1967	0.2017	0.3283	0.3287	0.3296
4	0.1972	0.2020	0.3312	0.3324	0.3338
5	0.1996	0.2038	0.3356	0.3367	0.3376
6	0.2051	0.2096	0.3423	0.3434	0.3452
7	0.2057	0.2102	0.3482	0.3512	0.3530
8	0.3264	0.3269	0.3635	0.3587	0.3607
9	0.4527	0.4542	0.4174	0.4033	0.3910
10	0.5336	0.5359	0.4608	0.4528	0.4338
11	0.5872	0.5905	0.4948	0.4831	0.4693
12	0.6230	0.6273	0.5210	0.5102	0.4971
13	0.6491	0.6530	0.5410	0.5316	0.5203
14	0.6695	0.6729	0.5589	0.5554	0.5479
15	0.6924	0.6901	0.5822	0.5787	0.5708
16	0.7162	0.7147	0.6127	0.6094	0.6013
17	0.7343	0.7322	0.6253	0.6225	0.6158
18	0.7501	0.7475	0.6383	0.6358	0.6293
19	0.7629	0.7608	0.6467	0.6450	0.6408

20	0.7731	0.7713	0.6546	0.6559	0.6524
21	0.7815	0.7802	0.6648	0.6661	0.6622
22	0.7888	0.7876	0.6729	0.6743	0.6709
23	0.7979	0.7968	0.6807	0.6825	0.6791
24	0.8035	0.8026	0.6882	0.6898	0.6878
25	0.8083	0.8074	0.6948	0.6976	0.6971
26	0.8139	0.8133	0.7020	0.7059	0.7064
27	0.8175	0.8166	0.7091	0.7139	0.7148
28	0.8202	0.8195	0.7160	0.7211	0.7214
29	0.8238	0.8226	0.7216	0.7268	0.7272
30	0.8261	0.8253	0.7268	0.7316	0.7320
31	0.8282	0.8272	0.7308	0.7353	0.7356
32	0.8302	0.8295	0.7338	0.7390	0.7389
33	0.8309	0.8302	0.7366	0.7419	0.7418
34	0.8311	0.8310	0.7390	0.7441	0.7442
35	0.8321	0.8319	0.7431	0.7479	0.7482
36					

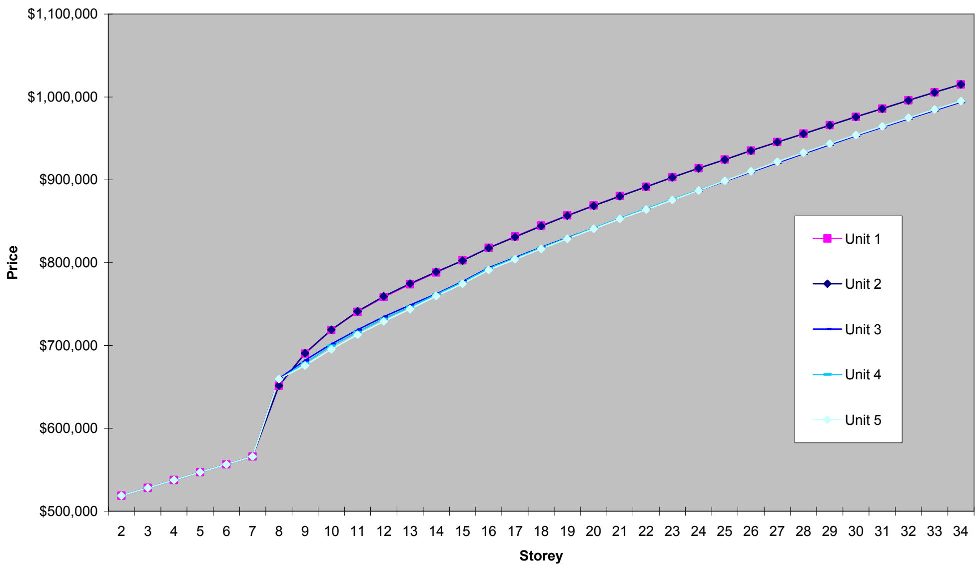
To value the new development, we adopt the sales comparison method and used the sales transactions of the old Viewpoint Condominium and a few neighboring developments as comparables. The details of the transaction data and the variables used in this valuation exercise are shown in Tables 1 and 2. Through a linear regression of these transaction data, we have obtained the coefficients of the various variables as shown in Table 4. Using these coefficients, we apply them to the new Viewpoint Condominium to devise the new price schedule as shown in Table 7. Figure 9 shows the price distribution of the new condominium in graphical form.

Table 7: Price Schedule of New Viewpoint Condominium

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
1	Communal Area				
2	$518,679	$518,679	$518,679	$518,679	$518,679
3	$528,151	$528,151	$528,151	$528,151	$528,151
4	$537,622	$537,622	$537,622	$537,622	$537,622
5	$547,094	$547,094	$547,094	$547,094	$547,094
6	$556,565	$556,565	$556,565	$556,565	$556,565
7	$566,037	$566,037	$566,037	$566,037	$566,037
8	$651,452	$651,580	$660,079	$658,968	$659,431
9	$690,323	$690,675	$682,102	$678,830	$675,955
10	$718,616	$719,138	$701,680	$699,801	$695,392
11	$740,549	$741,329	$719,045	$716,329	$713,116
12	$758,358	$759,352	$734,619	$732,108	$729,055
13	$773,914	$774,812	$748,761	$746,558	$743,926
14	$788,132	$788,910	$762,378	$761,573	$759,822
15	$802,920	$802,390	$777,290	$776,471	$774,620
16	$817,941	$817,578	$793,838	$793,088	$791,198

17	$831,613	$831,121	$806,244	$805,590	$804,042
18	$844,765	$844,156	$818,747	$818,172	$816,664
19	$857,206	$856,712	$830,180	$829,772	$828,797
20	$869,062	$868,648	$841,479	$841,797	$840,982
21	$880,483	$880,183	$853,340	$853,643	$852,719
22	$891,659	$891,372	$864,677	$865,004	$864,212
23	$903,252	$902,987	$875,961	$876,395	$875,593
24	$914,011	$913,816	$887,189	$887,565	$887,089
25	$924,614	$924,399	$898,207	$898,855	$898,734
26	$935,372	$935,247	$909,351	$910,259	$910,376
27	$945,700	$945,471	$920,460	$921,591	$921,796
28	$955,780	$955,615	$931,536	$932,726	$932,803
29	$966,104	$965,813	$942,309	$943,537	$943,615
30	$976,108	$975,924	$953,010	$954,118	$954,199
31	$986,054	$985,827	$963,407	$964,458	$964,528
32	$996,004	$995,841	$973,576	$974,778	$974,766
33	$1,005,635	$1,005,467	$983,705	$984,925	$984,908
34	$1,015,157	$1,015,126	$993,725	$994,920	$994,931
35					
36	$1,826,800	$1,826,753	$1,806,091	$1,807,208	$1,807,277

Figure 9: Price Distribution of New Viewpoint Condominium



We believe that such an approach has the potential to assist developers in their pricing strategies, especially for projects with units having full or partial sea view. This is clearly more objective than the present rules of thumb typically used by valuers.

6. Conclusion

The primary objective of this paper is to develop a more objective approach to analyse the impact of view in the valuation of properties using GIS and 3-D simulation. To this end, we have developed a method to quantify views from high-rise apartments based on ArcView's 3-D Analyst. This method constructs a viewshed index which can quantify the extent and quality of view thus enhancing the judgment of valuers as compared to the traditional use of subjective rules of thumb. We then apply the methodology to determine the impact of view on the transaction prices of properties in the East Coast area.

The second area of application is to determine the premium buyers are likely to pay for a full sea view. Using the viewshed index methodology, our regression results show that for private housing in the East Coast area, buyers are willing to pay up to nearly \$233,000 in premium for a unit with full sea view compared to a unit without any sea view. This is significant given that properties in the area range from about \$600,000 to \$5 million. For units in the lower price range, the premium constitutes a substantial portion of the price paid. Based on the average selling price, the premium is about 15%. Therefore, given the scenario whereby new developments could obstruct existing views, buyers need to ensure that they will not end up losing the premium that they had paid for, as in the case described in Yu and Chai (2004).

We then apply the methodology to a potential redevelopment site. We simulate the design and layout of the new development such that the sea view can be maximized. Together with the new planning parameters, we show that the developer could benefit substantially from the premium that could be fetched from units with full sea view. We believe this will significantly help developers in their pricing strategies, especially for sites fronting a water body that can attract buyers.

We believe that our model of pricing view would be highly beneficial to developers. In some instances, developers would pre-sell the property units before the start of construction and would need to determine the price schedule of the property units even before the properties are constructed. In such circumstances, the developer has no objective means of ascertaining the quality and extent of the view. Our model would be able to determine the appropriate pricing for units with different extent of view via the viewshed index.

And last but not least, from the policy makers' perspective, it is also important for them to consider the impact of view on property values. This is especially so as the new Downtown and Marina area would be able to provide new buildings with panoramic views. However, the impact of such views may be different for different property uses. Although our analysis is restricted to only residential developments, the impact of view on the value of office, for example, is likely to be different.

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