Disentangling Access and View Amenities in Access-restricted Coastal Residential Communities

Abstract: In coastal communities with uniform flood risk, amenity value is comprised of two components – view and access. Having controlled for view, it is assumed that any residual amenity value represents the benefit derived from households from accessing the beach for leisure or recreational purposes. However, as properties closer to the beach typically have improved viewsheds, the two amenities are highly correlated, and disentangling view and access is problematical. We posit that for many coastal communities, access is restricted to designated public access points, precluding local residents from accessing the beach area directly from their property. To appropriately account for restricted access, we incorporate a network distance access measure into a spatial autoregressive hedonic model to capture ease of beach access for local residents. Our findings suggest that, as network distance varies independently from property viewshed, collinearity effects are mitigated, and access and view can be disentangled.

JEL Classification: Q26, Q50, Q51

1. Introduction

Since Rosen (1974) provided a theoretical platform for estimating the implicit values of housing attributes, hedonic property price models have been used extensively to estimate the value of structural, neighborhood, and locational or amenity attributes in property markets. One important contribution of a number of these studies is the quantification of amenity values in relation to given resources, such as beaches, lakes, oceans, open space, urban parks, and more (Lansford and Jones 1995; Parsons and Powell 2001; Boyle and Kiel 2001; Parsons and Noailly 2004; Pompe 2008). Generally, hedonic studies capture amenity value by including a linear distance variable from the property to the resource as an explanatory variable in the hedonic (see for example, Tyrväinen 1997; Bin and Polasky 2004; Pompe 2008; Bin et al. 2008). However, the benefits of living close to a resource can rarely be defined by a single proximity measure. In coastal markets for example, it is hypothesized that residents derive benefit from both the aesthetic quality that an ocean view provides, and also the ease of access to the beach area for recreation or leisure purposes (Bourassa et al. 2003).[1] While empirically appealing, disentangling viewshed and access amenity values in the hedonic is econometrically problematical as homes with improved views are typically located closer the beach area. As such, view and access are highly correlated, raising obvious collinearity concerns. If collinearity is present, then

[1] Typically, proximity should also reflect amenity risk as properties located closer to the water are more likely to have a greater chance of flooding. Bin and Polasky (2004) and Bin et al. (2008) control for risk by including a dummy, equal to one for properties within the Special Flood Hazard Area (SFHA). We do not control for risk in the model as all properties in the sample are located within the SFHA, so risk is uniform across the sample.

disentangling amenity values may lead to inflated standard errors and imprecise coefficient estimates.

This research seeks to demonstrate that collinearity impacts can be mitigated and reliable estimates of viewshed and access values can be derived through a more appropriate measure of the access parameter than is typically used in hedonic studies. Previous research that has attempted to separate viewshed and access benefits captures access by including either housing block dummies or a simplistic linear distance parameter from the property to the shoreline (Pompe and Reinhart 1995; Parsons and Noailly 2004; Bin et al. 2008), However, in many coastal communities, especially those located along the Eastern Seaboard of the U.S., beach-front private property, and/or a vegetated dune structure, and/or local ordinance can restrict beach access to state-designated public access points.[2] As suggested by Bin et al. (2008), the proximity parameter estimate for distance should reflect the ease of access to the shore for leisure and recreation purposes. Therefore, a true measure of access in these communities is not the linear distance to the shoreline, but rather the linear "network" distance from each property to the closest designated beach access point. Economic theory suggests, as individuals seek to maximize utility, they will prefer properties that provide better access to the shoreline, all else being equal. Therefore, in restricted-access communities, having controlled for all other factors, individuals should be willing to pay a premium for properties located closer to designated access points, even if these properties are located farther from the shoreline. We believe that using a network distance parameter in the hedonic has two overall benefits. First, it more appropriately measures the ease to which residents access the beach for leisure and recreational purposes in

[2] For example, in Florida, State law precludes beach access via private property but it does provide a policy of the State Comprehensive Plan to ensure that the public has a right to reasonable beach access. As a result, individuals must access the beach via state designated public access points.

property markets where access is not a function of the linear distance to the shoreline. Second, network access varies independently of view as homes farther from the shoreline with reduced viewsheds can be closer to access points. As such, collinearity effects are likely to be diminished, and our two amenity parameters, access and view, can be separated in the hedonic.

We follow recent research that utilizes innovations in Geographic Information Systems (GIS) and Light Detection and Radar (lidar) data methods to construct our property viewshed measures (Patterson and Boyle 2002; Bin et al. 2008). As lidar data accounts for the coastal topography and other property or vegetation obstructions, it has the advantage of providing a more objective and continuous measurement of household viewshed. We also use GIS methods to construct our network access parameter. Due to the high cost associated with developing a continuous measure of viewshed data, we generate a modest sample of coastal property transactions to provide a pilot study that demonstrates the potential benefits of including a network access measure in a hedonic framework when separating amenity values. Results from a spatial autoregressive model indicate that including a more appropriate measure of access into the hedonic allows viewshed and access to be disentangled. We believe that the robust model results provide a platform for future hedonic analyses where access is an important component of the household purchase decision.

2. Theoretical Framework

Hedonic property price models are based on the theory of household behavior. The theory suggests that households value a good because they value the characteristics of the good rather than the good itself. In hedonic property price theory, the relationship between property price and the property's various attributes can be expressed as:

$$\boldsymbol{P} = \boldsymbol{P}(\boldsymbol{S}, D, V) \qquad [1]$$

where the sales price of properties, $\boldsymbol{P}$, is a function of a vector of structural attributes, $\boldsymbol{S}$, (such as size and age of home, number of bathrooms, and so on) D, the distance to closest beach access point, and V, viewscape of the resource from properties.

The housing market is assumed to be in equilibrium, and so, prices are at the market clearing level. Each individual chooses a property and location by maximizing the utility function:

$$U = U(Z, \boldsymbol{S}, D, V) \qquad [2]$$

where Z is a composite, representing a bundle of other goods with price equal to one, subject to a utility constraint:

$$Y = \boldsymbol{P} + Z \qquad [3]$$

where Y represents income. Taking the partial derivative of Equation (1) with respect to each housing attribute variable yields the corresponding implicit price of the housing attribute. So, estimating the partial derivative of Equation (1) with respect to the viewscape attribute variable yields the first-order necessary condition:

$$\left(\frac{\partial \mathrm{U}}{\partial \mathrm{V}}\right) \Big/ \left(\frac{\partial \mathrm{U}}{\partial \mathrm{Z}}\right) = \frac{\partial \mathbf{P}}{\partial \mathrm{V}} \qquad [4]$$

Equation (4) represents the individual's marginal willingness to pay for a change in property viewshed.

3. Study Area and Data

The study area is Pensacola Beach, located on the western segment of Florida's Panhandle (see Figure 1). Pensacola Beach's location on the Gulf of Mexico and the claim of having the "whitest beaches in the U.S." make it a popular tourist destination and desired property location. There are 281 single family residences along a two-mile stretch of residential units on the Gulf-side portion of Pensacola Beach.

INSERT FIGURE 1 HERE

Property price and attribute data come from the Pensacola Association of Realtors (PAR) database of property transactions. [3] Our dataset contains attribute and sales price information on 101 single family residences, sold between 1998 and 2007. We include many of the structural housing attributes common to the hedonic literature. The average sales price for homes in the sample is $559,306, adjusted to 2007 prices using the consumer price index for housing. The average home is 31 years of age, with 1,804 square feet of living space, two bedrooms, and a single-car garage. In estimation, we also include a dummy for Gulf-front properties. As private property owners pay a high premium for a Gulf-front location and high property taxes to acquire, not only, an improved viewshed and immediate access, but also a unique bundle of property rights, we include a dummy variable to capture this effect. Finally, the average property has a 43-

[3] The authors express their gratitude to PAR for allowing us to access their database.

degree viewshed of the shoreline, with a network distance to the nearest access point of 173 meters, and a linear distance to the shoreline of 150 meters.

INSERT TABLE 1 HERE

4. Measuring Access and Viewshed

Two beach access measures are constructed by calculating; (1) the linear network distance between each property in the dataset and the nearest designated beach access point; and (2) the direct linear distance from each property to the shoreline. While Gulf front properties have immediate access to the beach, properties located one, two, or more blocks back must access the beach at a designated point. These beach access points provide the only access to the beach, as Gulf-front private property, and/or a vegetated dune structure, and/or local ordinance prohibit merely crossing directly to the beach at other points. As such, a property four blocks back may have a shorter network beach access distance than a property located closer to the shoreline. To illustrate this point, Figure 2 depicts two properties on Pensacola Beach.

INSERT FIGURE 2 HERE

While Property A is located farther from the beach, it is closer to the nearest public access point so has improved access to the beach relative to Property B. Property A has a network distance from the nearest beach access point of 134 meters, while Property B's network distance is 295 meters. Traditional methods of capturing access would incorrectly imply that Property B has preferable access relative to Property A. Designated beach access points along Pensacola Beach are located using data provided by the Escambia County GIS and Engineering Department. Access network distance is then calculated from each property to the nearest public access point using GIS. We also use GIS to calculate the conventional linear distance to the shoreline from each property.

We also provide an objective and continuous measure of view for use in the hedonic. We follow Bin et al. (2008) by constructing the angular viewshed of the shoreline from each property in the sample. Viewshed is measured using lidar data, which provides information on the topographic surface of the coastal area, including all property structures, dunes, and other vegetation, through generating three-dimensional mass-point structures that record the elevation of detected objects by a laser pulse. The elevation data for use in this study were collected in June and July, 2006. The measurement of an individual property's viewshed in this study is an angular measurement noting the amount of ocean and beach visible from each individual property. Due to the linear nature of the shoreline in this area, the Maximum View Angle (MVA°) of the shoreline is 180 degrees.

INSERT FIGURE 3 HERE

Figure 3 provides a schematic to represent the estimated view from two different properties. Property A is located one block back (Row 2) from the shoreline with a vacant lot in front of its property. By extending out a radius viewshed of 1000m from the spot elevation determined for this home, an angular measure of viewshed is determined for the property. Property A has 131 degrees of Gulf viewshed. Property B is located two blocks back (Row 3) from the shoreline, and also has vacant property directly in front. It has an angular viewshed of the Gulf of Mexico totaling 39 degrees.

A critical component in capturing viewshed from each property is to determine a common desired observer location in each property from which to make the measurement. The desired observer location used in this study is the window level of the highest livable story of each home, with the observer located at the Gulf side of each property. We believe that this technique provides an improvement on other studies that use a standard distance from the elevation of the roof to place the observer (Patterson and Boyle, 2002; and Bin et al. 2008). Using a standard distance has the drawback of situating the virtual observer at different points within a property as roof types vary by property. For example, using a standard 3 meter offset for all roof types places the virtual observer at a lower point in flat-roofed properties relative to more traditional, angled-roofed homes. This study expands on the process by using lidar and property data to delineate roof type, and hence adjust the offset according to roof structure. Essentially, as properties have different roof structures (flat or angled), we use different offsets, based on roof type, to place the observer at the same desired location for each property. For flat-roofed properties, we assume an observer location of 1.5 meters below the roof level, while for traditional, angled-roofed properties, we assume a 3 meter offset.

We also follow recent research by considering the spatial dependence in the hedonic framework (Paterson and Boyle 2002; Kim, Phipps, and Anselin 2002; Bin et al. 2008). This recent research focused its attention on the spatial dependence of error terms in estimated hedonic models. The argument is that interdependence exists among property sales prices due to the proximity of homes to one another. As such, property sales prices for homes in common neighborhoods are interdependent as they typically share similar housing characteristics and location amenities. Spatial autocorrelation measures the nature, level, and strength of any interdependence, and if present, may be positive or negative. Positive autocorrelation implies that adjacent homes are likely to have similar values (Patterson and Boyle 2002; Bin *et al.* 2008), while, negative autocorrelation suggests that one is less likely to observe similar home values for neighboring properties (Irwin and Bockstael 2002). Failure to account for spatial dependence can violate the assumption of uncorrelated error terms and lead to biased and inefficient coefficient estimates. Spatial dependence can be incorporated into the model in one of two ways. The first possibility is to estimate a spatially lagged dependent variable that assumes that the spatially weighted sum of contiguous property prices is an explanatory variable in the hedonic. The second method is to estimate a spatial-error model, which assumes that the nature of the spatial dependence is a function of the omitted variables or measurement errors that vary spatially. Based on results from robust Lagrange Multiplier tests, we estimate a spatial-lag hedonic model.[4]

The first step in controlling for potential spatial dependence is to create a spatial weights matrix that reflects the structure of the hypothesized spatial dependence. As suggested by Anselin and Bera (1998), we analyzed the fit of different weights matrices (using different distance measures) in the hedonic. In estimation, we use a spatial weights matrix consisting of binary elements equal to 1 if two properties are within 100 meters of each other, zero otherwise. The diagonal elements of the weights matrix are set to zero and the row elements are standardized so that they sum to one.

The spatial-error model takes the form

$$\boldsymbol{P} = \alpha + \beta \boldsymbol{S} + \delta D + \gamma V + \lambda \boldsymbol{W}\boldsymbol{P} + \varepsilon \qquad [5]$$

[4] A Robust LM test indicated spatial-lag dependence ($\chi^2 = 4.459$; p-value = 0.035), while a robust LM test did not indicate spatial-error dependence ($\chi^2 = 0.408$; p-value = 0.523).

where λ, is a spatial autoregressive coefficient, ***WP*** is a vector of spatially lagged dependent variables for ***W***, the weights matrix, and ε is a vector of independent and identically distributed random error terms. The coefficients α, β, δ, γ, and λ are all to be estimated in the model.

Results from the spatial-lag model are then used to estimate the marginal willingness to pay for access and view. As described in Bin et al. (2008), in a spatial regressive model, a marginal change in one of the coastal amenity variables has a direct impact on a property's value but also an indirect impact on neighboring properties. The indirect impact is picked up by λ***WP*** in the spatial-regressive model. The sum of the direct and indirect impacts then provides the total impact of a change in access or view on the average price of a property. As such, the marginal willingness to pay for an improvement in view or access is given by $(\frac{\gamma view}{1-\lambda}).H$ and $(\frac{\delta\ distance}{1-\lambda}).H$ respectively.

5. Results

As the functional form of the hedonic model is not known a priori, we examined different standard functional forms (Freeman 1993). As a semi-log model provided a better fit, we estimate and report the results from two semi-log spatial autoregressive hedonic property price models. Model 1 captures access by using the linear network distance from each property to the nearest state-designated public access point while Model 2 includes the standard linear distance to the shoreline as the measure of access.

INSERT TABLE 2 HERE

Before discussing the key variables of interest (access and view), some other observations are noteworthy. First, in both models, the spatial autocorrelation coefficient, λ, representing the average influence on observations by neighboring observations, is positive and significant at the 1% level, indicating statistical support for spatial dependence in housing prices across residential beach properties. The structural parameters indicate that the size of the home and the size of the garage are positively correlated with the property price, as is the number of bedrooms, although this effect is only marginally significant in Model 1. The age of the home does not affect home price.

Not surprisingly, our Gulf-front property dummy (GULF) is large and significant. Again, we include the dummy to control for Gulf-front proximity effects. Specifically, the dummy should capture the effect of Gulf-front property owners paying a premium for a unique bundle of property rights and guaranteed beach access. We also include time dummy variables to capture changes in property price over time with 1998 as the omitted year.

Recall, we posit that network distance varies independently of viewshed so collinearity concerns are mitigated when separating the two amenities in the hedonic. Before considering the amenity parameters, the correlation matrix provides some support of this notion, showing a high correlation between viewshed and shoreline distance relative to our network access measure and viewshed. While collinearity effects do not reduce the predictive reliability of the model, its presence means that there is a lack of observations for which shoreline distance changes independently of viewshed. Consequently, the standard errors of the amenity variables in the conventional model may be inflated relative to our network access model.

INSERT TABLE 3 HERE

Analyzing the model results with the inclusion of network distance as the access measure (Model 1), the findings show that in access-restricted communities, access is important. NET_ACC is negative and significant indicating that households are willing to pay more for homes closer to access points, ceteris paribus. We find that, on average, households are willing to pay $585 for a one-meter decrease in distance to the nearest access point. Results from Model 1 also suggest, as expected, that an increased view of the shoreline increases a property's value. We estimate a marginal willingness to pay (WTP) of $1,170 for a one-degree increase in property viewshed. This finding is in line with Bin et al. (2008), who estimate a WTP of $995 for a one-degree increase in viewshed on coastal properties across North Carolina coastal communities.

Comparing these results with the conventional model (Model 2) highlights the concern associated with disentangling amenity values while using a direct linear distance measure for access. The shoreline distance access measure (SHORE_DIS) remains negative and significant, although the size of the coefficient suggests that households are willing to pay $1,080 for a one-meter decrease in direct distance to the shoreline, approximately twice the implicit value of network access. Also, in Model 2, VIEW is now statistically insignificant. Overall, results from the conventional model imply that the presence of collinearity has inflated the standard errors of the amenity variables; leading critically to the conclusion that viewshed is not an important amenity characteristic in the home purchase decision.

Overall, we believe that many hedonic studies overlook the importance of the access amenity in the home purchase decision. Property markets in communities proximate to beaches, ski resorts, parks, lakes etc. all generate a desire for access, in which typically, access is not a function of the linear distance to the resource. Not only does the conventional linear distance measure fail to capture the access issue, it also makes disentangling access and viewshed problematical in a hedonic framework. Our findings suggest that inclusion of a network distance measure in the hedonic not only provides a more precise indicator, and therefore, measure of access, but can mitigate collinearity concerns, and yield more reliable amenity value coefficient estimates.

6. Conclusion

In coastal communities, residents derive benefit from both the aesthetic quality that an ocean view provides, and also the ease of access to the beach area for recreation or leisure purposes. Ideally, researchers would like to disentangle and measure the value of both amenities, however, in a conventional hedonic framework where access is measured by the linear distance from each property to the shoreline, this is problematical as view and distance are often so highly correlated. Consequently, the standard errors of the amenity variables may be inflated, generating unreliable coefficient estimates.

We argue that, as many residential coastal communities have beach-front private property, and/or a vegetated dune structure, and/or local ordinance that restrict access to non beach-front homes to designated public access points, true access is provided, not by the linear distance to the shoreline, but rather, by the network distance from each property to the nearest designated access point. Results from a spatial autoregressive model indicate that including a network access measure into the hedonic not only provides a more precise indicator, and therefore, measure of access, but, as network distance can vary independently of viewshed, its inclusion can mitigate collinearity concerns, and yield more reliable amenity value coefficient estimates.

We believe that the results from our modest sample of coastal properties provide a useful insight into appropriately measuring access in restricted access communities and provide a platform for appropriately disentangling amenity values in future hedonic analyses. While the focus of this paper is on a coastal community, the implications hold for other property markets proximate to a given resource (such as ski slopes, lakes, parks etc.) where access is a critical issue but is not a function of the linear distance to the resource.

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Table 1 – Definitions and Summary Statistics

Variable	Definition	Mean	Std. Dev.
PRICE	House sales prices adjusted to 2007 dollars	559,306.2	429,202.1
YR1998	House sale in 1998 (=1)	0.02	0.14
YR1999	House sale in 1999 (=1)	0.06	0.24
YR2000	House sale in 2000 (=1)	0.13	0.34
YR2001	House sale in 2001 (=1)	0.09	0.29
YR2002	House sale in 2002 (=1)	0.21	0.41
YR2003	House sale in 2003 (=1)	0.09	0.29
YR2004	House sale in 2004 (=1)	0.16	0.37
YR2005	House sale in 2005 (=1)	0.07	0.26
YR2006	House sale in 2006 (=1)	0.07	0.26
YR2007	House sale in 2007 (=1)	0.11	0.32
AGE	Age of house	30.57	11.95
SQFT	Total square footage of the house	1,804.25	667.05
BATH	Number of bathrooms	2.28	0.80
GARAGE	Number of vehicles accommodated by garage space	1.08	1.14
GULF	Dummy variable for Gulf-front properties (=1)	0.16	0.37
NET_ACC	Linear network distance to nearest beach access point	172.64	111.83
SHORE_DIS	Linear distance to shoreline	149.97	78.89
VIEW	Viewscape measured by degree of view across 1000m distance	42.69	56.69

Table 2 – Spatial-Lag Hedonic Property Price Model Results

	Model 1 – Network Distance			Model 2 – Shoreline Distance		
Variable	Coefficient	Std. Error	*p*-Value	Coefficient	Std. Error	*p*-Value
LAMDA (λ)	0.044	0.011	0.000	0.039	0.011	0.000
CONSTANT	11.705	0.313	0.000	12.148	0.383	0.000
YR1999	-0.098	0.210	0.639	-0.212	0.215	0.324
YR2000	-0.071	0.190	0.708	-0.159	0.190	0.403
YR2001	-0.186	0.202	0.358	-0.249	0.202	0.217
YR2002	0.086	0.188	0.648	-0.018	0.187	0.924
YR2003	0.183	0.203	0.368	0.083	0.201	0.217
YR2004	0.618	0.191	0.001	0.527	0.191	0.006
YR2005	0.400	0.207	0.053	0.323	0.206	0.118
YR2006	0.747	0.205	0.000	0.680	0.204	0.001
YR2007	0.348	0.197	0.078	0.257	0.199	0.195
AGE	-0.001	0.003	0.668	-0.004	0.003	0.219
SQFT	0.001	0.000	0.024	0.001	0.000	0.121
BATH	0.092	0.059	0.119	0.119	0.055	0.032
GARAGE	0.095	0.029	0.001	0.098	0.029	0.001
GULF	0.320	0.160	0.046	0.349	0.156	0.025
VIEW	0.002	0.001	0.042	0.001	0.001	0.583
NET_ACC	-0.001	0.000	0.054			
SHORE_DIS				-0.002	0.001	0.010
R^2	0.83			0.83		
Obs	101			101		

Table 3 – Correlation Matrix

	Shoreline Dist	Network Dist	Viewshed
Shoreline Dist	1.00		
Network Dist	0.685	1.00	
Viewshed	-0.835	-0.633	1.00

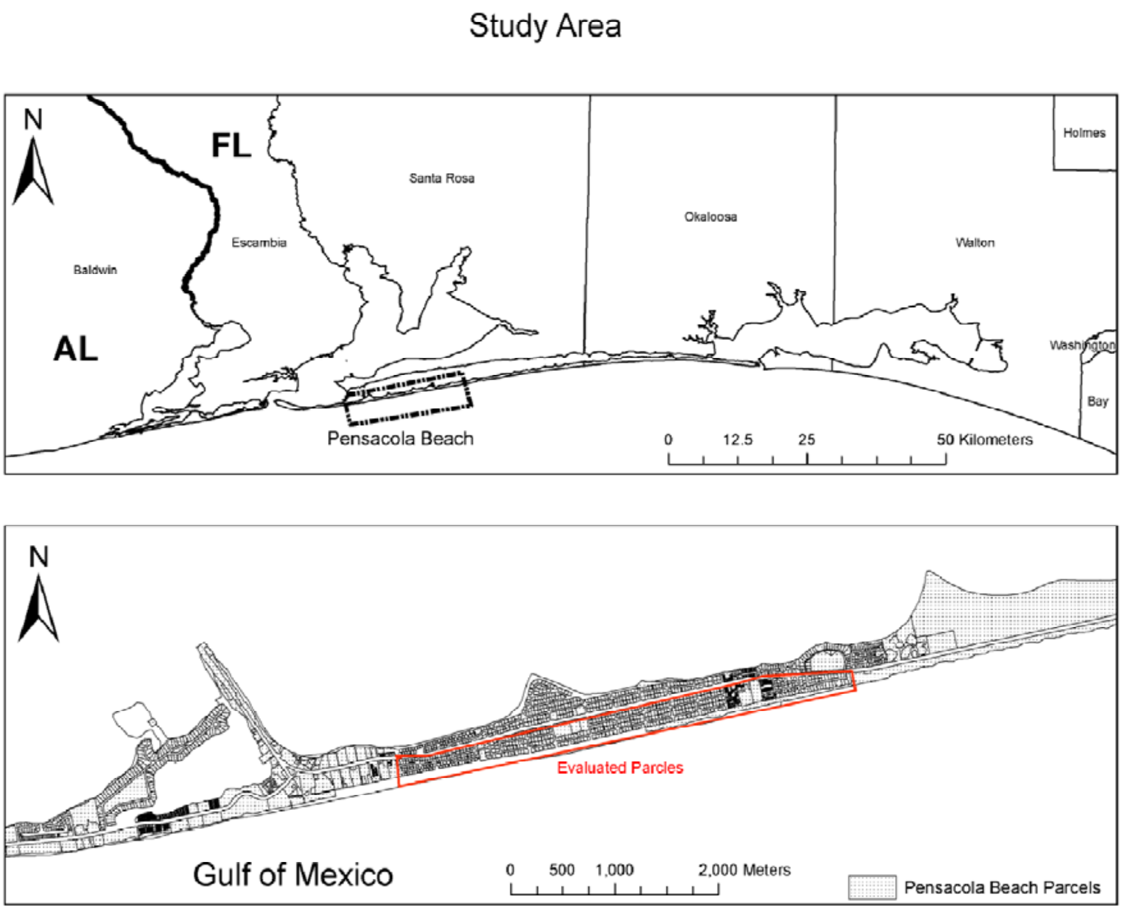

Figure 1. Region of Interest

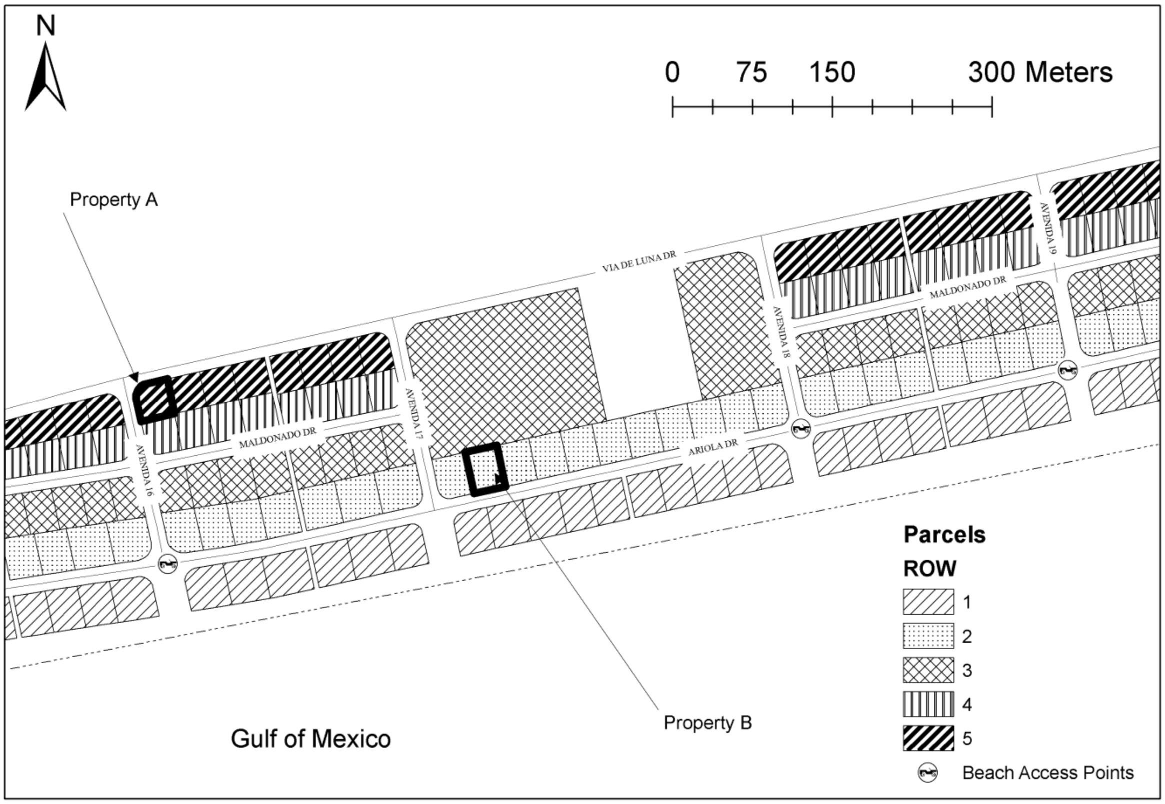

Figure 2. Beach Access

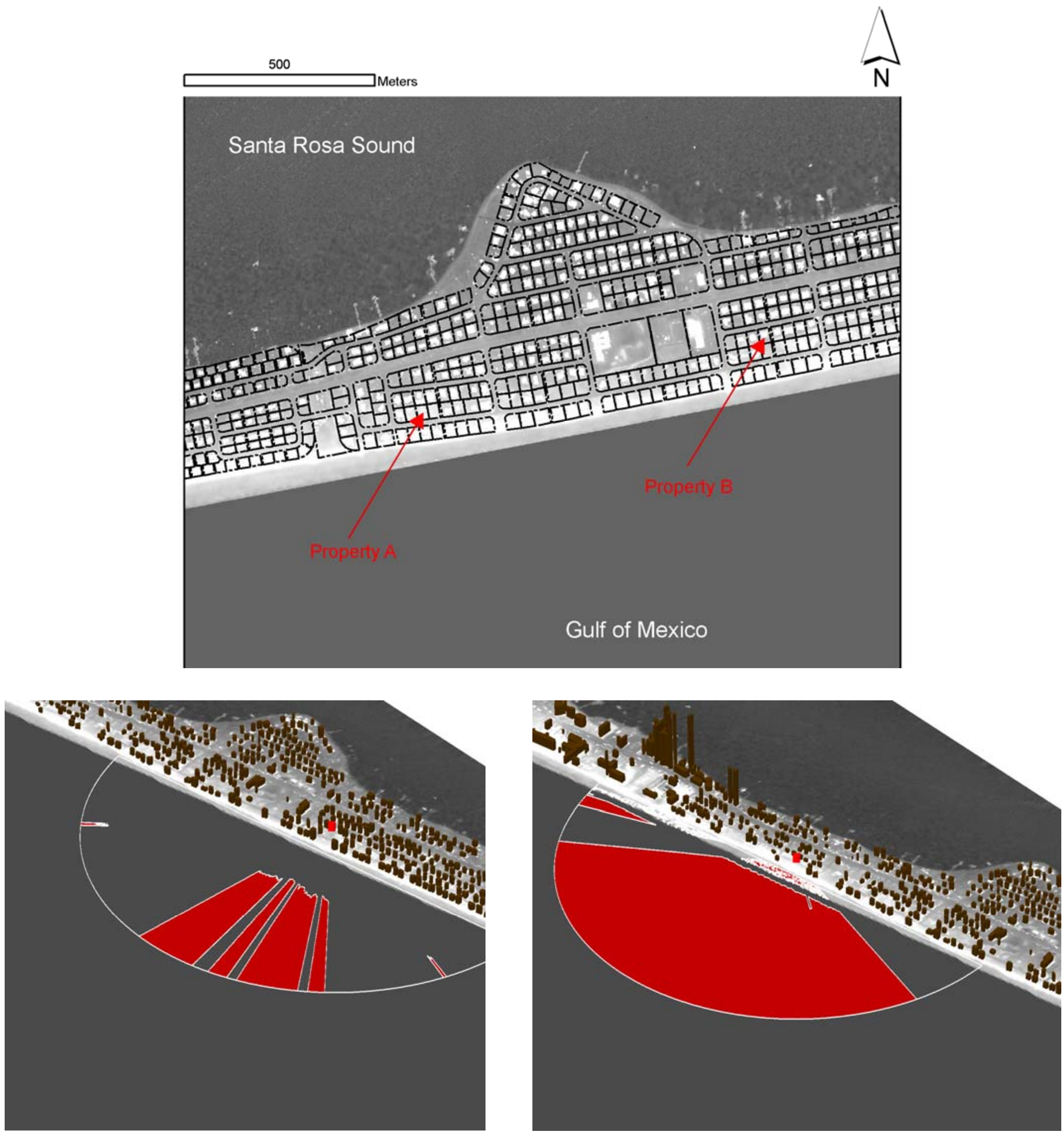

Figure 3. Property Viewshed