Valuing Forests

Assessing the effect of non-market amenities on real estate prices

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Valuing Forest Amenities -

Assessing the effect of non-market amenities on real estate prices

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Abstract

Quantitative information on residents' valuations attached to forests is needed for assessing land use, city planning, and the development of policies for forest preservation. This paper aims to value implicitly non-market forest amenities by estimating real estate housing prices and specific amounts of environmental amenities associated with recreational houses, specifically forest types. The empirical study is based on data from the sales of recreational houses in the county of Hässleholm in Sweden from 2018 to 2021.

Two different models were used in this research, focusing on both global and local estimates. Proximity to pine forests, arable land, and bodies of water displayed significant effects on prices for recreational houses. The results suggest that individuals value natural amenities differently. Pine trees are seen as a disamenity that brings down the price of houses while proximity to both water and arable land affects prices positively.

The model focusing on global estimates explains more efficiently the changes in prices in the housing market. It is recommended to consider more information about the real estate market structure and non-marker amenities to fully exploit the explanatory potential of local estimates.

Keywords: amenity, hedonic price method (HPM), forests, city planning, dwelling prices, revealed preferences.

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Abbreviations

ArcGIS	Aeronautical Reconnaissance Coverage Geographic Information System
ES	Ecosystem Service
GWR	Geographically Weighted Regression
HPM	Hedonic Pricing Method
TEV	Total Economic Value
OLS	Ordinary Least Square
WTP	Willingness to Pay

1. Introduction

This paper intends to find the effect that proximity to non-market amenities, specifically forest types, has on recreational property prices and the importance of adding these effects into value-assessment methods for recreational housing.

This research aims to test the hypothesis that proximity to different types of forests have varying effects on property prices. The objective is also to contribute to ongoing debates over the development of spatial methods intended to value local environmental attributes, or ecosystem services (ES) found within forests, that are not commonly tradeable in the market and therefore do not have a monetary price.

The importance of finding a monetary value for non-market amenities is connected to how many of their ecosystem services can benefit our lives at different levels with or without our knowledge. Amenities are location-specific goods that are often found to affect the value of nearby housing positively and are often related to natural assets (Nilsson, 2014). These benefits affect individuals directly (using the forests for recreational purposes such as running or meeting friends) or indirectly (benefits from living close to the area such as cleaner air, less noise pollution, etc.). However, such benefits often cannot be commercialized in monetary terms. Hence, there is a need to develop methods that can assess their worth in units that allow for a better understanding of their monetary value.

Revealed preference valuation techniques can provide insights into how the market and consumers value ecosystems through purchasing power. Models such as the Hedonic Pricing method, Benefit-Transfer method, travel-cost technique, and others have been developed to answer such questions.

In this research, the focus lies on the Hedonic Pricing method to empirically estimate implicit prices that consumers are willing to pay for obtaining some recreational housing characteristics, and how they perceive the value of a nearby environmental resource. These properties are small houses (‘Småhus’) but do not have to be registered in the civil registry, and they are used mainly for recreational purposes and seasonal dwelling[1].

[1] In Swedish it is called ‘Folkbokföring’.

Previous research, such as the one done by Mansfield et al. (2005), shows that there is a monetary value added to properties in proximity to forests that goes beyond any aesthetic or environmental worth. According to the authors, such value is linked to direct and indirect use values obtained from being close to them, for example, recreational values.

Results, i.e. the economic value of environmental amenities, shown through a premium on housing price, provide important knowledge for local land-use planning policy. This paper argues that proximity effects are not yet thoroughly researched, and therefore this study seeks to contribute to the literature by focusing on the effects that can be accounted for through distance variables to different forest types. In other words, focusing on the impact of forests, classifying them by types of forest, and studying whether implicit prices (i.e. willingness to pay) vary among them.

The research seeks to highlight the relevance of ES and recreational values to society and the importance of further developing conservation policies for their conservation.

This dissertation is organized as follows. First, the theoretical basis for the research is presented in chapter 2 by focusing on the benefits of ES services, specifically concerning the variables of interest (type of forests) and how they are hypothesized to affect recreational property prices.

Chapter 3 describes the data used for this research. The data has been obtained with the help of the Swedish housing statistics (Svensk Mäklarstatistik[2]) and other Swedish governmental authorities (Naturvårdsverket, Skogsstyrelsen).

Chapter 4 discusses the methodological approach used for estimations, especially i) the relevance of using mapping-system tools such as ArcGIS for studying spatial autocorrelation between properties and forest location, and ii) the relevance of using both aspatial and spatial regression models such as Ordinary Least Squares (OLS) and Geographically Weighted Regression (GWR) in the context of hedonic pricing.

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[2] ***NOTE***: according to Swedish Housing Statistics (Mäklarstatistik) agreements, this data is not allowed for online open access. Specific information regarding individual house prices and location will not be displayed. This paper will primarily focus on showing results and will refer to average prices and factors driving up the commodity prices from the said average.

Finally, a Hedonic Pricing model using the proximity to different types of forest variables described previously will be presented and the following results will be analyzed in chapter 5. Possible limitations and discussion will be assessed, followed by concluding remarks in chapter 6.

2. Theoretical Approach

The importance of natural amenities can be inferred by understanding the Ecosystem Services that they provide for recreational houses. ES are benefits obtained from forests, i.a., that impact all living beings with or without their knowledge while promoting economic growth, both wild animal and human livelihood through sheltering, cleaner air, and carbon sinking.

ES provide cultural, spiritual, aesthetical, and recreational values as explained by the Millennium Ecosystem Assessment (MEA) in their Synthesis report (Assessment, 2005). However, said benefits do not have a price value since there is no market for environmental services. The term ES has become quite widespread across the academic world with a special interest in calculating the economic value of ES regardless of the ethics, as explained by Baral et al. (2014).

The motivation is to capture the way ES can be valued for a cost-benefit analysis that can impact policy development and decision-making related to the proper use of land and city planning. The effects of being nearby non-market amenities such as forests can influence the decision-making process, particularly in the case of property acquisition.

Moreover, when assigning a value to a natural amenity, this needs to be done in terms of Total Economic Value (TEV), for example, in the case of ES provided by forests in regards to its productive value, environmental contribution, and recreational properties (Zhang, 2016: Pearce et al., 1989). TEV can be understood as resources available, expressed in monetary terms that people are willing to pay for. In other words, the TEV is the result of evaluating different aspects related to the direct or indirect use of available resources or ES, as shown in Figure 1.

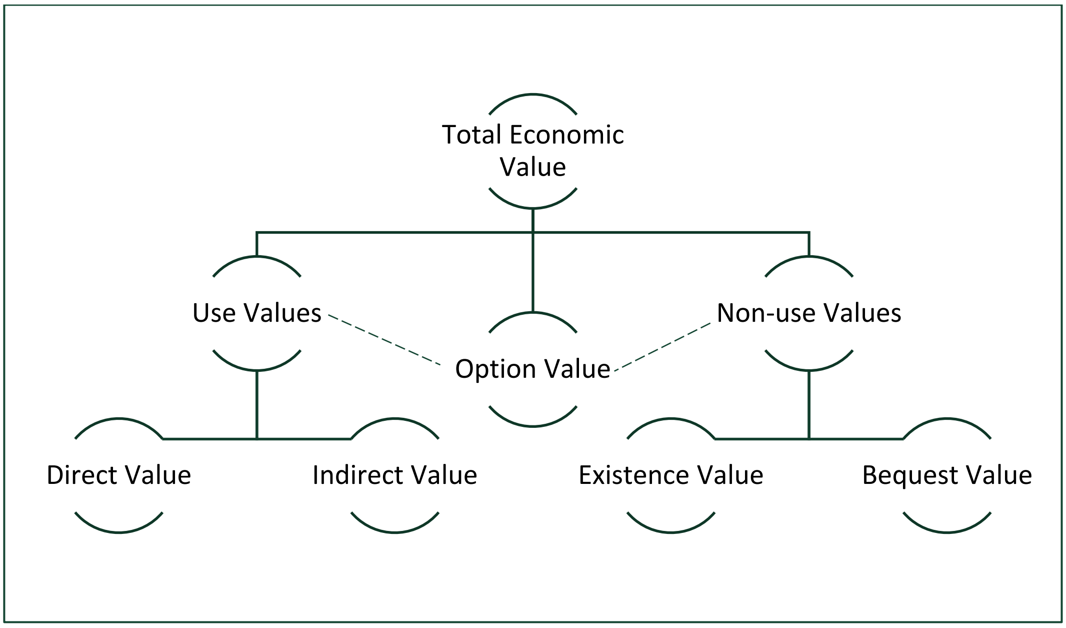

Figure 1: Total Economic Value. Source: Pearce et al. (1989)

TEV can be defined as the following according to figure 1:

TEV= Direct-value + Indirect-value +Optional Value + Existence Value + Bequest Value.

OR

TEV= Use value + Non-use value, especially in the case of forest benefits.

The focus of this paper lies on the Use-values shown above, since these explain the value given to services and goods that can be physically used, i.e. benefits such as timber, wood applications, charcoal, recreation, tourism, and national parks contribute to an increase of the economic value. Use-values are formed by Direct values, entailing non-consumptive services, i.e. recreation and cultural activities that benefit those who live near forests (Zhang, 2016). Use-values are also formed from indirect values of ES found in forests and can benefit both people and the ecosystem's development and preservation, therefore being of great importance to preserve in the long run.

By using valuation methods, revealed and stated preferences will be explored. In other words, how individuals behave in markets. For this reason, revealed preferences valuation methods were designed to understand said preferences in monetary terms. To determine these preferences, both sides of Figure 1 can be evaluated, focusing on Use and Non-use values that contribute to decision-making.

This information is usually obtained by means of surveys and choice experiments where people can be asked directly about their preferences. However, there is a difference between what people say they prefer consciously and what they do in the end, which motivates studies like this one to reveal preferences by assessing the values of direct and indirect use. This research focuses rather on the latter part, trying to reveal housing preferences while subjected to factors that influence individuals' decision-making when confronted with proximity to non-market amenities. Preference towards said amenities can be explained by the direct use and the indirect benefits associated with them, that consumers may not fully consciously be aware of, and its impact in their daily lives, but also in situational decisions.

Methods used for finding revealed preferences are the Travel Cost method, Hedonic Price Method, Defensive Expenditure Approach, and the Production Function Approach and are characterized by their ability to capture use values (Acharya et al., 2019; Bamwesigye, 2020; Chau & Chin, 2003)

Environmental valuation methods are designed to assist in decision-making related to forests and other natural resource development, considering their non-market value (Kerkhof et al., 2010; Tao et al., 2012). The Hedonic Pricing Model is used to evaluate ES since this method estimates the value of environmental benefits reflected in the price of market transactions.

The Hedonic Pricing Model (HPM) was initially developed by Rosen (1974) and has been used as a methodological basis for analyzing real-estate markets ever since. The main focus is to work with implicit prices for attributes and characteristics associated with non-market amenities. Following Rosen’s structure, the class of goods to be considered can be described by several characteristics that have been objectively measured, and that will be called $\boldsymbol{m}$. Moreover, the location of the properties is represented by a vector of coordinates

$$\mathrm{L} = (\mathrm{l}_1, \mathrm{l}_2 \dots \mathrm{l}_\mathrm{m}) \qquad (1)$$

where each $\boldsymbol{l}$ will account for a given characteristic present in each good and is expressed in numerical values. This implies that there are different configurations for the consumer to choose from and therefore sales can be seen as the result of a bundle of locational characteristics chosen by consumers and producers for every single point in the plane, combined with a price function that signals said characteristics as

$$\mathrm{p}(\mathrm{l}) = \mathrm{p}(\mathrm{l}_1, \mathrm{l}_2 \dots \mathrm{l}_\mathrm{m}) \qquad (2)$$

The function (2) is determined by some market-clearing conditions:

1. Offered houses must equal the demanded amount from consumers that choose to live in the designated area.
2. Location and quantity of properties are determined by maximizing behavior with equilibrium prices set so that both buyers and sellers are evenly matched.
3. There are no limitations to choosing. All optimal choices are feasible.

.

In its formal expression, a usual hedonic price equation is described as

$$lnP_i = X_i\boldsymbol{b} + \varepsilon_i \quad (3)$$

where P_i is the price of real-estate i, X_i the matrix of explanatory variables, b is the vector of parameters to be evaluated, and ε_i is an error term.

The method addresses the issue of varying consumer's perception of the value of a good by stating that it will be identical across all of them, so that specifications of properties differ depending on other factors such as the environment in which the property is located, accessibility and characteristics of the property, e.g.: number of rooms, year of construction, etc.

Literature suggests that when studying explanatory factors, there is a need to account for those that can be influential such as the presence of schools, local shops, and other public services, the same methodology used by Tyrväinen (1997). Explanatory factors need to be suitable for the research and their use for recreational houses, therefore, mentioned variables will not be considered due to the focus on environmental amenities.

The HPM studies environmental variables to capture the effect of people's WTP in the given environment, for example, the presence of trees, sound quality, the value of clean air, etc. Nonetheless, the importance of choosing the right environmental variable can be seen in the paper of Graves et al. (1988) with results showing that, for example, the value of clean air is not very relevant for decision-making. The authors explain that property value remains the same regardless of other characteristics, such as the size of the property and the buyers' perception of the air's quality when making a decision.

The effect of noise pollution was researched by McMillan et al. (1980). They discussed the possible effects of noise pollution on consumers' willingness to pay and discovered that revealed willingness does not differ greatly in areas with high levels of noise pollution from the quiet ones.

It can be argued against using noise pollution as an environmental variable due to the location of recreational houses, which are primarily located on the outskirts of a city or in villages close to rural areas. The location of recreational housing already takes care of any expected effect since none of the properties will be found in the city centre or industrial zones, therefore it can be assumed that the levels of noise disturbance can be more or less the same across the houses and do not provide a significant effect nor contribute to the decision-making debate. The latter argument will be confirmed in later chapters showing the distribution of data across the chosen location.

This paper focuses on the environment surrounding properties and will mainly discuss its effect on prices as a result of appreciation for ES found within all forests. Previous research has also looked into the effect of forests on property prices while accounting for other factors in the surroundings (Luttik, 2000; Mansfield et al., 2005; Melichar et al., 2009; Payton et al., 2008). However, the search for effects can be refined by focusing on areas where decision-making is influenced by factors that are merely non-existential, and therefore provide an opportunity to test preferences and willingness to pay for recreational houses that are rather close to nature.

Additionally, different data collection methods have been applied in the past, with other research choosing to use survey data that shows people's preferences at a given time and place. It can be argued that this approach may be the most direct one for gathering information, but also the most susceptible to external factors that could impact people’s answers, which cannot be controlled. This paper uses coordinates data of sold properties over a period of time. This allows to collect and work with data compatible with spatial methods. With this approach, the implicit price set to a property will be estimated and willingness to pay said price will be discussed.

3. Data

Data pertinent to housing prices were selected and obtained from the Swedish Real Estate Statistics (Svensk Mäklarstatistik AB[3]) accounting for the last 48 months. The data available goes from January 2018 to January 2021 and a total of 134 properties were studied.

A longer time frame was not necessary for the analysis given that the observations are not repeated and the purpose is to analyze the current market behavior. Therefore, the focus lies in the latest market transactions for each housing by assigning a time window while controlling for the time that it was in the market. The search was narrowed down by looking into housing with pertinent property codes, available on the Swedish Tax Agency website.[4]

A representative location was chosen with the addition of its coordinates to calculate the distances between forest areas and properties with the help of the geographical software ArcGIS. The data provided by Mäklarstatistik was in terms of average prices per square meter (SEK/m^2) and geolocation for each sold property. This information helps to accurately assess the distances to forests by using measurement tools found in the program ArcGIS. Additionally, distances to other natural amenities were calculated using the same method.

For this investigation, information on the forest types was obtained from both Skogsstyrelsen GIS downloadable data on their website[5] and the National Land Cover Database from the Swedish Environmental Protection Agency[6].

In addition to variables related to forest type, distance to recreational housing, and prices in the market, additional data were obtained pertinent to other natural amenities located in the vicinity of these properties while also controlling for the value set to houses over time.

[3] https://www.maklarstatistik.se/

[4] www.skatteverket.se : codes for properties 220,225

[5] Skogsstyrelsen - Ladda ner geodata

[6] Naturvårdsverket: https://www.naturvardsverket.se/

The taxation value was used as it captures the quality of the property. It is based on local specific factors (such as age, near access to local shops and schools, living area of an apartment, and the number of rooms) added to the market value.

3.1 Study Area

The area designated for this paper is the municipality of Hässleholm, located in the county of Scania (Skåne), with an area of over 1306 km^2 and a population of over fifty-two thousand inhabitants. The study area is of regular size and it is not near elements that could influence estimations (i.e. not by the sea). At the same time, it also presents characteristics that are representative of the Swedish landscape (presence of diverse types of forests, lakes of different sizes, and rivers).

The study subject is recreational houses in Hässleholm, these are properties designed solely for recreational purposes. By focusing on this group, the intrinsic motivation for purchasing can be narrowed down by excluding other motivators that can drive up sales, such as the need for having a place to live or proximity to work, and other central areas that could account for a monocentric structure. A special feature of this type of house is that it does not have to be registered in the civil registry.[7]

The housing market in Hässleholm was analyzed and the sales of recreational houses in the period 2018-2020 were reported in Figure 2. For the purpose of exploring price patterns, a cluster analysis was used in order to identify areas with selling prices above the average.

Results in Figure 2 show that the recreational houses' price gradient differs in different areas of the county, however due to the recreational value of the houses, the price gradient is not associated with proximity to the centre as in the case of previous literature (Nilsson, 2014).

After observing the location of the properties shown in Figure 2, it could be identified that there is a polycentric market structure in Hässleholm, which could be explained by the presence of diverse natural amenities in the county but also the structure of the market. The data show hotspots across the territory, meaning that there is not a unique point where houses are being sold but rather the opposite.

[7] In Swedish, it is called '*Folkbokföring*'

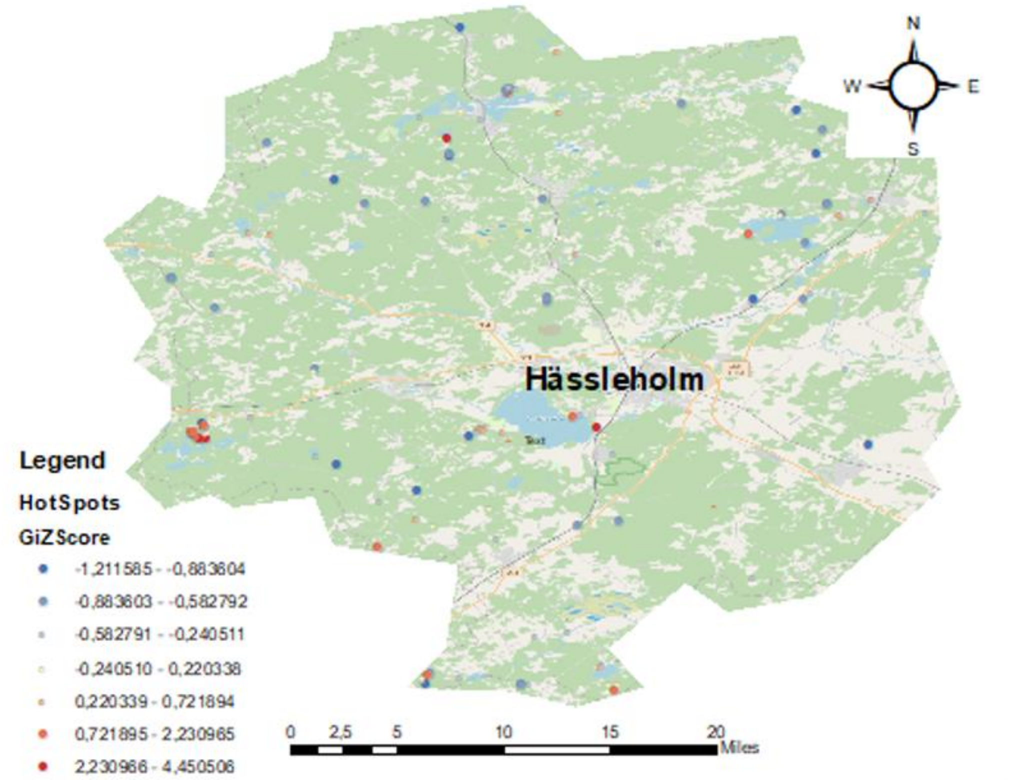

Figure 2: Distribution and hotspots of properties sold across the county. Getis-Ord clusters w.r.t. prices per m^2. This figure shows GiZ scores from clusters in the map related to sale prices per m^2. The data is classified by means of standard deviation (Gettis & Ord, 1992)[8]. Red dots indicate sales with prices significantly above the average, and the blue dots indicate sale prices below the average for this county. Source: Mäklarstatistik

An explanation for the results shown in Figure 2 can traditionally be found when considering factors present in the houses' surroundings, i.e. the presence of forests, recreational activities nearby, development of new urban areas, growing labor markets, tourism, etc. The county of Hässleholm provides an array of activities for visitors throughout the year, these activities could perhaps explain the concentration of properties in certain areas around the territory as shown in Figure 2.

The location of the county makes it less feasible to explain the preference for buying houses in given areas due to significant drivers such as ski resorts, proximity to open waters, and more. Additionally, as explained in the previous chapter, the focus will be on studying forests close to these properties.

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[8]The Getis-Ord local statistic is given as:

$G_i^* = \frac{\sum_{j=1}^{n} w_{i,j} x_j - \bar{X} \sum_{j=1}^{n} w_{i,j}}{S \sqrt{\frac{n \sum_{j=1}^{n} w_{i,j}^2 - \left(\sum_{j=1}^{n} w_{i,j}\right)^2}{n-1}}}$, where x_j is the attribute value for feature j, $w_{i,j}$ is the spatial weight between feature i and j, n is equal to the total number of features. The G_i^* statistic is a z-score.

3.2 Identifying Natural Amenities

This paper's contribution to the discussion about how to assess the value of natural amenities in commodity prices is to calculate the WTP for recreational houses, in relation to the type of non-market amenity found nearby. The focus will lie on the location of forests since they provide residents with several benefits by means of their ecosystem services.

However, there can be differences when estimating the effect depending on the type of forest and its ecosystem services, therefore the paper's take on this debate is that research should be more specific about the forests surrounding the property and their positive and negative impact on the value assessment of houses. Thus, environmental variables are added to the estimations by calculating the distance from properties to each forest type.

The distance method used was the Geodesic method. This allows to accurately measure the distance between two points while searching for the closest point between them. The distance is calculated in a spherical space (3D) and takes into account the curvature of the earth in its calculations (pro.arcgis.com). Using this method accounts for any distortions that could be present when calculating distances in a large area, as the case of a country. In the case of the size of the study area being smaller than a country scale, the Geodesic method provides similar results as when using a linear method in a 2D plane.

3.2.1 Which types of forest can be identified?

The types of forest present in the area of Hässleholm were identified with the help of the Swedish Environmental Protection Agency raster data. The data obtained describe the location of forests in the county with the distinction between coniferous (pine, spruce, and other needled trees) and deciduous trees.

Figure 3 shows the shares of trees present within a forest and how entities such as the Swedish Forest Board[9] use these shares to classify the type of forest. Different forests have different properties and economic values.

This paper studies how the proximity to a forest can affect housing prices, however, different forests possess different attributes. Forests are constituted by varying trees

[9] Skogsstyrelse: https://www.skogsstyrelsen.se/

and there is a need to classify forests by the share of trees as these can provide different ecosystem services.

Classifying forests can provide insight into how individuals value their properties and which types of forests are seen as an amenity or disamenity for the market.

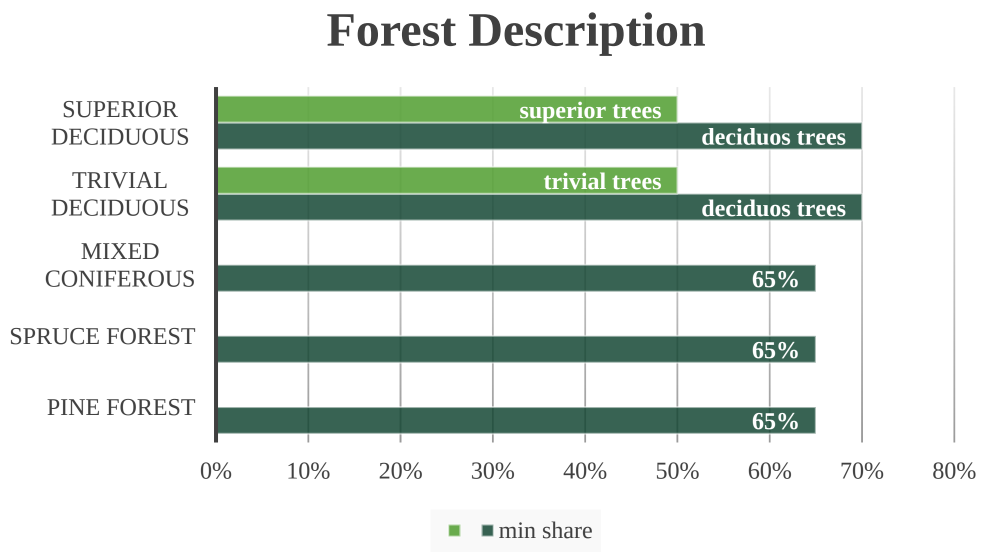

Figure 3: Minimum shares of trees by forest type. Source: The Swedish Forest Board (Skogsstyrelsen).

The classification shown in Figure 3 provides a common understanding of which forest can be present around recreational houses.

Figure 3 shows the share of trees necessary in a forest to classify it as a forest. For example, a pine forest contains at least 65% pine trees. In the case of deciduous trees, a superior forest contains 50 % superior trees and the area has at least 70% deciduous trees. In the case of a forest with a share of 50% coniferous trees, this would be classified as a mixed forest.

Using this definition provides information about the type of nature that is present around the properties. Types of forests could be differently appreciated by individuals. Therefore, it is necessary to follow the classification above.

The Swedish Environmental Protection Agency provided raster data pertinent to the location of each type of forest across the county. This information was uploaded to the ArcGIS program and used as a basis for distance calculations among the properties of interest.

Similarly, data showing the location of arable land were obtained from the Swedish Forest Board. This type of land is characterized by having less tree density, but at the same time provides broader landscapes and therefore a better line of sight. On the other hand, there is less natural protection against weather conditions (storms, fires, etc.).

The proximity to bodies of water was also assessed, especially in the context of recreational housing, since water can be very attractive for future house owners due to its natural characteristics that offer many aesthetic and recreational values and ecosystem services. There is extensive literature discussing the effect of water proximity on property prices (Luttik, 2000; Nilsson, 2014; Tyrväinen, 1997).

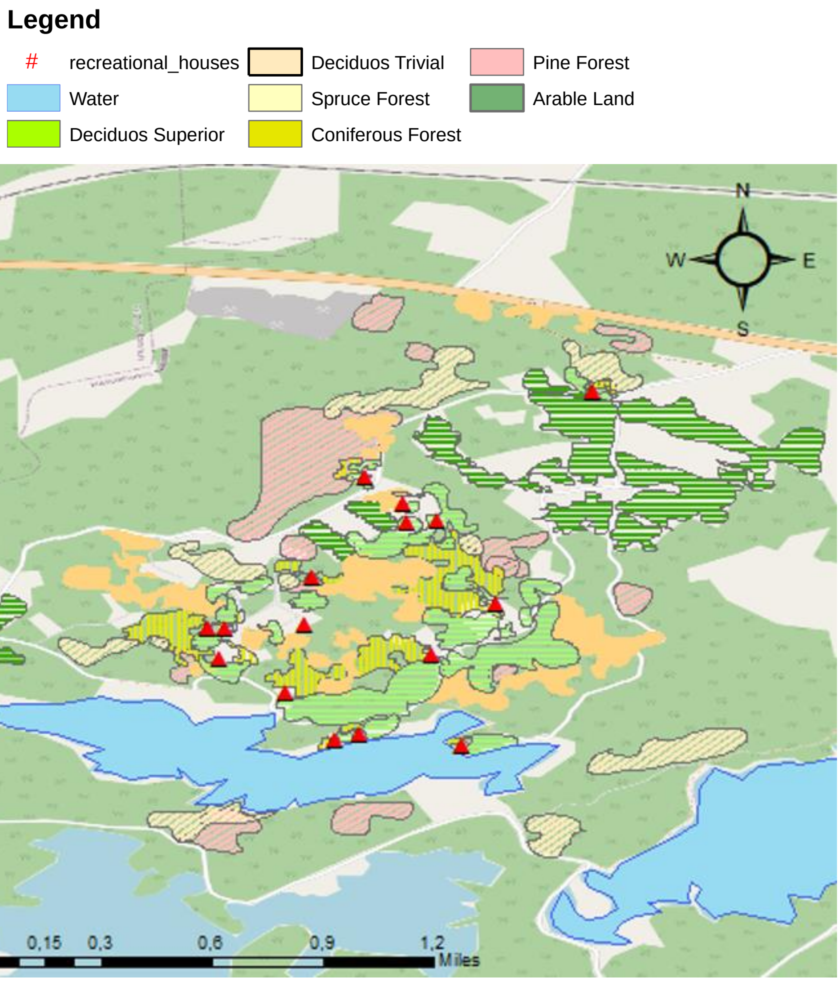

Figure 4: Environmental amenities around recreational houses in the county of Hässleholm.

Figure 4 shows how environmental amenities were identified around properties by using the Geographic Information Center (ArcGIS). The figure shows that each property has a different level of exposition to diverse types of forest and other natural amenities such as nearness to water and arable land. Figure 4 shows a section of the county characterized by displaying a cluster of properties being sold during the period 2018-2021. Distance calculations were made with the ‘near table’ function within the program ArcGIS and a list of forests close to each property was made.

4. Methodology

The method used for testing the hypotheses was the Hedonic Pricing Model as it can provide this investigation with insightful information about the way amenities and their ES are valued, and how this is reflected in purchase decisions. With the help of the geographical system ArcGIS, the data obtained from the Swedish Real Estate Statistics were transformed into a dataset with given coordinates for the representative location. These data were combined with calculated distances from the properties to the forest areas.

The regression follows the following expression:

$$p_i = \alpha_i + \beta_{i1} \ln \boldsymbol{S}_i + \beta_{i2} \ln \boldsymbol{N}_i + \beta_{i3} \ln \boldsymbol{L}_i + \varepsilon_i \qquad (4)$$

$$i = 1,2 \ldots 134$$

With p_i being the price of the property i; α is the intercept at location i; S_i is a vector of house structural variables; N_i is a vector of neighborhood characteristics; L_i (location) is a vector for the distance to urban centres and natural amenities and β_{i1} to β_{i3} are vectors of the respective parameters of the control variables. The functional form of the hedonic equation is characterized by a linear dependent variable and logarithmic explanatory variables to correct heteroscedasticity in the data (linear-log).

Two different types of regression were used in this research. The first is a standard OLS (Ordinary Least Square) regression, followed by the GWR (Geographically Weighted Regression). The reason for choosing both models is their ability to find aspatial and spatial relationships in their estimations. This paper intends to determine which method is more suitable for analyzing the topic of research.

In both statistical models, the dependent variable was the development of property prices per square meter (SEK/m^2) explained with the following variables: purchase price coefficient, the average price per zip code, distances to forest type, and more, using methods for calculation explained in Chapter 3.

To control for factors that do not align with the goal of the paper, the following assumptions will be made following Tyrväinen (1997), so that the focus is on assessing the intrinsic value of the forest and its effect on real estate:

1. The entire urban area can be treated as a single market
2. The housing market is in or near equilibrium
3. The rateable value covers many characteristics pertinent to the quality of the house.

In Chapter 1, a general hedonic price function linking together prices and attributes of the property was presented. The following section will discuss how to conduct a comprehensive HPM study parting from an appropriate choice of environmental variables. The functional form of the hedonic equation and consideration for preventing multicollinearity will also be discussed.

4.1 Variables

This paper determined variables that will be used in the model and estimations. For this purpose, available literature that discusses the relevance of using locational, structural, and environmental attributes was used. The selection of a specific environmental variable can affect the results but also explain them. The variable of interest is the price per square meter (SEK/m^2) for housing whose price fluctuation will be explained by using variables chosen for their ability to reflect the quality of a property, environmental attributes, and proximity to forests. These aspects could also help to determine implicit pricing.

In their critical literature review on the Hedonic Price Model, Chau & Chin (2003) listed commonly used housing attributes in hedonic models with expected effects of said variables on the price of houses as shown in Table 1.

Using the proximity to forest to explain the housing price may be difficult to calculate, given that it changes depending on the area. Moreover, generalizing the effect of forest proximity to properties would only lead to understatements if the qualities of each type of forest are not considered.

Table 1: List of Commonly Used Housing Attributes in Hedonic Price Models. Source: Chau & Chin (2003)

Attribute		**Expected effect on housing price[a]**
Locational	Distance from City Centre	-
	View of the sea, lakes, or rivers	+
	View of hills/valley/golf course	+
	Obstructed view	-
	Length of land lease	+
Structural	Number of rooms, bedrooms, bathrooms	+
	Floor area	+
	Basement, garage, and patio	+
	Building services (e.g. lift, air conditional system, etc.)	+
	Floor level (multi-store buildings only)	+
	Structural quality (e.g. design, materials, fixtures)	+
	Facilities (e.g. swimming pool, gymnasium, tennis court)	+
	Age of the building	-
Neighborhood	Income of residents	+
	Proximity to good schools	+
	Proximity to hospitals	?
	Proximity to places of worship (e.g. mosques, churches, temples)	+
	Crime rate	-
	Traffic/airport noise	-
	Proximity to shopping centres	?
	Proximity to forest	?
	Environmental quality (e.g. landscape, garden, playground)	+

[a] + positive impact on housing prices; – negative impact on housing price; ? varies from place to place, the actual effect is an empirical question

The expectations shown in Table 1 will serve as a guide for interpreting results in the following chapters.

Table 2 focuses only on environmental variables related to the proximity to each type of forest and expected effects on housing prices according to the literature available. As mentioned in Table 1 the effect depends on empirical questioning and the circumstances, therefore there is no certainty about the effect of the type of forest, but results can contribute to further exploration of these topics.

Table 2: Expected effects of forest variables on housing price.

Attribute		**Expected effect on housing price**	**Literature**
Forests proximity	Spruce forest	-	(a), (b)
	Pine forest	-	(a), (b)
	Coniferous tree forest	-	(a), (b)
	Trivial deciduous forest	+	(a),(b)
	High-value deciduous forest	+	(a), (b)
Others:	Arable land	-/+	(c)

(a): (Tyrväinen, 1997) *(b): (G. Garrod & K. Willis, 1992)* *(c): (Le Goffe, 2000)*

To focus on the importance of environmental attributes, other characteristics will be controlled for but will not be further explored as shown in Table 2. The expected effects shown in the table are obtained from previous literature, however, previous research has not been limited to recreational housing. This could lead to differences in estimated results against the expected ones.

The expected effect suggested by Tyrväinen (1997) and Garrod & Willis (1992) accounts for the presence of coniferous trees and broad-leaved trees[10] without a more extensive classification of forest types. Similar to Table 1, the effect on housing prices depends on the empirical question and the circumstances, therefore, there is no certainty about the effect of the type of forest, but results can contribute to further exploration of these topics.

Another variable of interest is the arable land which is often found in the countryside and is largely present in the south of Sweden. The expected effect of arable land on the housing prices could be expected to be negative given the possible disamenities that it produces such as noise, smells, and degradation of soil by intensive fodder and livestock farming. However, the literature suggests that if kept as permanent grassland, its presence affects the line of sight, providing landscapes for those located nearby and this could be seen as an amenity (Le Goffe, 2000)

Further, locational attributes kept are those that show the distances between properties and bodies of water or the city centre. In the case of structural attributes shown in Table 1, this paper focuses on using the taxation value of the property, since it encompasses the characteristics of the house such as location, number of rooms, size, year, and more when assessing the value of the property.

[10] Type of deciduous tree.

Using this method helps to explain the implicit pricing in the housing market, meaning the consumer's WTP for a property that has certain characteristics. It is calculated by dividing the property's contract price[11] by the taxation value

$$Market\ Price\ Coefficient = \frac{Contract\ Price}{Taxation\ Value} = K, \qquad K \geq 1$$

By calculating the coefficient, as shown above, the results can be understood as the factors that add value above the quality of the house and provide a clue regarding the preferences or other factors that raise the value of the property

Using the taxation value can help to reduce the level of variables being used and therefore reduce the risk of multicollinearity in the results. The risk of multicollinearity could be due to the complementarity between the variables that describe a property and its quality – many factors are related to each other and therefore the more is added, the higher the risk of multicollinearity being present in our results.

For dealing with endogeneity, the distance to other natural amenities was calculated as a control for possible effects that can drive up or down property prices. To reduce the chance of having an omitted variable bias, the proximity to bodies of water is also considered since these areas can drive decisions, especially when considering the purpose for buying a house, which is recreational, and how close lakes and rivers are to forests.

The area of study was also chosen to prevent endogeneity by choosing a small market that can provide a better understanding of its structure and behavior.

Table 3: Variables assessment. NK= not kept, K=kept, TV=taxation Value

	Attribute	**Action**
Locational	Distance from city centre	K
	View of the sea, lakes, or rivers	K
	View of hills/valley/golf course	NK
	Obstructed view	NK
	Length of land lease	NK
Structural	Number of rooms, bedrooms, bathrooms	TV
	Floor area	TV
	Basement, garage, and patio	TV
	Building services (e.g. lift, air conditional system, etc.)	TV

[11] The taxation value for recreational housing is around 75% of the selling price. However this value can change every year depending on decisions made by the Tax agency (Skatteverket).

	Floor level (multi-store buildings only)	TV
	Structural quality (e.g., design, materials, fixtures)	TV
	Facilities (e.g., swimming pool, gymnasium, tennis court)	TV
	Age of the building	TV
Neighborhood	Income of residents	NK
	Proximity to good schools	NK
	Proximity to hospitals	NK
	Proximity to places of worship (e.g. mosques, churches, temples)	NK
	Crime rate	NK
	Traffic/airport noise	NK
	Proximity to shopping centres	NK
	Proximity to forest	K
	Environmental quality (e.g. landscape, garden, playground)	NK

For the selection of variables, only those presumed to have the explanatory potential for the model were chosen, as shown in Table 3. The information on these variables was obtained with help of government authorities.[12]

Another aspect to consider is spatial autocorrelation or dependency, which usually occurs in properties that are close to each other because they are exposed to similar effects to those located further away. This is something to take into account in the hedonic price function, and that is the effect of houses being located in different villages within a county. Similar to Cavailhès et al. (2009), the following price function explained in the first chapter is used:

$$p(l) = p(l_1, l_2 \dots l_m), \quad (1)$$

where l_i denotes the set of locational characteristics present in each good expressed in numerical values. Expression (1) is used to obtain the hedonic price function for the environmental attributes and village effects found across the county (written as v_j) as the following:

$$P_{i,j} = \propto_{i,j} + \beta_i * ln l_{i,j} + \beta_j * \ln v_j + \cdots \varepsilon_{i,j}, \quad i = 1,2,3 \dots 134 \quad (5)$$

Where $\boldsymbol{P_{i,j}}$ is the price of the real-estate i in the village/town j; $\propto_{i,j}$ is the intercept of the property i in town j. Further, $l_{i,j}$ is the matrix of explanatory variables

[12] Naturvårdsverket, Skogsstyrelsen, Svensk mäklarstatistik.

(including environmental ones) in every village; v_j is a variable that represents the village j characteristics, and $\varepsilon_{i,j}$ is the error term.

4.2 Global vs. Local Estimations

Estimating the effect of the variables mentioned above on housing prices could vary due to spatial heterogeneity, meaning that the price of each property may be different according to a number of environmental factors found in their surroundings. In this case, it is useful to compare estimations that focus on aspatial and spatial characteristics. This paper will run two models and will compare their results.

4.2.1 Ordinary Least Square – Global model

It is the most common regression model used in a variety of contexts including in hedonic pricing studies. This method predicts implicit prices and explains the strength of relationships between a continuous response variable and explanatory variables within a linear model. This model is characterized by random variables which are normally distributed, and it works best with continuous data.

The OLS regression is used here to find the linear relationship between environmental variables and the dependent variable, by using logarithmic transformation to improve the fit of the model and the distribution of the features (skewness).

4.2.2 Geographical Weighted Regression – Local model

Firstly introduced by Brunsdon et al. (1998), GWR is a spatially explicit method that allows for modelling relationships between independent and dependent variables according to their location. This tool is characterized by its ability to visualize variation in stimulus-response according to space variation and correlation between variables across the plane. This approach provides local results since it generates separate OLS equations for every location in the data, taking into account both dependent and explanatory variables within a bandwidth[13] of each target location.

A general version of the model can be expressed as:

[13] Bandwidth refers to the distance radio between variables of interest, i.e. 5km.

$$y_i = \beta_0(u_i, v_i) + \sum_{z=1}^{n} \beta_z(u_i, v_i)x_{i,z} + \varepsilon_i \quad (6)$$
$$i = 1,2,3 \ldots 134$$

Where y_i is the dependent variable, in this case, the price of a house at location i, $\beta_0(u_i, v_i)$ denote the intercept coefficient at location i, $x_{i,z}$ is the value of the zth explanatory variable at locations i, and ε_i is the random location-specific error term.

This model will provide information at the local level and intends to reveal differences with global results shown in the OLS regressions. The regression of both mentioned models will be made using the information shown in Table 4 capturing both structural, environmental, and locational variables.

Table 4: Descriptive Statistics

Variable	Unit	Min	Max	Mean	Std. Dev.
Structural Characteristics					
House price[14]	SEK	305	3900	1,121.4	610.6
Purchase Coefficient		1	6	2.522	1.002
Price per m^2	SEK/m^2	5	65,789	18,196.3	10,939.9
Environmental Characteristics					
d. Arable Land	Meter	99.5	34,883.18	18,626.68	10,155.13
d. Spruce	Meter	0.55	1,054.75	114.7	148.76
d. Pine	Meter	1.12	1,676.83	378.02	354.82
d. Trivial	Meter	1.05	634.35	100.5	98.84
d. Coniferous	Meter	0.85	1,560.06	263.8	243.39
d. Water	Meter	19.64	8,850.34	1,607.86	1,718.27
d. City Centre	Meter	2,889.8	28,288.02	1,6517.99	6,126.13
d. Superior	Meter	0.141	414.19	38.33	70.67

A hedonic function of the following form is estimated:

$$P_i = \propto_i + \beta_{1i} ln\boldsymbol{S} + \beta_{2i} ln\boldsymbol{N} + \beta_{3i} \ln \boldsymbol{L} + \varepsilon_i \quad (4)$$
$$i = 1,2, \ldots, 134$$

With p_i showing the sales property price of house i sold at location i, $\propto_i$ is the intercept of house specific variables, $\beta_1 to\ \beta_3$ are the coefficients for the type of

[14] In thousand Swedish kronor (SEK). Average values in the period 2018-2021.

variable at the property i, and ε_i is the error term. The type of variables at the property i can be vector S (structural), N (neighborhood) and L (locational).

5. Results

Regression results are reported in Table 5, model A shows the marginal effects obtained by using the OLS regression, while model B shows the estimates from the GWR regression.

Table 5: Global and Local Results on SEK/m^2

Parameters	Model A (OLS)	Model B (GWR)		
	coefficient (std. error)	Low	Median	High
ln Purchase Coefficient	4,903.19* (691.65)			
ln City Centre	344.427 (1,509.25)			
ln Arable Land	-1,372.485* (654.07)	-1,853	-1,853	-1,852
ln Spruce	-806.997 (592.13)	-901.4	-900.6	-898.6
ln Pine	1,911.104* (588.27)	2,447.6	2,448.4	2,450.5
ln Trivial	269 (561.788)	-651	-650.5	-649.9
ln Superior	31.145 (416.84)	313.66	313.85	314.24
ln Coniferous	5.29 (735.64)			
ln Water	-2,530.12* (554.034)	-4,393	-4,392	-4,390
Intercept	17,120.43	57,455.34		
Global adj. R-squared	0.580018			
Local R-squared		0.4214	0.4216	0.4218
AIC	2,771.57		2,815.52	
Condition Number			27	

Low= 25th quintile | Median= 50th quintile | High= 90th quintile

In both models, the dependent variable is the price per square meter for recreational houses (SEK/m^2). Table 5 shows that the adjusted $R^2$of the model changed from 58% to 42% while the AIC criterion increased from 2,771.57 to 2,815.52 compared to the least square estimation in model A. This shows that initially, the OLS method explains better the variations in the model. Some of the results in model A have also statistical significance, specifically variables related to purchasing coefficient, proximity to arable land, pine forest, and bodies of water.

The result of the local R^2 is 42%. Local collinearity in GWR models is controlled through condition number. The condition number is 27 which is still within the boundaries of non-collinearity[15] and suggests that results are not influenced by other variables in their interpretation. The GWR regression results in 134 coefficients for each parameter, therefore estimates are reported in a quantile range.

5.1 Spatial relationships in the housing market.

Analyzing the results obtained from both models it can be observed that in Model A the estimated baseline price is 17,120 SEK/m^2 and any values above or underneath are the results of environmental variables explained in the model. In contrast, the GWR model intercept coefficient is 57,455.34 SEK/m^2.

Differences in local and global R^2 could be the result of assumptions made when choosing explanatory variables. Applying restrictions to the variables used for the estimations can compromise the ability of the model to fully explain the change in the dependent variable.

Both models show an almost identical expected effect of the type of forest on housing prices except for trivial deciduous forests whose results from the OLS are not significant. However, the results obtained from the local model align with previous papers such as the research of Garrod & Willis (1992) and Tyrväinen (1997) stating that this type of forest positively affects the housing prices. This could indicate that this amenity effect is better captured with local models.

Despite the result not being significant, the effect of proximity to the city centre could explain why the coefficient affects the price of recreational housing negatively. This result can be expected since recreational houses are not located in city centres and therefore, the value of these properties increases the further away they are from the city centre. The research made by Tyrväinen & Miettinen (2000) showed in their research on property prices and urban forest amenities that, in the case of terraced houses, the further away a property is from the city centre the lower its price. Regardless of the result being insignificant, it can be argued that the expected coefficient should be as obtained in the estimations and not as shown in Table 1, since it reflects the purpose of the house. In this case, the property is

[15] Condition numbers that are above 30 are a sign of multicollinearity in estimations.

destined for recreational purposes, and during the first assessment of the distribution of properties (see Figure 1), it was evident that this type of property is not located near the centre, which supports the coefficient obtained in the results. Nonetheless, the result shows very little significance and does not explain the model appropriately. However, it is also important to point out that perhaps a better result could have been achieved by taking the distance from the properties to the centres of each town nearby instead of only using the city centre as a point of reference.

The market price coefficient also shows some significance, however, it can be expected given that this information is closely related to the dependent variable in the way that the coefficient is calculated.

Figure 5 shows the differences in the estimation of both models with a focus on the environmental variables.

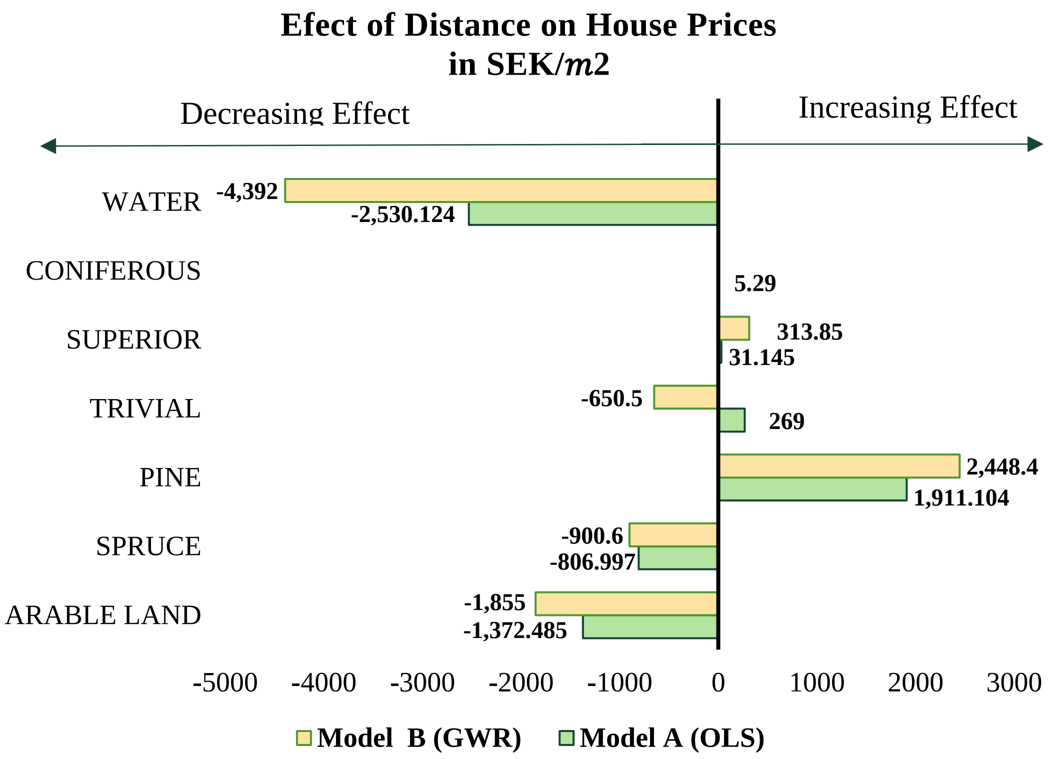

Figure 5: Effects of natural amenities' proximity on housing prices according to two models. Units are in SEK/m^2

Large differences in estimations can be observed in the case of proximity to water, pine forests, and arable land. These three variables are all significant in the OLS estimations with a statistical significance of $p < 0{,}01$. This difference implies that the observed effects work on different spatial scales. Nearness to water works at a larger spatial scale than proximity to some forest amenities. This effect is expected and it shows that Model B estimates the impact of water in a local context which is a contribution to the study and an argument for the potential of using local-based models.

When interpreting environmental variables, the results in Table 5 can be explained as the effect on property prices caused by proximity to the different types of forests. In this case, the results shown in both OLS and GWR regressions explain how the SEK/m^2 develops the further away the property is from the forest.

Regression results for arable land suggest that the housing price decreases by a coefficient of 1,372.48 ln(x) and continues to decrease the greater the distance from the house. An explanation for this result could be associated with the benefits of living close to such an area which is, i. a., a landscape that people highly appreciate. The results show a statistically significant p-value of $p < 0{,}01$, meaning that it has an explanatory weight for the development of property prices. These results align with previous research made by Cavailhès et al. (2009), where they discovered that when located in the line of sight, both trees and farmland have a positive effect on housing prices nearby.

However, the significance of their results can be seen within a distance of 100-300m, in other words, as far as the eye can see or enjoy the landscape. The results from Cavailhés et al. (2009) focus on the city of Dijon, France, and its suburbs focusing on factors that block the line of sight and therefore the landscape while accounting for other city-specific factors. In contrast, this research contributes to research by showing similar results but in a different setting. This paper shows that the same result holds in the case of recreational houses in rural areas.

The properties being discussed are usually located out of the city centre, however, in terms of landscapes, it could be said that trees act in the same manner as buildings do by blocking the line of sight, regardless of the benefits of having trees and forest in our surroundings. Le Goffe (2000) came to similar conclusions in his research.

Results for the pine forest have a significance of $p < 0{,}01$. This shows that the value of properties increases the further they are located from pine forests. The effect is aligned with results from Tyrväinen (1997). The coefficient is

$$-1{,}911.1 \ln((100 + perc.distance)/100) \text{ SEK}/m^2$$

In other words, a 10% longer distance from the average would result in prices sinking to -1,831.994 SEK/m^2. It is worth mentioning that these effects could be caused by the way the housing market is structured, and further research needs to be done in this case.

The proximity to water significantly affects property prices, showing a statistical significance of $p < 0{,}01$. The results can be explained as another effect that drives up prices when buying recreational housing, and that is when located near the water. The effect of water on recreational housing is the largest of them all, moving away from the water has a greater effect on the housing price. This result aligns with previous papers, stating that the further away a house is from the water the more negatively impacted the price will be (Luttik, 2000; Tyrväinen, 1997). The strong effect of this variable can have similar explanations related to the benefits of having a line of sight, similar to arable land.

Regardless of the explanatory power of both models, this paper shows that GWR is useful for local planning purposes as it can identify which forests and lakes are associated with the highest implicit prices. With OLS an average is obtained considering all the trees and all the lakes which is not as informative for local planning or place-based policies. GWR results can be useful for the municipality in determining which areas are more attractive because of natural amenities so that preservation efforts can be intensified in such areas.

However, improvements need to be made in the selection of variables for estimations. There are more explanatory variables (see Table 3) that can affect prices in the market and these need to be accounted for and included in the model.

The potential of GWR results can be shown when focusing on a specific area in which a cluster of properties sold can be observed (as shown in Figure 1). The cluster area is shown in Figure 4. Using the GWR model on the cluster could explain how implicit pricing varies in that area according to the proximity to different forest types and other elements, as explained in previous chapters. Table 6 shows local results for the identified cluster area. Results are within the initial GWR model range, and coefficients vary according to situational characteristics within the chosen area. Nonetheless, it can be observed that the intercept estimate is slightly higher than in the initial GWR calculations.

The results shown by the local estimates provide the possibility to calculate individual prices given the natural amenities (forests) found nearby each house complying with the concept of spatial heterogeneity.

Table 6: Local results for identified cluster area

Parameters	Model B (GWR-cluster) coefficient (std. Error)
ln Purchase Coefficient	-
ln City Centre	-
ln Arable Land	-1,852.65 (590.3565)
ln Spruce	-901.318 (593.2865)
ln Pine	2,450.2328 (667.9925)
ln Trivial	-649.9368 (653.4267)
ln Superior	313.5345 (485.1236)
ln Coniferous	
ln Water	-4,393.7807 (586.6481)
Intercept	57,458.705
Global adj. R-squared	
Local R-squared	0.42177211
AIC	
Condition Number	27

Using the results in Table 6, the implicit price for housing can be estimated following the interpretation rule for a linear-log model and its coefficients.

Estimating an implicit price from the regression coefficients obtained for the cluster area would give the following expression in its functional form:

$$\begin{aligned} p_i = 57{,}485.705 - 1{,}852.65 \ln arable_i - \ 901.318 \ln spruce_i \\ + 2{,}450.2328 \ln Pine_i - 649.9368 \ln Trivial_i \\ + 313.53 \ln Superior_i - 4{,}393.78 \ln water_i + \varepsilon_i \\ i = 1{,}2 \ldots 134 \end{aligned} \quad (7)$$

The linear-log model is interpreted as an expected increase in p_i of β units resulting from a one-unit increase of the ln(variable). Meaning that the expected change in p_i associated with a percentual increase in given variable is calculated as the following:

$$\beta \cdot \ln([100 + \ percentage]/100) \quad (8)$$

For a small percentage, approximately the effect can be calculated as the following:

$$\beta \cdot \ln([100 + \ percentage]/100) \approx {}^{percentage}/_{100} \quad (9)$$

For percentages equal to 1, it can be interpreted as the increase in Y from a 1 percent increase in a variable

$$\beta/100 \tag{10}$$

In other words, assuming that the house distance to arable land is 10 % longer than the average, then the effect of this variable on price would be estimated as:

$$^{16}p_{cluster} = 57{,}485.705 - 1{,}852.65 \ln(1.1) = 57{,}309.1286 \text{ SEK}/m^2$$

However, if the distance was at a 100 % distance[17], the price would have decreased to 56,201.5459 SEK/m^2 only with this variable.

These results reflect the WTP of individuals living near different types of forests. The changes in price caused by disamenities are an example of how local characteristics can change an individual WTP for a property. The results show that in the case of deciduous trees, there is no significant effect to be observed.

5.2 Final Remarks

The debate on whether assigning a monetary value to nature or not could be ethical or pragmatic in general terms is usually discussed within the scientific and philosophical fields. Some arguments highlight the advantages of valuating non-market amenities to bridge the interest of environmentalists and decision-makers, as discussed by Kumar (2010). On the other hand, there is also a concern due to the lack of proper nature knowledge to account for the diversity of nature when giving it a monetary value that could be undervaluing it instead, as discussed by Kallis et al. (2013).

This paper's approach does not intend to contribute to the moral debate, rather, it lies on the specifications of conceptual methodology and intends to discuss how rural attractiveness can be used for planning recreational houses with the knowledge gained from estimated implicit prices or revealed preferences.

Additionally, investigating the attractiveness of rural areas contributes to their conservation by researching their economic value which is of interest to city

[16] **Note**: the price is only an estimate and is not showing actual prices provided by Swedish Real Estate Statistics.
[17] Assuming that the variable is not present at all.

planners. Expanding the range of the study could also provide useful information to develop more efficient spatial methods and therefore, a more efficient hedonic evaluation model.

The potential of using spatial methods for city planning can be observed when studying local effects. Identifying high-value amenities can reshape the way neighborhoods are built and how the market is structured.

Results suggest that more value is put into the line of sight instead of the proximity to other natural amenities, suggesting that in some cases, a specific type of forest can be seen as a disamenity, as in the case of pine forests. The effect could be seen when compared to arable land, as their main difference is the presence of large trees or them being clear-cut. This argument aligns with results from Cavailhés et al. (2009) focused on urban areas. This research contributes to their work by adding that the same effect could be expected in the case of recreational housing.

Bodies of water could be a potentially more prominent influencer than forests and arable lands. The results showed a higher correlation to property prices being consistently higher at locations near the water than when classifying forest types in their surroundings. This means that individuals value higher this amenity and are willing to pay more for it.

Results need to be compared to those for traditional houses and larger samples. In this case, 134 recreational houses were analyzed. The results could have been more significant if there was more available information regarding the sales of traditional houses e.g. more variation in the sample. Additionally, seasonal information pertinent to sales could also clarify whether the housing market behaves differently depending on the season.

These results cannot be applied to every housing market, given that depending on the country, preferences for buying a house and its location may be different. Many countries show different real estate structures. For example, high-income individuals move outside of the city centre where prices are lower, and lower-income individuals live closer to the city centre where rent is higher. That is the case with the American market structure. The European market structure is quite the opposite. Thus, the type of local market should be considered when studying recreational housing. However, the results in this paper are supportive of previous findings in different parts of the world, suggesting that there is comparability to some extent.

6. Conclusions

This paper aimed to understand the way individuals value non-market amenities found in their surroundings of recreational houses. For this purpose, the Hedonic Pricing Method was used to study the prices of recreational dwellings located in rural areas in the county of Hässleholm, Sweden. The goal of this study was to assess whether the proximity to different natural amenities such as forest types, bodies of water, and arable land potentially affects the prices of previously mentioned properties.

This thesis provided a literature review of methods used for evaluating natural amenities and their ecosystem values. Starting with the concept of Total Economic Value (TEV), the focus was set on the Use- and Non-use values, especially the direct and indirect values generated from services and goods that can be physically used but that do not possess a market value.

Data pertinent to sales of recreational houses during 2018-2011 and environmental amenities were obtained from the Swedish Real Estate Statistics (Mäklarstatistik) and other governmental authorities. The data were processed with the help of the Geographical Information System ArcGIS, where distances from each property to every type of forest and other amenities were calculated.

Two statistical models were used for assessing the sales data, the Ordinary Least Square (OLS) and the Geographical Weighted Regression (GWR). Results show that the OLS has a better explanatory ability, but this is due to limitations set within the GWR approach. Reconsideration of variable choosing is advised for future research. The model identifies pine forests as a disamenity to recreational houses, while proximity to water and arable land positively affects the price. Other types of forests did not display significant results in this paper. A WTP for houses was calculated using results from cluster areas analyzed with GWR.

Using a local model for estimations (GWR) is strongly recommended for future studies, but further analysis of variables needs to be explored and the sample size needs to be larger for better results. Information on other types of housing is necessary for comparing the effects in the results.

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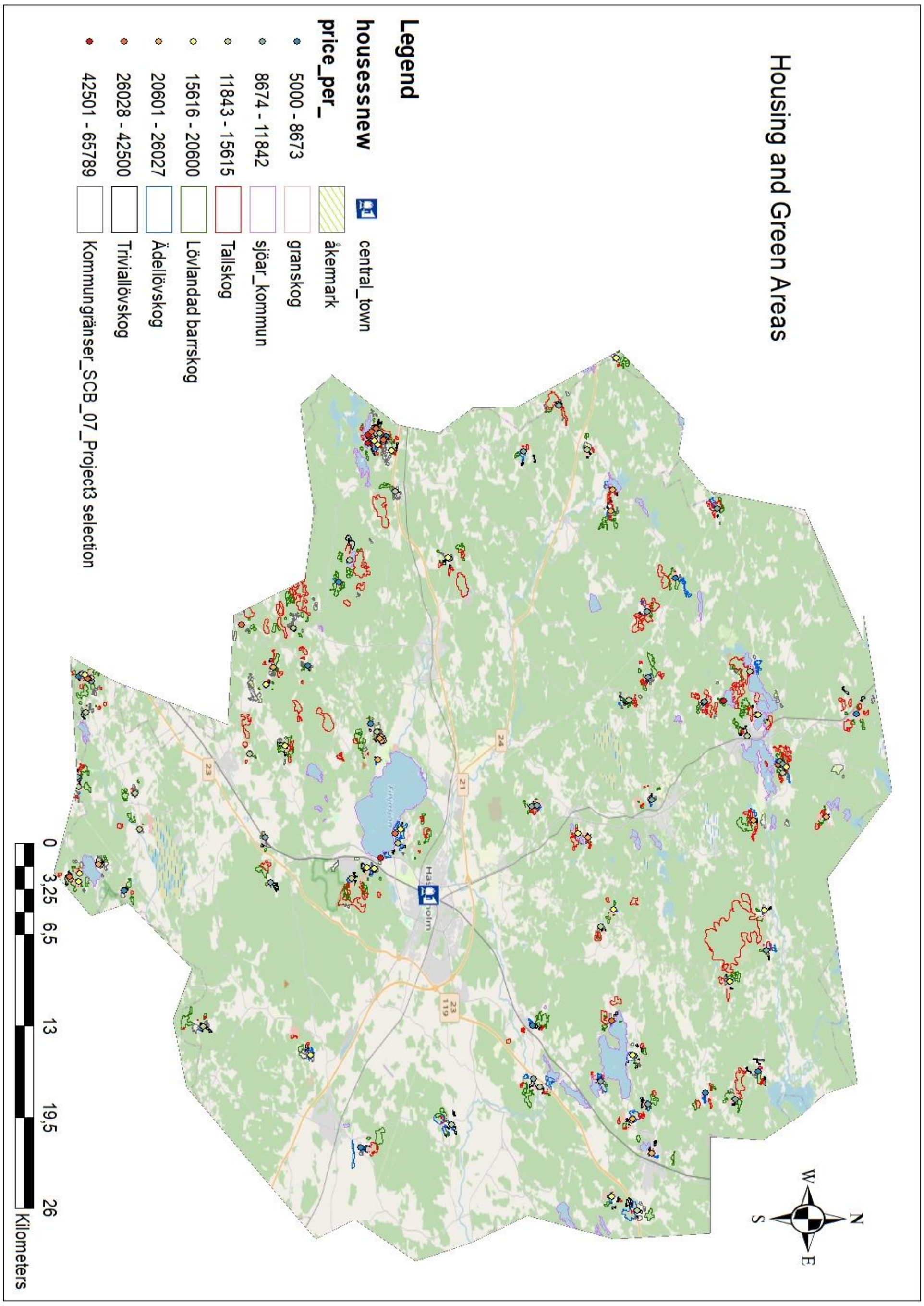
Appendix 1



Housing and Green Areas
Legend
housessnew
price_per_
5000 - 8673
8674 - 11842
11843 - 15615
15616 - 20600
20601 - 26027
26028 - 42500
42501 - 65789
central_town
åkermark
granskog
sjöar_kommun
Tallskog
Lövlandad barrskog
Ädellövskog
Triviallövskog
Kommungränser_SCB_07_Project3 selection
0
3,25
6,5
13
19,5
26
Kilometers
N
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