

SCENIC WEALTH OF BIOSPHERE RESERVE: VALUING CULTURAL ECOSYSTEM SERVICES USING HEDONIC PRICING

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Abstract. This research uses the hedonic pricing method to explore the economic valuation of cultural ecosystem services (CES). North Vidzeme Biosphere Reserve, located in Latvia, has been used as a case study site. This vast area, with its diverse ecosystems, is crucial for studying CES due to its unique ecological and cultural significance as well as its interaction with human settlements. CES, including recreation, aesthetic appreciation, and cultural heritage, contribute to human well-being but are underrepresented in economic valuation and can be utilised in decision-making, especially in decisions regarding development alternatives. This study uses real estate transaction data and geographical information systems (GIS) to analyse how proximity to natural and cultural amenities influences property values. The research variables include structural attributes (e.g., property size and age), environmental factors (e.g., distance to waterbodies, coastlines, or nature trails), and neighbourhood landscape characteristics. Hedonic pricing models reveal that properties near natural amenities, such as coastlines and nature trails, exhibit higher valuations, reflecting the premium on access to CES and the potential for higher usage. Key findings include significant positive correlations between property prices and proximity to CES-rich environments, underscoring their role in shaping market perceptions and economic behaviors. However, the study highlights areas of concern, such as data limitations and methodological complexities, in isolating the specific impacts of CES. This interdisciplinary research provides empirical evidence for integrating CES into sustainable land-use planning and policy-making. By quantifying the economic benefits of CES, it advocates for enhanced recognition and preservation of these services, thereby balancing ecological conservation with socio-economic development. **Keywords:** countryside, cultural ecosystem services, hedonic pricing, economic valuation, water bodies

Introduction

As of 2023, approximately 109 million people reside in rural areas of the European Union, constituting about 24,3 % of the total EU population. These rural regions encompass over 80 % of the EU's territory and represent a core of the European way of life [17]. Many cultural traditions contribute significantly to national and regional identities. In Latvia, the rural population accounts for 31,6 % of the country's total population [17;30]. Although depopulation makes the countryside emptier and older, counter-urbanisation is evident in various regions, caused by various pull factors [30;13]. Especially as remote work and improved infrastructure make living outside cities more feasible, cities are left in favour of more space and especially a desire for a connection with nature, among many other reasons. The problem is that this may increase demand and pressure on the most scenically outstanding and ecologically sensitive natural areas, among which waterfronts are prominent [50]. This shift raises important questions for rural regions, particularly concerning the sustainability and demand of existing rural properties. Many occurred in historical times, providing another argument for choosing the location – will they be in demand in the future? Buying a property in the countryside to live close to nature offers unique competitive advantages, factors, and considerations that differ from those of urban property purchases. When purchasing a countryside property, the ultimate goal is to strike a balance between your desire for a natural lifestyle and practical considerations, such as accessibility, comfort, and long-term value.

Historically, society has undergone various phases in its relationship with nature – from fear and worship to domination and exploitation, and from provision and utilitarianism to acceptance and sustainability [51;52;10;2]. These late-phase efforts, among others, have led to the introduction of the biosphere reserve concept, with the "Man and the Biosphere Programme" (MAB) highlighting its impact on integrated, holistic, and sustainable development [9], [10]. Even after a few decades, researchers have questioned critically our ability to make real progress in these special status areas [11]. MAB ideals integrate the sciences, economics, and education to enhance human livelihoods and promote the

equitable distribution of benefits while safeguarding natural and managed ecosystems. This approach fosters innovative, socially and culturally appropriate, as well as environmentally sustainable, economic development strategies [12]. It's important to note that the North Vidzeme Biosphere Reserve encompasses several value zones, each with different base values.

Until the 1990s, several terms were used to express the benefits that humans derive from nature, including environmental services or natural capital [42;9] and ecosystem services (ES) [15;16;35]. Ecosystem services are "the benefits humans derive from ecosystems" [35], including regulatory, provisioning, cultural, and support services. According to Costanza et al. [8] cultural ecosystem services are defined as "ecological processes, functions, and processes that directly or indirectly contribute to human well-being." In other words, non-material benefits that people gain from interaction with different environmental places. The concept of cultural ecosystem services is useful for capturing the full range of values provided by ecosystems that go beyond their material and regulatory functions, ensuring that cultural, spiritual, recreational, and identity benefits are recognized in science, policy, and everyday life [35]. Several researchers have emphasised the need to expand the scope of research on cultural ecosystem services beyond its predominant focus on more tangible forms of nature, such as tourism and recreation [36;20;34]. For example, a comprehensive review highlighted that while recreation and ecotourism services account for around 60,9 % of empirical CES research, other categories remain under-represented. Furthermore, the literature on ecosystem services has underlined that sociocultural and environmental values are underweighted relative to those in economic decisions, and there are often intangible, implicit, unstated, difficult to express, and poorly represented in public policy processes [27]. The authors recommend that future research delve deeper into these under-researched areas to gain a more comprehensive understanding of CES [53]. This highlights a persistent lack of knowledge in this area, which is further underscored by the research focus in the rural region, particularly within the Biosphere Reserve.

Hedonic pricing has been chiefly used for CES evaluation in urban green space [40;44].

Several studies have shown that natural amenities, including water views, proximity to green spaces, and scenic landscapes, have a positive impact on property values. The hedonic pricing method is a robust tool to quantify these effects, aiding in informed spatial planning and real estate valuation. Hedonic pricing method result as an indicator according [4] can be defined as a verifiable data-based measure that provides information not only about itself. There is a growing demand for assessments to evaluate ecosystem services in terms of specific outcomes [21]. To make this possible, indicators must be "SMART" (specific, measurable, achievable, relevant, and time-bound) [48]. The urban waterfront study employed the hedonic pricing method to measure the impact of proximity to various waterfronts, including bays, rivers, and streams, on residential property values in coastal Alabama. Findings indicated that properties with water views commanded a premium, with water views associated with a 26 % increase in house prices [12]. Aladwan and Ahamad [1] found that property prices are positively influenced by factors such as maintenance, cleanliness, historical value, green space, purchasing power, and accessibility to public transportation and upgrading programs. Loomis et al. [14] proved that house sale prices within 2 km of a special protected area were, on average, 9.8 % higher.

Conversely, land-use patch richness, an aging population, traffic noise, and proximity to freeways negatively impact prices. While structural and locational attributes play key roles, neighbourhood characteristics, traditional views, and customs were found to be insignificant. GIS analysis was used to measure property distances to key amenities, revealing that buyers prioritise structural attributes over other factors. Hedonic pricing is an economic theory that suggests that the price of a good or service is related to its various characteristics, or "attributes". This approach assumes that the value of a product is derived from its characteristics rather than the product itself. "Hedonic" derives from the Greek word "hedone," meaning pleasure or delight. Hedonic pricing models in real estate valuation have been frequently applied in numerous research studies and projects since their introduction by Rosen in 1974 [1]. It is an economic valuation method used to estimate the economic value of non-market goods and services, including cultural ecosystem services. In the context of hedonic pricing for valuing cultural ecosystem services, the approach involves examining how changes in the quality or quantity of cultural amenities provided by ecosystems affect property values, thereby evaluating the impact of proximity to green infrastructure on real estate markets [32]. This method assumes that individuals are willing to pay a premium for properties with better access to cultural amenities.

Examining how changes in the quality or quantity of cultural amenities provided by ecosystems affect property values to evaluate how proximity to green infrastructure impacts real estate markets [32]. Hedonic pricing assumes that individuals are willing to pay a premium for properties with better access to cultural amenities. The technique assumes that a property is sold (or bought) as a package of inherent attributes. Four broad categories of variables are primarily addressed through the hedonic model. They include following characteristics: structural (such as age of the house, type of construction materials, size and number of bedrooms), locational (such as distance to the central business district), neighborhood (such as income and education levels in a block), and environmental (such as air and landscape quality) [25]. Each

characteristic has its implicit price, which the hedonic equation could estimate.

While some researchers believe that various ecosystem services can be valued using hedonic pricing, Czembrowski and Kronenberg [11] are somewhat sceptical about this assumption and highlight that hedonic pricing is not powerful enough to separate the effects of individual ecosystem services, even if the buyer recognises them. Similarly, other researchers argue that the hedonic pricing method has limitations in isolating the effects of individual environmental attributes on property prices [5;41;28]. In Latvia, research has been conducted on the value of cultural ecosystem services for various ecosystems [39;49;43;31;45], however, their impact on real estate prices in highly valued natural areas has not been studied in depth. Another study was conducted in two cities in each country to assess real estate using a GIS approach (based on similar methodologies in Latvia and Brazil), but ecosystem values were not analyzed [33]. Most people involved in the real estate industry agree that among the various criteria for evaluating real estate, one of the most important is the "view from the window," as well as the improvement of the territory and surroundings, proximity to infrastructure, accessibility to nature, and various recreational opportunities—everything that a potential buyer might find important and that determines overall demand [37]. At least five international projects have been implemented using the cultural ecosystem services measurement approach, but not specifically in relation to real estate demand. To address this information gap, a hedonic price methodological approach has been applied to assess the impact of proximity to a biosphere reserve on real estate prices.

This leads to the research question: How does proximity to scenic landscapes and integration with nature influence the market value of rural residential properties in a biosphere reserve? The research objective of this study is to quantify the influence of proximity to scenic landscapes and integration with nature (CES) on the market value of rural residential properties within a biosphere reserve using the hedonic pricing method.

Hypothesis 1: The pricing of housing is affected by coastline, water bodies, and viewpoints. The EUR per kilometre would explain the result quantitatively if there is a causal relationship. Hypothesis 2: CES positively impacts property listing valuation in NVBR.

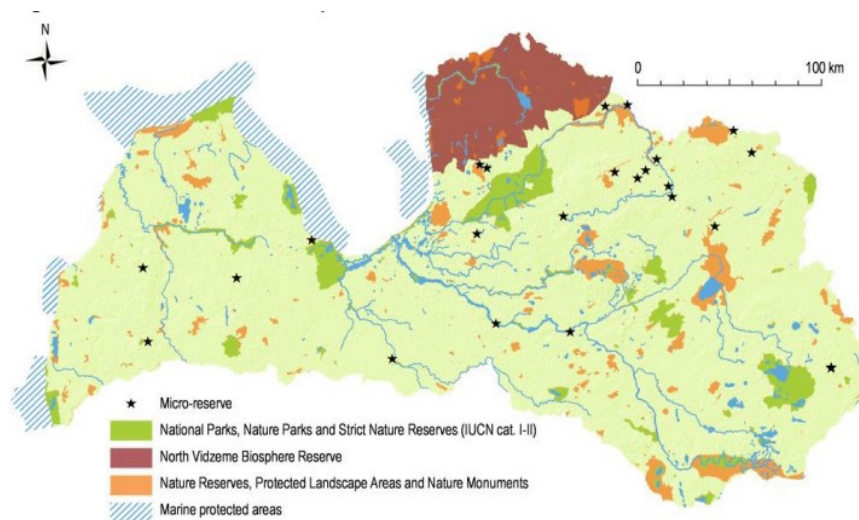
Materials and Methods

Case study area

The study is interdisciplinary, connecting economics, ecology, and sociology. The North Vidzeme Biosphere Reserve has been selected as a study site due to its relevance to the purpose of such an area. It is also a typical rural area with a sufficiently large number of rural property transactions that can be analysed quantitatively. It is a vast area where nationally and internationally important natural and landscape values are preserved by ensuring sustainable social and economic development. NVBR is the only biosphere reserve in Latvia, established in 1997 and recognised as a protected territory of international importance within the framework of the UNESCO MAB program. Together, covering 4,576 km² of land and 167.5 km² of sea, about 6% of Latvia's total area, it is well accessible and home to 2.6% of Latvia's population (49,600 inhabitants as of July 1, 2022).

Research design

The study design involves a mixed research approach. Following a documentary study reviewing key publications and reports to establish a solid theoretical basis combining



Source: OECD report Latvia, 2019³⁵

Fig. 1. Map of North Vidzeme Biosphere Reserve in comparison with other major SPNAs in Latvia [37]

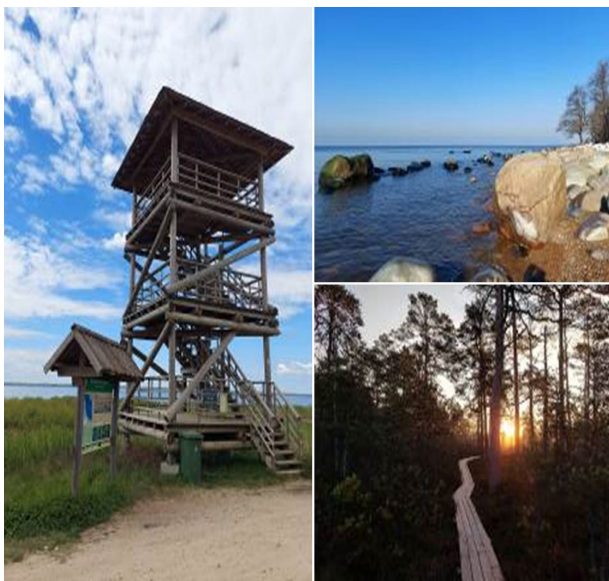


Fig. 2. North Vidzeme nature [foto by L.Kaulina]

the measurement of cultural ecosystem services using the hedonic price approach. Primary data collection is carried out using GIS datasets, supplemented by secondary data, including statistical analysis. This data is synthesized to integrate the findings from the sources used into a unified analysis. Finally, our disseminated results ensured that the knowledge gained effectively contributed to the field. This study uses the Cultural Ecosystem Services (CES) framework, which includes subgroups such as inspiration, aesthetic values, social relationships, sense of belonging, cultural heritage values, and educational values in the context of the real estate market using hedonic price analysis. We chose hedonic pricing as the methodological approach for this study because it can be measured and is considered an appropriate indicator for this type of research.

Hedonic pricing method and cultural ecosystem services

The hedonic pricing method conceptualises property value as a function of its inherent attributes, which can be categorised into four key groups. Structural characteristics encompass variables such as the age of the building, construction materials, total area, and number of bedrooms. Locational characteristics refer to spatial factors, including proximity to the central business district and accessibility to essential services and amenities.

Neighbourhood characteristics encompass socioeconomic indicators, including distance to the nearest educational institution and distance to the capital city, within a specific area. Environmental characteristics include landscape aesthetics [25]. Each attribute possesses an implicit price that can be quantified using the hedonic pricing approach, enabling the estimation of its contribution to the overall property value. A facility's distance to the nearest hotspot for five CES benefits (ecotourism and recreation, landscape aesthetics, spiritual, heritage, knowledge development, and scientific research) represented environmental attributes. Comparable studies use hotel proximity to scenic spots [54], tourist attractions [22], heritage sites, nearby beaches, and forest areas [29] on-site green infrastructure within the city, views of natural elements, and water bodies [32] as measures of environmental attributes.

Data collection

Sales data are open-access data for everyone in Latvia. The State Land Service has published Real Estate Market Data on the Latvian Open Data Portal (<https://data.gov.lv/dati/lv/dataset/nekustama-ipasuma-tirgus-datu-bazes-atvertie-dati>). The data is updated monthly and contains information on real estate transactions registered in the Real Estate Market Information System as of 2012. Within one year, the Real Estate Market Database may record data on transactions from different years, as ownership rights are registered in the State Unified Computerized Land Register several years after the transaction occurs. For example, the transaction occurred in 2012, but the ownership was registered in the State Unified Computerized Land Register in 2020. Real estate transaction data are grouped in specific files according to the registration date. One file contains information on a single object type: land, land and buildings, or groups of rooms (such as condominiums). The data used for the study were groups of rooms and land with buildings. We used the flats and buildings as one-, two-, or three-apartment houses in the NVBR area. As different variables are available in the files, the specific files have also been analysed differently, thus showing the difference between the characteristics of apartment and house purchases. However, we paid the most attention to determining the CES value. 334 records were selected for further processing from room groups (further RG) out of 24281 relevant on a national level and 451 from land and buildings (further LB) out of 9592 relevant on a national level. We restructured the data in the datasets as spatial data for the NVBR using Esri ArcGIS software and the prepared NVBR

$$\ln P = \beta_0 + \beta_1 \ln ARE_{GROUP} + \beta_2 \ln TOTAL_{AREA} + \beta_3 \ln NUM_{ROOMS} + \beta_4 \ln NUM_{BEDROOMS} + \beta_5 \ln AGE + \beta_6 \ln DEPRECEATION \\ + \beta_7 \ln LOW_{FLOOR} + \beta_8 \ln HIGH_{FLOOR} + \beta_9 \ln DIST_{COAST} + \beta_{10} \ln DIST_{WATER} + \beta_{11} \ln DIST_{NAT_{TRAIL}} \\ + \beta_{12} \ln DIST_{VIEWP} + \beta_{13} \ln DIST_{CUL} + \beta_{14} \ln DIST_{EDI} + \beta_{15} \ln DIST_{RIGA}$$

in which β_0 is the stochastic term and $\beta_1 \dots \beta_{15}$

EQUATION 1. HEDONIC PRICE EQUATION [adapted from Jim&Chen; 25]

area layer. We measured distances between the property and spatial variables using the BalticMaps online map viewer measurement tool. Spatial measurements are in meters of driving or walking distance.

Hedonic Equation

The research employed the semi-log functional form, featuring a log-dependent variable and a linear combination of independent variables. It has been demonstrated to provide a sound statistical fit [19] and has been widely adopted in empirical studies (see Equation 1).

The listing price (€) was the dependent variable, whereas the structural characteristics were the independent variables including environmental (5) that are representing CES analysed among other 10 variables. We conducted the hedonic regression analysis using Microsoft Excel.

Selection of model variables

Table A-1 for RG and Table A-2 for LB (included in the Annex) define the dependent variable (PRICE) and the explanatory variables used in this study. For RG, 15 explanatory variables were employed. Eight variables related to housing structural characteristics were considered: area of group of rooms (AREA_GROUP), total area of apartment (TOTAL_AREA), Number of rooms in group of rooms (NUM_ROOMS), number of bedrooms in apartment (NUM_BEDROOMS), age of home in years (AGE), physical deterioration of the building (DEPRECEATION), lowest floor of the group of rooms (LOW_FLOOR) and highest floor of the group of rooms (HIGH_FLOOR), for LB 13 explanatory variables were used. Six variables related to housing structural characteristics were considered: total area of land sold (TOTAL_AREA_LAND), number of buildings (NUM_BUILD), number of floors above ground (NUM_FL_ABOV), total building area (TOTAL_BUILD_AREA), age of home in years (AGE), physical deterioration of the building (DEPRECEATION). Five explanatory variables

described the environmental amenities representing the CES. They include distance to the coast/seaside (DIST_COAST), distance to the nearest waterbody (DIST_WATER); distance to the nearest nature trail (DIST_NAT_TRAIL), distance to the nearest designated viewpoint (DIST_VIEW) and distance to the nearest cultural attraction or object (DIST_CUL). Two explanatory variables described neighbourhood variables: distance to the nearest educational institution (DIST_EDI) and distance to the capital city, Riga (DIST_RIGA). This study does not include variables such as distance to the nearest forest or green area, as all points are within a 10-15 minute walk or less from the nearest green area.

Results and Discussion

The country as a whole is experiencing a downward trend in the total number of real estate transactions from the second half of 2022 onwards, which is closely linked to the geopolitical situation and the general social and economic situation in the country, where energy and consumer prices have risen and mortgage interest rates continue to increase. During the COVID-19 pandemic, there was a strong interest in properties in rural areas, as people sought to escape crowding and be closer to nature.

Spatial dispersion

The number of permanent residents per square kilometre in 2023 (see Fig 2) indicates that most people live in the transition zone. However, compared to other specially protected nature areas elsewhere in the world, there is also a higher population density in the immediate vicinity of the core zones.

A spatial visualisation of the data in Fig. 3 shows that in 2022, most RG transactions were located in or very close to towns, with most LB observations in the coastal area (129 observations). The distribution is relatively even throughout the region, except at the border with Estonia,

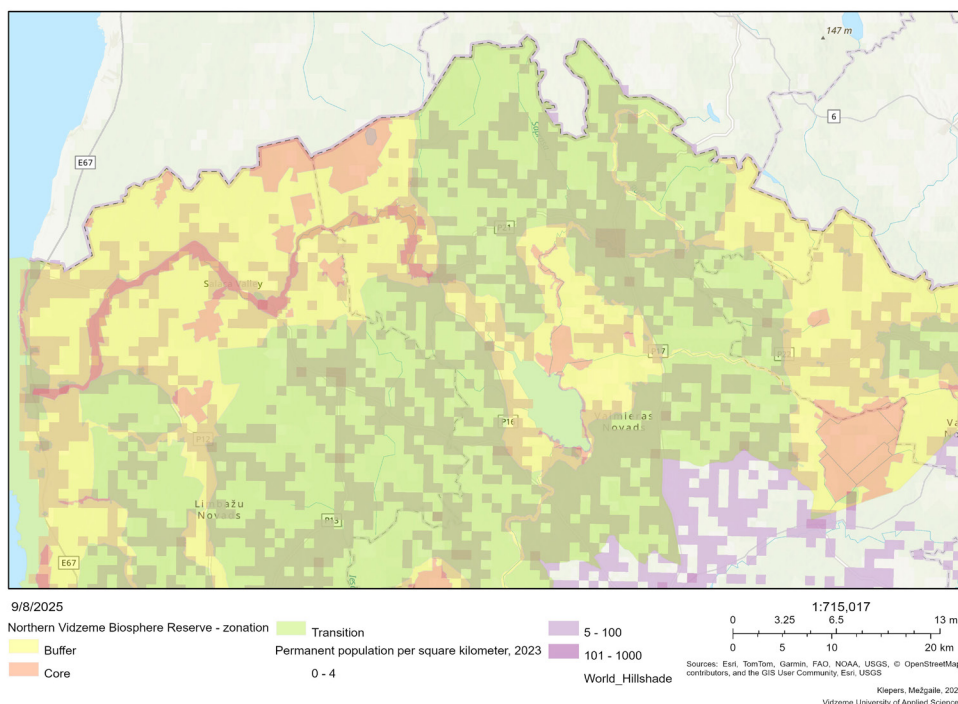


Fig. 3. Permanent population per square kilometre in 2023 and zoning of the North Vidzeme Biosphere Reserve

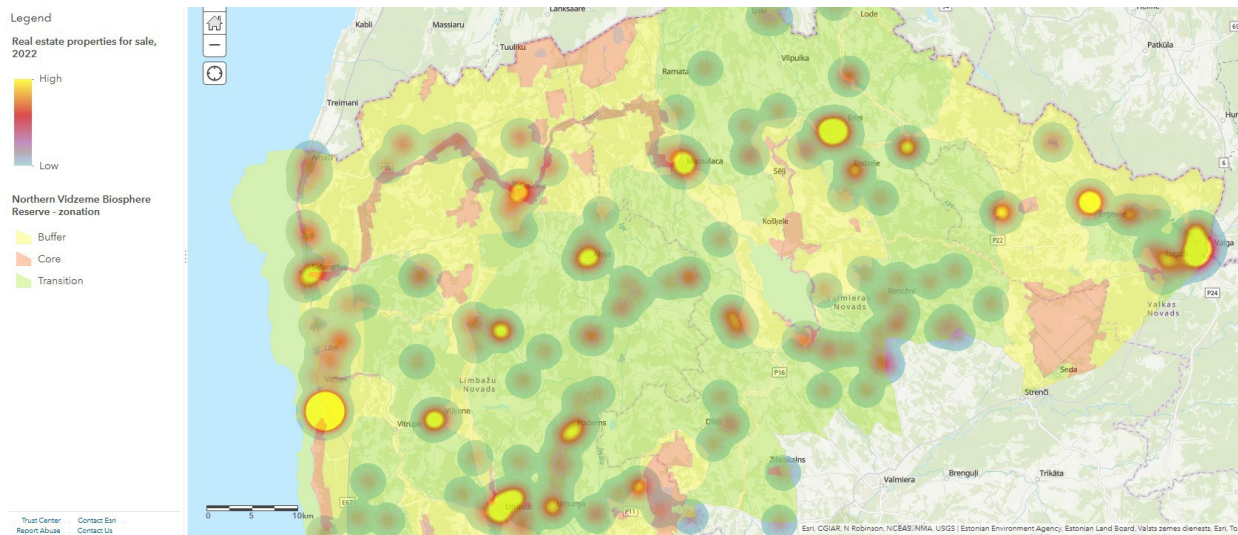


Fig. 4. Heatmap of real estate transactions – room groups and land and buildings 2022 in NVBR [created by author's]

where there are almost no transactions, despite the lower population density in that area.

Hedonic price analysis

We carried out a hedonic price analysis separately for RG (see Table 1) and LB (see Table 2). The regression was run with a 95 % confidence level.

The correlation coefficient that range from -1 to 1, and its absolute value indicates the strength of the relationship is calculated in the table above. For the RG, the R square indicated that the price listings explain 42 % of the characteristic's variations. The adjusted R-squared indicated that the price listings explain 39 % of the variation in the values of the structural characteristics. However, for the LB, the R-squared value indicated that the price listings explain 47% of the variation in characteristics. The adjusted R-squared indicated that the price listings explain 45 % of the variation in structural characteristics. This reinforces that the model is a good fit.

The standard error represents the average distance that the observed listing prices (in euros) deviate from the regression line. On average, the observed values fall € 9024,01 from the regression line in RG. There is a 95 % confidence level that the observed sample mean is plus or minus 1.96 standard errors from the population mean.

Positive coefficients indicate that for every increase in the unit of an independent variable, the dependent variable increases. Likewise, negative coefficients indicate that for every unit increase in the independent variable, the dependent variable decreases in value. Therefore, the signs of the coefficients in this research suggest the increase or decrease of the listing price in euros when structural variables are detected. Five of the total 15 variables had positive coefficients, and 10 had negative coefficients for RG. Out of the total 13 variables, six had positive coefficients, and seven had negative coefficients for RG. Both studies demonstrated that the coastline, waterbodies, and viewpoints have a positive impact on housing prices, thereby confirming Hypothesis No. 1.

Seven of the coefficients were statistically significant for RG and six for LB. This is established through P-values that are less than 0.05. This results in the rejection of the null hypothesis for these coefficients. The null hypothesis of the P-values was that the coefficient equals zero, implying that it has no effect. Therefore, the P-values indicate that these coefficients have a statistically significant impact on the listing prices (dependent variable). The results showed that proximity to the coast,

The complete results of the hedonic pricing
for RG [created by author's]

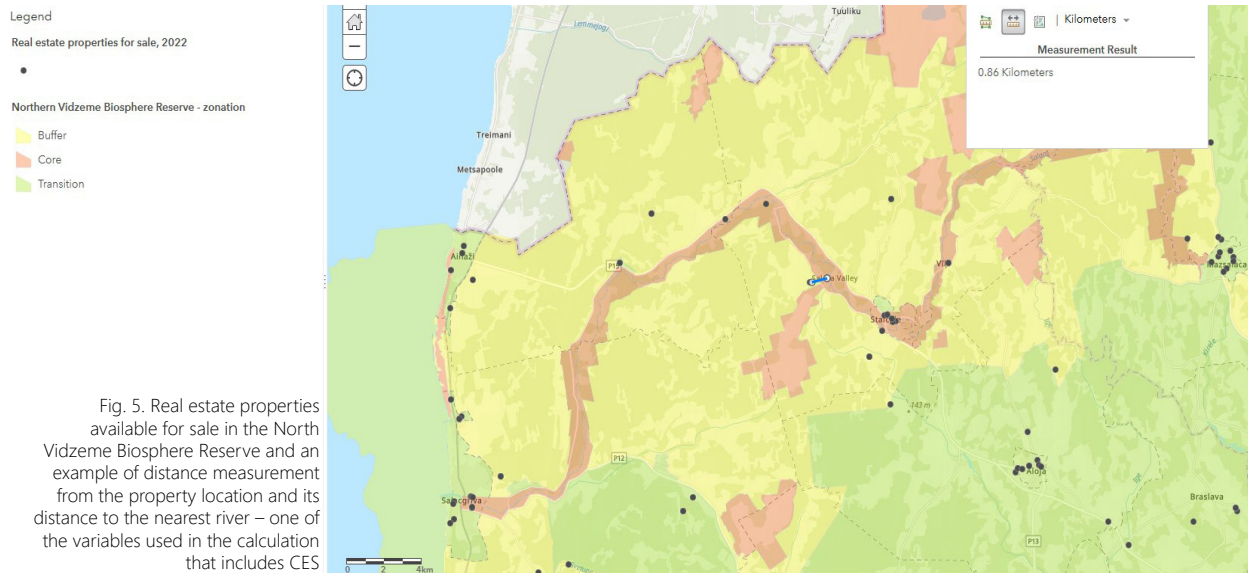
	CES represented	Coefficients	Standard Error	t Stat	P-value
Intercept		22757,23	4103,82	5,55	0,00
AREA_GROUP		412,46	117,25	3,52	0,00
TOTAL_AREA		-313,83	123,72	-2,54	0,01
NUM_ROOMS		-143,36	432,66	-0,33	0,74
NUM_BEDROOMS		2765,48	1187,83	2,33	0,02
AGE		-41,24	27,47	-1,50	0,13
DEPRECIATION		-65,63	41,07	-1,60	0,11
LOW_FLOOR		54,91	1922,69	0,03	0,98
HIGH_FLOOR		1582,82	2003,74	0,79	0,43
DIST_COAST	+	-0,06	0,02	-4,19	0,00
DIST_WATER	+	-0,15	0,37	-0,40	0,69
DIST_NAT_TRAIL	+	-0,38	0,18	-2,07	0,04
DIST_VIEWP	+	-0,31	0,18	-1,75	0,08
DIST_CUL	+	-0,65	0,52	-1,26	0,21
DIST_EDJ		0,00	0,10	0,04	0,97
DIST_RIGA		-0,17	0,03	-5,00	0,00

Multiple R 0.65 R Square 0.42 Adjusted R Square 0.39 Standard Error 9024.01

TABLE 2
The complete results of the hedonic pricing for LB [created by author's]

	<i>CES represented</i>	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Intercept		40596,81	11659,45	3,48	0,00
DIST_COAST	+	-0,16	0,08	- 2,06	0,04
DIST_WATER	+	-0,54	0,70	- 0,78	0,44
DIST_NAT_TRAIL	+	0,27	0,46	0,59	0,55
DIST_VIEWP	+	-0,96	0,42	- 2,31	0,02
DIST_CUL	+	-0,92	0,74	- 1,23	0,22
DIST_ED1		1,38	0,42	3,27	0,00
DIST_RIGA		-0,06	0,10	- 0,55	0,58
TOTAL_AREA_LA ND		0,28	0,02	16,1 4	0,00
NUM_BUILD		99,86	266,22	0,38	0,71
NUM_FL_ABOV		3485,39	3637,04	0,96	0,34
TOTAL_BUILD_A REA		13,67	9,45	1,45	0,15
AGE		67,55	61,31	1,10	0,27
DEPRECIATION		-427,55	99,78	- 4,29	0,00

Multiple R 0.68 R Square 0.47 Adjusted R Square 0.45 Standard Error 27897.35926



water bodies (see Fig. 4) and specially designed viewpoints increases the price of real estate.

For example, with every one-metre increase in distance from the coastline for RG, the real estate listing lost €0.06 in value. This equates to a €60 loss of value per km away from the coastline. Moreover, for every one-metre increase in distance from the nature trails, the real estate listing lost €0.38 in value. This equates to a €380 loss of value per km away from the nature trails. For every one meter increase in distance from the capital city of Riga, the real estate listing lost € 0,17 in value. This equates to a €170 loss of value per km away from the capital city, Riga.

Similarly, for LB, with every one-metre increase in distance from the coastline, the real estate listing lost €0.16 in value. This equates to a €160 loss of value per km away from the coastline. Furthermore, for every one-meter increase in distance from the waterbodies, the real estate listing lost € 0,54 in value. This equates to a €540 loss of value per km away from the water bodies. For every one-meter increase in distance from the designated viewpoint, the real estate listing lost € 0,96 in value. This equates to a € 960 loss of value per km away from the designated viewpoint.

The standard errors of the coefficients were also displayed in the output. This is the standard deviation of each coefficient. The standard error value indicates the model's precision for that coefficient. The standard errors in the model are significant across the output compared to the coefficients. This implies that the model does not accurately reflect the overall precision of the results.

The model produced mainly unexpected results. Many of the coefficients were counterintuitive values, not statistically significant, or did not meet the confidence thresholds in various statistical tests conducted using the hedonic price method. This implies that the results and model should be reviewed critically.

Meaning was not derived from any of the coefficients without statistical significance. The coefficients that were not statistically significant are still examined in the comparative literature. This research hypothesised that CES would positively impact property listing valuation in NVBR. Although many of the CES structural variables did not produce statistically significant results, it is worth noting what was not produced. No statistically significant result conflicted with Hypothesis 2 or the literature supporting positive associations between property valuation and CES.

The coexistence of several environmental factors makes

attributing price changes to a specific ecosystem service challenging and raises further discussion. Interaction with nature creates a sense of community and belonging, sets specific values [38]. Preferences and socio-economic factors influenced by customer values may affect the perception of different ecosystem services, leading to biased assessments. Similarly, buyers may not be aware of all the environmental benefits when they purchase a property, and some may only become apparent later as they develop a rural lifestyle. Therefore, the sceptical group of researchers can agree on the accuracy of using this method to disaggregate the individual components of the total price. This confirms the conclusions drawn by Boyle [5], Sander and Polasky [41], Klaiber and Phaneuf [28] and Czembrowski and Kronenberg [11].

At the same time, however, it should be recognised that the findings of one region are not so unique and could be transferred to another region, even though there are different market conditions and ecological characteristics. The study in a rural region, which drew lessons from this case, is comparable to similar results obtained by other researchers in a suburban environment, where people's preferences for locations with views and nature are similar [6;40;44]. The addition makes a new contribution to the knowledge of CES quantifications of monetary value outside the dominant tourism and recreation services sector. A comprehensive study of this kind in a biosphere reserve also provided insight into the socio-economic processes occurring in areas of this status, revealing that they are not significantly different from the situation in other regions.

Real estate prices in Latvia are relatively low compared to other European Union countries, but they still significantly impact individual finances. Recent data indicates that home ownership in Latvia has risen from 80.2 % in 2020 to 83.7 % in 2024. During the same period, the housing price index has also increased, showing a 153% rise from 2010 to 2024 [18;46]. Additionally, over the 10-year period from 2015 to 2025, the cadastral value of real estate has doubled [23; 26]. The conclusions and the need for further research also raise a question for discussion. Would biosphere reserves built on larger comprehensive ecosystems, and thus more effectively manage different environmental risks that are less influenced by external factors - would there be more advantages in the long term to living in a nature-friendly, biodiverse environment here than in other regions? Would the price aggregation arguments found in the study provide an advantage for selling real estate in the biosphere reserve in

the future? The best justification is likely to be for properties where the additional factors include good accessibility, a shorter distance to the service centre, and greater privacy of the space. It becomes more challenging to sell an apartment or part of a building in the countryside with outstanding natural views or waterfronts, mainly if it is a small and isolated apartment building, such as those constructed during the Soviet occupation, often located near cattle farms or in small villages, which are now commonly shared properties. The intention is to further test the use of different measured CES values in decision-making processes at various levels within local authorities, among other contexts, in situations where the benefits of natural ecosystems are sometimes countered by the notion of "positive change" in the name of economic development. The special ecological conditions and responsible local management of the Biosphere Reserve could become a long-term catalyst for building more resilient communities in rural areas and attracting new residents, thereby addressing a broader range of regional development challenges.

By quantifying the economic benefits of CES, it advocates for enhanced recognition and preservation of these services, thereby balancing ecological conservation with socio-economic development. The results obtained from the biosphere are typical for a rural region with its population structure. No specific characteristics of the impact of the biosphere region on the importance of ecosystem services were found. This raises questions for the discussion about the effectiveness and capacity of the UNESCO MAB programme to administer these objectives in an integrated manner, which is a complex task given the day-to-day functions carried out by local authorities or national conservation authorities, to which only part of the overall content of the MAB programme is delegated. Further research is needed on how to achieve more sustainable progress in specially designated biosphere reserves, which are subject to the same trends as the rest of the rural periphery.

Conclusion

Key findings include significant positive correlations between property prices and proximity to CES-rich environments, underscoring their role in shaping market perceptions and economic behaviours.

The study reveals that access to cultural ecosystem services, which offer scenic aesthetic values, social interaction, a sense of belonging, education, and inspiration, significantly influences real estate sales prices. For the LB group, the greatest influence is exerted by scenic viewpoints and proximity to waterfronts, while for the RG group it is nature trails (walking trails) and proximity to cultural sites. Depending on the type and location of the real estate, the availability of cultural ecosystem services can affect real estate prices, for example, distance to coastline from 1-5 %.

Overall trends in real estate transactions indicate a gradual shift in the rural population structure. There is a growing demand for properties in urban areas and the countryside, particularly in areas of outstanding scenic and natural beauty or near the coast. A few farmsteads, many of which were built 100 years ago on utilitarian agrarian landscapes, are no longer in such high demand. Similarly, with apartment blocks in remote small rural villages, some of which remain derelict and are losing their edge. The biosphere reserve has proved no more immune to general demographic and economic trends.

At the local and regional levels, policymakers could utilise the values calculated here, along with additional ecosystem service values calculated using hedonic pricing, to identify

the potential economic impacts of land-use policies. There is, thus, considerable potential to utilise economic values for ecosystem services, as calculated using hedonic pricing models, to promote more sustainable development. Land-use plans and policies that disregard impacts on these services not only may affect them but also are likely to negatively impact property values and the quality of life of local residents.

Research limitations include that several indicators did not show strong statistical significance, indicating that future work can be conducted to improve the model. To further enhance our understanding of the intricate interplay between people, environment, and behavior, studies could be expanded to different categories of housing with varied environmental qualities and varying provision of green spaces.

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Conflicts of interest

The authors declare no conflict of interest.

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Kopsavilkums

Lai novērtētu to, kādu pievienoto vērtību sniedz dabas tuvums nekustamā īpašuma iegādē, izmantota hedoniskā cenu noteikšanas metode. Tā izmantota, lai izpētītu kultūras ekosistēmu pakalpojumu ekonomisko vērtību. Kā pētījuma teritorija - Ziemeļvidzemes biosfēras rezervāts. Šī plašā teritorija ar daudzveidīgajām ekosistēmām ir ļoti nozīmīga kultūras ekosistēmu pakalpojumu (KEP) pētīšanai, jo tai ir unikāla ekoloģiskā un kultūras nozīme, kā arī tā mijiedarbojas ar cilvēku apdzīvotajām vietām. KEP, tostarp rekreācija, estētiskā bauda un kultūras mantojums, veicina cilvēku labklājību, bet ir nepietiekami pētīti ekonomiskajā griezumā, un var tikt izmantoti lēmumu pieņemšanā, jo īpaši lēmumos par teritorijas attīstības alternatīvām. Šajā pētījumā izmantoti nekustamā īpašuma darījumu dati un ģeogrāfiskās informācijas sistēmas (GIS), lai analizētu, kā dabas tuvums un kultūras objektu tuvums ietekmē nekustamā īpašuma vērtību. Pētījuma mainīgie ietver strukturālos atribūtus (piemēram, nekustamā īpašuma lielumu un vecumu), vides faktorus (piemēram, attālumu līdz ūdenstilpēm, krasta līnijām vai dabas takām) un apkārtnes ainavas raksturlielumus. Hedoniskās cenu noteikšanas modeļi liecina, ka nekustamajam īpašumam, kas atrodas tuvu dabas objektiem, piemēram, piekrastei un dabas takām, ir augstāka vērtība, atspoguļojot KEP pieejamības priekšrocības un potenciālu to plašākai izmantošanai. Pētījumā izcelti arī problemātiski jautājumi, piemēram, datu pieejamības ierobežojumi un metodoloģiskas grūtības, izdalot KEP konkrēto ietekmi. Šis starpdisciplinārais pētījums sniedz empīriskus pierādījumus KEP integrēšanai ilgtspējīgā teritorijas izmantošanas plānošanā un politikas veidošanā. Kvantificējot KEP ekonomiskos ieguvumus, tas aicina uzlabot šo pakalpojumu atpazīstamību un saglabāšanu, tādējādi līdzsvarojot ekoloģisko saglabāšanu ar sociālekonomisko attīstību.