Public Demand for Shores in Natural Condition: a Contingent Valuation Study in Estonia

M. Reimann, Ü. Ehrlich and H. Tõnisson

Abstract**—** Approximately 98% of the 3800 km long coastline of Estonia is still in the natural condition. Considering that seashores are attractive as places of residence, natural seashores have a strong pressure from real estate developers. The paper seeks to investigate the willingness of Estonian population to pay for preserving the Estonian seashore in its natural condition. Using the Contingent Valuation Method (CVM) a representative sample of Estonian working-age population was interviewed to find out their willingness to pay. Annual willingness to pay is asked separately for all main natural seashore types in Estonia, which include silty shore, till shore, cliffed shore, gravel shore, sandy shore. A total demand function was worked out to find the total demand for seashore in its natural condition as a valuable environmental good and on the basis of that a total demand curve was constructed. By integrating the demand curve we received results that annual total demand of the working-age population for seashores in their natural condition is 42.5 million euros. Important sociometric indicators for willingness to pay proved to be age and income. The study shows that the Estonian seashores in the natural condition are valuable environmental goods for which there is substantial demand.

Keywords**—**Coastal tourism, coastal values, contingent valuation, Estonian coast, monetary demand for shores, nature values.

I. INTRODUCTION

DUE to the increasing expansion of economic activities, urbanization, resource use and population growth, coastal zones are among the most vulnerable ecosystems on our planet. 41% of world global population (2.38 billion) live within 100 km of coast and by 2025 this number may rise to 3.1 billion. More than 50% of coastal countries have from 80 to 100% of their total population within 100 km of the coastline. 21 of the 33 world's megacities are found on the coast, so human impact on the coast as well as social and economic values of the coasts have high importance [1], [2]. This causes several interest and value conflicts. Human impacts and the public opinion have been investigated in case of several economic activities on the coastal areas like forest cutting [3], [4], farming [5], wind power production [6], [7], real estate development and tourism. All the preference studies have shown that naturalness is preferred to human activities. Historical buildings in the traditional fishing hamlet on the islands of Northern Norway formed the only exception in the study when natural settings were rated lower. Coastal impacts by tourism have been investigated through carrying capacity and planning issues [8]-[13].

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M. Reimann is with Department of Leisure Sciences, Tallinn University, Tondi 55, 11316 Tallinn, ESTONIA and Institute of Ecology and Earth Sciences, Tartu University, Vanemuise 46, 51014 Tartu, ESTONIA, mart.reimann@tlu.ee.

Ü. Ehrlich is with Tallinn School of Economics and Business Administration at Tallinn University of Technology, Akadeemia tee 3, 12618 Tallinn, ESTONIA, Ullas.Ehrlich@tseba.ttu.ee

H. Tõnisson is with Institute of Ecology, Tallinn University, Narva mnt 25, 10120 Tallinn, ESTONIA , hannes.tonisson@tlu.

Estonia is facing similar problems as many other regions in the world. Among all the other problems the most serious issue is real estate development, which causes visual impact and sometimes closes access to shores. Thus there are needs for analysing values of coastline from different perspectives. The current research is focusing on finding out the monetary equivalent of non-market value of Estonian seashores in the natural condition as environmental goods.

II. COASTLINE OF ESTONIA

Estonia is a relatively small country (45,227 km^2), but due to its geographical location between major geological structures (Fennoscandian Shield and East-European Platform) and comparatively long coastline (nearly 3,800 km) due to numerous peninsulas, bays and islands (over 1,500 island), it is rich in different shore types and valuable coastal ecosystems. The western coast is exposed to waves generated by prevailing westerly winds, with NW waves dominant along the north-facing segment beside the Gulf of Finland, contrasting with southern relatively sheltered sectors located on the inner coasts of islands and along the Gulf of Livonia (Riga). During the Soviet Union era, most of the 3,800 km long coastline was closed for public and development activity and therefore the impact of human activity was minimal. Most of the seashore was preserved in its natural condition. Few natural seashores are left in Europe and residents regard them as very valuable.

After regaining independence, pressure of human activity on Estonian seashores has increased. The government measures have to be implemented to preserve the shores in their maximum possible natural condition and make them available for recreation and tourism. However, a lot of decision making power is in the hands of local municipalities and often very hot discussions emerge due to real estate and infrastructure development. Supporters of development claim that it brings more inhabitants, more money to the region and "just watching coastal beauty by tourists and locals will not bring any benefits". Supporters of protection claim that it will raise living standard of locals and make the region more attractive for tourists.

Much of the coast (77%) is irregular in outline, with the composition Capes and bays being either hard bedrock or unconsolidated Quaternary deposits, notably glacial drift). The cliffed northeastern coast around Ontika, has been straightened by erosion, whereas the beach-fringed Narva Bay has an outline smoothed by deposition [14]. Coasts straightened by a combination of erosion and deposition can be found on the northern shore of Köpu Peninsula, in the western part of Hiiuma Island, and around the Gulf of Livonia.

Coastal evolution has been influenced by changing sea levels [15]: the Ancylus transgression (9500-9000 years ago), followed by the Litorina transgression (8200-7000) and an ensuing regression (7,000-5,000 years ago). During the Litorina transgression there was extensive erosion, producing cliffs and shore platforms which generated large amounts of sand and gravel, with residual boulders occurring where glacial deposits (till) had been dispersed. During the ensuing regression sand, gravel and boulders on the emerging sea floor formed beaches, beach ridges and dunes by wave and wind activity.

Postglacial isostatic movements since the Ancylus Lake period, resulted in land uplift ranging from *circa* 45 m. in southern Estonia up to 75 m. on the northern coast, Beaches formed are often backed by beach ridges and dunes, tilting has continued on either side of a zero isobase that runs SW-NE through Riga in Latvia, with land uplift of about 1 mm/yr. at Pärnu, 2mm/yr. at Tallinn and 2.8mm/yr. on the northwestern coast [16]. Such forming conditions created diverse coastline.

The coastline classification is based on the concept of wave processes straightening the initially irregular outlines, via erosion of capes, deposition in bays, or a combination of the two [17]-[19]. Based on the initial relief slope, geological character of the substrate and dominant coastal processes, the following shore types are distinguished [17], [20]:

- Cliffed shore (approximately 5% of Estonian shores) – an abrasion bluff in resistant Palaeozoic rocks (limestone, dolomite, sandstone);
- Till shore (35%) – an abrasion till sloping shore;
- Gravel shore (11%) – a depositional shore with beach ridges formed of gravel and pebbles;
- Sandy shore (16%) – a depositional shore with sand ridges often backed by foredunes or dunes;
- Silty shore (31%) – a depositional shore with fine-grained (silty) sediments; usually it has a very flat nearshore and a tendency to become overgrown;
- Artificial shore (2%) – a shore with its natural dynamics altered by anthropogenic constructions (breakwaters, protecting walls, berms).

This classification is well supported by other international coastal classifications [21]-[23]. Those shore types are well distinguishable and not known only by scientists, but also for most of the people in Estonia.

The Baltic Sea is a relatively shallow sea and uniquely almost tideless (tidal range is mostly less than 10 cm). Storm events take place during a short period starting in autumn and ending in early winter. Therefore Estonia has ideal preconditions for coastal scientists to investigate shore processes [24]-[32] and at the same time, the recreational value of the Baltic Sea and its shores has been evaluated highly by several studies [33], [34].

Waves and currents (especially during heavy storms), long-shore drift, onshore winds, and human activity are the main agents of coastline evolution. Higher sea levels in winter is often the cause of rapid shore processes. During storm surges, onshore winds and low barometric pressure may raise sea level by nearly 3 m [35] above the Kronstadt zero (benchmark for the eastern Baltic Sea). This is when major coast changes take place, with cliffs undercut at a higher level, high beach ridges formed, and large quantities of sand moved alongshore.

Estonia is sensitive to climate change manifestations such as an increase in cyclonic activity, westerly circulation and a northward shift of the Atlantic storm track over the last decades. There has been an increase in storminess in the coastal waters of Estonia with over 10 major storms between 1965-2010 with an intensity that previously occurred only once or twice in century [36], [28], [37] - [39], [32]. Changes in meteorological conditions have changed wave climate and sea-level conditions (storm surges are more frequent), as well as the rate at which shore processes occur. Frequently raised sea level by storm surges, a general absence of shore ice cover with unfrozen shore sediments in milder winter conditions allow waves to attack the coast and shape the beaches even in winter. Despite tectonically uplifting coast, beach erosion attributable to increased storminess has become evident in Estonia in recent decades. Measurements at various study sites in western Estonia, shows that the current rate of coastal change is many times higher than in the 1950s. These factors are responsible for acceleration in the rate by which such coastal processes are occurring. Each subsequent storm reaches an already vulnerable beach profile. In addition, higher sea levels during storms have also caused the erosion area to move further inland with any subsequent storm. Even accumulative shores (sand shores, gravel shores) in normal conditions have turned to abrasion in many locations [37], [40], [32].

The impact of climate change on meteorological conditions, hydrodynamics and coastal processes have been well analysed and future scenarios with adaptation costs to climate change have been estimated for Estonia [41] and for the whole Baltic Sea [42], [43]. However, those estimations were based on the cost of infrastructure – artificial shore type (protecting private property, -roads, -harbours, building dykes etc.), which covers only 2% of Estonian shores, but the project was unable to calculate the values of natural ecosystems (such as the cost of coastal wetland, sandy beach, gravel-pebble beach ridges etc.) which are important in terms of biodiversity and recreational activities.

III. Material and Methodology

A. Contingent Valuation

Many values of the nature are non-market. Individuals' economic judgment of these values is revealed by the willingness to pay for preserving or restoring the natural object as the bearer of value. Methodologically correctly identified willingness to pay gives information on the monetary equivalents of values of the nature.

The value attached to the object by the respondents in the form of willingness to pay is contingent in relation to the constructed or simulated market (or market scenario) in the questionnaire [44].

Comprehensive accounts of the method may be found in Mitchell and Carson [45], Hanley and Spash [46] and Bateman and Willis [47].

During the last decades, the method has gained more ground due to the lack of suitable alternatives [48], especially for estimating economic value of certain territories (mainly protected areas) [49]-[52], as well as communities and ecosystems [53],[54] and certain biological species [55].

B. Contingent Valuation of Estonian Shores

The paper seeks to investigate the willingness to pay of Estonian population for preserving different seashore types as environmental goods in their natural condition. The contingent valuation (CVM) method was used. A representative questionnaire survey was carried out among Estonian working-age population. The sample size was 1700 people. The questionnaire contained information on Estonian shores (market scenario), colored prints with descriptions of all seashore types represented in the questionnaire (silty shore, till shore, cliffed shore, gravel shore, sandy shore), preliminary questions and the willingness-to-pay question. All the respondents were asked to read through the questionnaire, the market scenario and seashore descriptions. After that, they were asked to answer the following questions: 1) „Do you agree that Estonia shores should be preserved in their maximum natural condition?" and 2) "In case you agree that Estonian shores should be preserved in their maximum natural condition, then how much are you willing to pay for this annually?" Answers were asked to be provided for every seashore type separately. It was underlined in the questionnaire that although the answer did not presume actual payment, the respondents were asked to answer as truthfully as possible and considering their financial possibilities. Additionally, all the respondents were asked to write down their sociometric indicators: gender, education, age and average monthly income. Insufficiently completed questionnaires were not used in the analysis.

IV. Willingness to Pay and Total Demand for Estonian Shores

A. WTP for Different Types of Seashore

The question „Do you agree that Estonia shores should be preserved in their maximum natural condition?" was answered "yes" by as many as 89% of all respondents. The number of "yes" answers was the biggest in the age group 18-23, 32% of all the respondents, and the smallest in the age group >70, 2.4% of all the respondents.

The results of the willingness-to-pay questionnaire are summarized in Table 1.

Table 1. Willingness to pay (WTP) with respect to socio-metric variables

		silty shore		till shore		cliffed shore		gravel shore		sandy shore	
		Individual's average WTP,€	Difference from total average, %	Individual's average WTP,€	Difference from total average, %	Individual's average WTP,€	Difference from total average, %	Individual's average WTP,€	Difference from total average, %	Individual's average WTP,€	Difference from total average, %
Gender	Male	9.7	103.7	7.6	82.0	11.9	105.6	6.3	87.8	16.9	84.3
	Female	9.2	98.3	10.4	112.1	10.8	96.0	7.8	108.7	22.2	110.6
Education	Primary	8.8	94.1	6.1	66.3	9.4	83.8	5.2	71.4	17.3	86.1
	Secondary	7.9	83.9	10.4	111.9	11.7	103.8	7.7	106.9	24.2	120.7
	Sec.technical	6.5	69.5	5.9	63.9	8.3	73.8	5.1	70.4	13.1	65.2
	Higher	14.1	149.9	13.9	149.8	19.6	174.3	9.6	133.4	25.0	124.6
Age	18-23	8.7	92.3	11.0	119.0	12.0	106.5	8.6	119.6	24.6	122.5
	24-29	12.6	134.4	10.6	113.9	11.1	98.5	7.6	105.6	16.4	81.6
	30-39	13.9	148.3	11.6	125.4	17.9	159.1	7.9	109.1	28.4	141.6
	40-49	7.9	84.6	6.3	68.0	9.4	83.7	6.3	87.0	16.8	83.5
	50-59	6.1	65.4	5.9	63.4	6.8	60.2	4.7	64.7	11.9	59.4
	60-69	4.2	44.5	4.4	47.4	5.3	47.1	2.9	40.7	8.6	42.8
	> 70	3.3	35.6	2.0	21.9	3.5	31.3	2.7	37.6	5.8	28.8
Average monthly income (net), €	<128	4.7	50.4	4.9	53.0	5.9	52.4	6.0	83.0	13.1	65.4
	128-255	4.7	49.7	4.4	47.5	6.0	53.1	4.5	61.9	8.9	44.4
	256-383	5.1	54.0	3.7	39.7	5.2	45.9	3.7	51.8	14.5	72.3
	384-511	15.1	160.5	11.0	119.0	10.7	95.3	7.1	98.8	14.0	69.9
	512-703	6.6	70.7	7.2	77.9	7.0	62.4	5.4	74.2	20.0	99.9
	704-958	10.8	114.8	18.1	195.7	19.4	172.6	11.8	163.2	32.9	164.1
	959-1278	24.9	265.0	17.5	188.9	31.4	278.8	12.2	168.8	41.8	208.2
	>1278	13.4	142.7	13.4	144.6	18.3	162.8	13.0	180.3	30.5	152.1
Total average		9.4	100.0	9.3	100.0	11.2	100.0	7.2	100.0	20.1	100.0

Both average annual willingness-to-pay for preserving all seashore types in their natural condition on the basis of sociometric indices, as well as potential difference of all groups of sociometric indicators from average willingness-to-pay for the respective seashore type are presented.

Gender is not a strong willingness-to-pay determinant. Annual average willingness-to-pay among men, in comparison with the average of the respective seashore type, was highest for the cliffed shore (11.9 €; 105.6%), while women preferred till shore (10.4 €; 112.1%). The lowest willingness-to-pay among men was for till shore (7.6 €; 82.0%) and among women for cliffed shore (10.8 €; 96.0%). Noteworthy is the diametrically different attitude of men and women toward the cliffed shore. The low relative willingness-to-pay among women, based on the comments written in the questionnaire, was that cliffed shore is dangerous to children; men, however, value the grandeur of the cliffed shore and the magnificent view. Absolute willingness-to-pay is the biggest among both men and women for the sandy shore (16.9 € and 22.2 €, respectively).

Education is in strong correlation with the willingness-to-pay. While the annual willingness-to-pay among the respondents with primary education is for all seashore types lower than average, then among the respondents with higher education it is higher than average for all seashore types. The smallest absolute willingness-to-pay among the respondents with primary education is for gravel shore (5.2 €) and the overwhelmingly biggest for sandy shore (17.3 €). The absolute willingness-to-pay of the respondents with higher education is also highest for the sandy shore (25 €), which paradoxically is the smallest relative willingness-to-pay among the respondents with higher education (124.6%). The biggest relative willingness-to-pay, 174.3 per cent, is among the respondents with higher education for cliffed shore.

Age is also in strong correlation with absolute willingness-to-pay. Average age groups (24−29, 30−39), compared to older groups, have higher average willingness-to-pay for almost all seashore types. The biggest absolute willingness-to-pay among all age groups was in the age group 30−39 for sandy shore (28.4 €). All age groups were willing to pay for sandy shores more than for other seashore types. Willingness-to-pay in age groups 60−69 and >70 is decreasing sharply for all seashore types. With the exception of sandy shore, willingness-to-pay among older age groups does not depend much on seashore type.

Income is, as expected, positively correlated to willingness-to-pay. An exception here is income range 256−383 € where average willingness-to-pay is smaller than in the preceding income range. Absolute willingness-to-pay is the biggest in all income groups again for sandy shores and equally small for gravel shores. The biggest willingness-to-pay on the basis of all sociometric indicators, 41.8 €, is in the income range 959−1278 for sandy shores.

Average willingness-to-pay among all respondents varies considerably by seashore type (Table 2). The overwhelmingly biggest average willingness-to-pay is for sandy shore (20.1 €) and the smallest for gravel shore (7.2 €). Willingness-to-pay for silty shore and for till shore is nearly equal (9.4 and 9.3 €, respectively). The second by willingness-to-pay is cliffed shore (11.2 €), which is nearly half of sandy shore. The overwhelmingly biggest willingness-to-pay for preserving sandy shore in the natural condition is not surprising since sandy shore is preferred as a recreation area by most people irrespective of the sociometric indicators. Attitudes toward the cliffed shore, which was second by willingness-to-pay, however, vary much more and the willingness-to-pay depends much more on sociometric indicators.

Table 2. Total demand for shores by type

Shore types	Coastline, km	Individual's average WTP, €/y	Total demand per 1 km, thousand €	Total demand, million €
Silty shore	1178	9.4	5.95	7.01
Till shore	1330	9.3	5.22	6.94
Cliffed shore	190	11.2	43.95	8.35
Gravel shore	418	7.2	12.85	5.37
Sandy shore	608	20.1	24.65	14.99

B. Total Demand for Estonian Seashore in Natural State

There are several different ways to find the aggregated amount of WTP. The open-ended scale and asking of the actual amount of willing to pay allow us to calculate the aggregated WTP by multiplying the average or median WTP obtained from sample with number of total working age population. However, such calculations tend to overestimate or underestimate the aggregated WTP [56]. For more reliable results the authors use the fitting of demand curve.

The construction of aggregated demand curve for take Estonian working age population is based on the actual distribution of WTP amounts obtained from the survey. The results are generalized to the whole working age population; i.e. 893 000 persons.

The most appropriate functional form, for presenting WTP data is the exponential model

$$WTP = ae^{-bX} \quad (1)$$

where WTP is the amount of willingness to pay, x is the number of people willing to pay at least this amount, and α, β the parameters under estimation.

The results of regression estimation, using the least squares method are shown in Table 3. The value of coefficient of determination (R2=0.93) indicate a high goodness of fit, both parameters are statistically significant.

Table 3. WTP regression results

Variable	Coefficient
α	212.44
β	0.005
R^2	0.9343

Based on the estimated parameter we can write the equation of demand curve as:

$$WTP = 212.44e^{-0.005x} \quad (2)$$

The demand curve, fitted graphically based on this equation is given in Fig. 1. The vertical axis represents the WTP amounts (thousand €) and horizontal axis the number of persons willing to pay at least this amount.

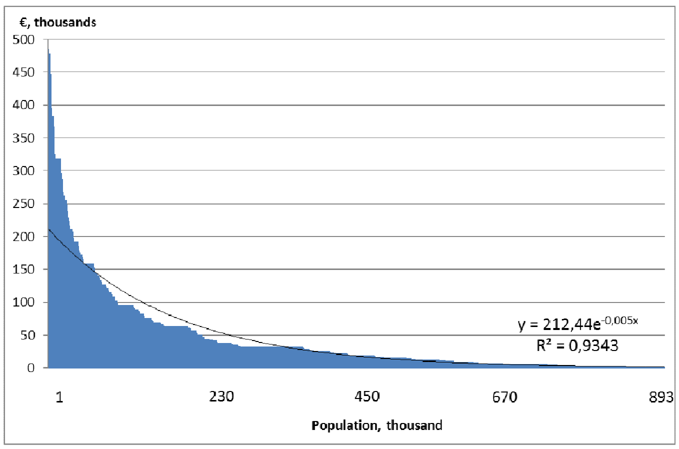

Fig 1. Estimated demand curve

The area under the demand curve represents the consumer surplus (CS) of the working age population and we can estimate it by a definite integral:

$$CS = \int_{x_1}^{x_2} WTP(x)dx = \int_{x_1}^{x_2} \alpha e^{-\beta x}dx = -\frac{\alpha}{\beta}(e^{-\beta x_2} - e^{-\beta x_1}) \cong \frac{\alpha}{\beta} \quad (3)$$

where x_1=0 and x_2 are the number of people with positive WTP (893thousands).

Replacing the values of parameters a and b we receive that the estimated consumer surplus.

$$CS = \frac{\alpha}{\beta} = \frac{212.44}{0.005} \approx 42.5 million€ \quad (4)$$

Hence the annual demand of Estonian working-age population for the Estonian coast in natural state is 42,5 million €. Consequently also the monetary equivalent of the value of the Estonian coast in natural state as an environmental good is 42.5 million € annually.

The influence of the sociometric features to the amount of WTP is estimated as follow

$$\ln(WTP_i) = \alpha + \beta_1 gender_i + \beta_2 \ln(age_i) + \beta_3 \ln(educ_i) + \beta_4 \ln(inc_i) + \varepsilon_i \quad (5)$$

where gender is dummy variable (male=1, female=0) and all other variables are categorical variables. The results of estimation given in Table 4 suggest that the amount of WTP is not affected by all the sociometric features. There are not statistically significant differences in WTP amount by gender or level of education. The size of WTP is influenced only by age and amount of income, the persons with better income tend to pay more.

Table 4. The influence of the sociometric indicators to the WTP amount, Tobit model

Dependent Variable: WTP_EURO
Method: ML - Censored Normal (TOBIT) (Quadratic hill climbing)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	2.435232	8.136936	0.299281	0.7647
AGE	-1.171893	0.570759	-2.053219	0.0401
EDUCATION	0.733718	2.169197	0.338244	0.7352
GENDER	2.298354	3.875066	0.593114	0.5531
INCOME	5.990321	1.084400	5.524089	0.0000

V. CONCLUSIONS

Approximately 98% of the Estonian seashores are still in the natural condition. The CVM study demonstrates that seashores in the natural condition are regarded as very valuable environmental goods. Total demand for preserving Estonian seashores in their natural condition is considerable – 42.5 million euros annually. There is demand, although uneven, for all main seashore types. The highest average willingness-to-pay of the respondents is for sandy shores, 20.1 euros, which makes total demand ca 15 million euros annually. The lowest willingness-to-pay (7.2 €/y) and hence also total demand is for preserving gravel shores in their natural condition (5.4 million €). The total demand per 1 km of coastline is highest for cliffed shore – 44 thousand euros, sandy shore is in the second position – 25 thousand euros. The demand per 1 km of silty shore and till shore is significantly smaller – 6 and 5 thousand euros respectively.

The total demand depends on the respondents' sociometric indicators. Higher income is positively correlated with the willingness-to-pay. The willingness-to-pay of middle-aged people is higher than that of younger and older age groups.

The high total demand for preserving Estonian seashores in their natural condition is an important argument for making plans for seashores, for resource use there and adoption of plans.

The findings allow concluding that it is in the interest of inhabitants that seashores are preserved in the natural condition rather than the natural state is destroyed by real estate development. The most preferred usage of shores is recreation and nature tourism, which guarantees sustainable preserving of natural condition of shores, at the same time enabling public access. Economic, nature protection and organisational aspects of Estonian coastal tourism is required to be investigated further.

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