WILLINGNESS TO PAY FOR URBAN ECOSYSTEM SERVICES AS INPUT FOR STATISTICS: A CASE OF ESTONIA

Üllas Ehrlich[1]
Tallinn University of Technology

Abstract

Finding a monetary equivalent for non-market ecosystem services is precondition to develop a worldwide standard for statistics on ecosystem services. The objectiv of this study is to find out the monetary equivalent of the value of Estonian urban ecosystem services and to determine the dependence of people's willingness to pay on their sociometric indicators.. Using the contingent valuation method, the willingness to pay (WTP) of the Estonian adult population for the maintenance and management of Estonian urban ecosystems has been identified. The total annual WTP is about 17 million euros. Using regression analysis, it was determined that the amount of WTP is positively related to education level, income and gender (women pay more), but not related to age of respondents. In order to divide the total WTP among all the services of all the ecosystems studied, the respondents were asked to rank the urban ecosystems and the services they provide according to their subjective preference. The highest rank among ecosystems received large parks and among ecosystem services urban air purification. According to the results obtained, a matrix was compiled in which all services of the studied all ecosystems are assigned a monetary equivalent, which can be used as an input in the statistics on ecosystem services.

Keywords: Urban green areas, valuation of ecosystem services, contincent valuation, environmental accounting

JEL Classification Codes: Q5; Q51; Q56; Q57

1. Introduction

Urban ecosystems are of particular importance compared to other ecosystems, as it is in urban areas that a large number of people come into contact with ecosystems in a concentrated way and consume the values of ecosystem services. Given the extent of human exposure to ecosystems in urban areas, it is clear that for many ecosystem services, urban ecosystems play an important role in influencing the welfare of urban dwellers. This applies both to cultural services (such as recreation) and to regulatory services that affect the quality of the urban environment (such as air purification from PMs).

[1]Üllas Ehrlich; PhD; Sustainable Value Chain Management Unit: Department of Business Administration, Tallinn University of Technology; Ehitajate 5, 19086, Tallinn, Estonia; ullas.ehrlich@taltech.ee

Accessible and high-quality urban green and blue spaces, such as parks, urban forests, tree-lined streets, allotments, river banks and coastlines, provide significant health benefits to local communities (EEA, 2020). Green spaces improve air quality, reduce noise and enhance biodiversity (Maes et al., 2019). Local communities use green space for physical exercise and social interactions, and for relaxation and mental restoration. Exposure to green space benefits health by reducing mortality and morbidity from chronic diseases, improving mental health and pregnancy outcomes, and reducing obesity (EEA, 2020).

Finding out the value of services of ecosystems in urban areas is more difficult than in the case of natural ecosystems. In an urban area, we cannot talk about one ecosystem, but many different ecosystems that offer different services. In addition, the question arises, how many ecosystems should be studied in urban areas? For example, which elements of urban landscaping should be aggregated and which should be treated as separate ecosystems, which elements can be separated at all in the detail (square size) selected on the map, etc. It is also important how people perceive and differentiate urban ecosystems and their services. This is clearly shown by the fact that the contingent valuation study revealed that urban ecosystem services were ranked quite differently from natural ecosystem services in terms of subjective importance. For example, the recreational service in urban areas, which was one of the last natural ecosystem services, was one of the most important.

When evaluating the services of urban ecosystems, it must be taken into account that urban ecosystems influence individuals welfare differently from natural ecosystems, such as forests. This should also be taken into account when choosing ecosystem evaluation methods. For example, to visit a hiking trail in the forest, visitors usually has to drive there specially, the visitor's transport costs and the time spent on the visit can be well monitored. Consequently, it is very appropriate to measure the monetary equivalent of the recreational value of a forest ecosystem using either the travel cost method or the time cost method. People come into contact with the ecosystems of different areas differently, usually not as a result of a special trip to a large city park, but with many brief exposures to urban ecosystems, such as tree alleys, lawns and small parks. Contact with urban ecosystems takes place in many ways- on the way to and from work, on foot with the family, and why not from the window of the vehicle and the window of the office and the home apartment. In general, it can be said that the typical contact with the urban ecosystem in an urban area is rather short in time, but the number of contacts per person can be relatively high. The time taken for such contacts is difficult to measure using travel cost and time cost methods, because unlike visiting natural ecosystems outside the city, there are typically no travel costs, as ecosystems are not specifically visited but are contacted when moving for other purposes. However, based on a survey of people, it can be said that contacts with the ecosystems of urban areas have a positive effect on welfare, even if the visit to the ecosystem is not an end in itself, but takes place by passing. Therefore, when assessing the monetary value to ecosystem services in urban areas, it is reasonable to measure the change in human welfare due to ecosystem services directly, using the contingent valuation method (CVM). Thus, it can be argued that, given the specific nature of the expression of urban ecosystem services, the use of stated preferences-based methods (which also includes the CVM) for measuring their value is more justified compared to natural ecosystems.

The objective of this study was to find out the financial equivalent of Estonian urban ecosystem services and the dependence of people's willingness to pay and the amount of payment on their sociometric indicators. In addition, the aim was to identify people's preferences for different urban ecosystems and their services.
The paper presents the results of a CVM survey of urban areas conducted by the author. The dependence of the payment decision and willingness to pay amount on the sociometric indicators of the respondents has been analyzed. The total demand of the Estonian adult population for urban green areas is ascertained. Based on the CVM study, the monetary equivalents of the different services in each of the studied urban ecosystems are derived.

The results of the work can be used in the accounting and statistics of ecosystem services.

2. Definition of urban ecosystem

Both scientists and less qualified people in general have a fairly common and consensual understanding of what the forest looks like and the grassland looks like: the grassland is dominated by grasses and the forest is dominated by trees. Although the criteria for the transition of ecosystems can be debated (eg where a wooded meadow ends and a forest begins), the vast majority of meadows, forests and also bogs are so different from each other botanically (and more broadly biologically) that there is no need to be a scientist to determine the ecosystem.

The same cannot be said for urban ecosystems, which do not have such a uniform basis for classification. And that is where the problems of identifying and defining urban ecosystems begin. Different institutions try to set their own criteria, sometimes on the basis of subjective interest. For example, the classification of the forests surrounding a city as urban ecosystems or as forest ecosystems says nothing about its value but is rather statistical by nature. However, the possibility to decide on forest management issues by the city government may be reduced if the forest is administratively outside city borders and defined as a forest, instead of being defined as an urban ecosystem.

Thus, there seem to be two different ways of designating a forest as an urban ecosystem: urban ecosystem is considered to be one that is either the forest within the city administrative borders or where city inhabitants typically walk. However, both criteria are, unlike other ecosystems, non-biological and say nothing about the biological nature of the ecosystem, which is the basis for classifying other ecosystems, such as grassland, forest or bog. The urban ecosystem can be characterized by a meadow (eg a lawn areas in big parks), a forest (recreational woodlands inside the city) as well as a bog feature.

If there is any substantive biological criterion that connects these ecosystems, then the degree of human impact, i.e. the "degree of artificiality" of the ecosystem. The latter is suitable for green areas of the city, such as flower beds and lawns, but not for forest parks located in the city (eg Glehni Park in Tallinn), where typical forestry activities is definitely carried out with less intensity than in commercial forests.

A separate issue and also a criterion is how people subjectively perceive the urban ecosystem and its extent. Many people are likely to think about this issue when filling contingent valuation questionnaire. The natural solution to this question would be that "the urban ecosystem is what I feel as an urban ecosystem". Such an answer may be correct from the point of view of cognitive theory, but it hardly satisfies the needs of accounting and statistics.

In view of the above, it is clear that not an administrative, biological and subjective criterion taken separately can be used to define an urban ecosystem, but the achievement of the better result requires the development and use of a complex method that takes into account several different factors.
The criterion for classifying the urban ecosystem, which has been used in this work, is a complex criterion that considers both the population density and the distance of artificial areas from the ecosystem. Such criteria of urban ecosystem are expected to be closest to how people subjectively perceive it.

3. Methodology

In this work, the contingent valuation method is used to determine the monetary value of urban ecosystem services. The contingent valuation method (CVM) is a survey method that seeks to elicit people's preferences for changes in non-market good provision by finding the amount of money people are willing to pay in order to receive the change in question. The value attached to the object by the respondents in the form of the willingness to pay is contingent in relation to the constructed or simulated market (or market scenario) in the questionnaire (Portney 1994). If there is no actual market for some goods, it has to be created hypothetically. The hypothetical scenario is then presented to people and they are asked how much money they would agree to give up if the change was undertaken, alternatively to avoid the change. Theoretically, the maximum amount of money an individual is willing to pay for a welfare increasing change is equivalent to the amount that he or she would give up while keeping his or her utility constant (Freeman, et al., 2003). The first empirical application of the contingent valuation method was made by Davis (Davis, 1963) in his study of hunters in Maine. The method has become very widely used. In the overview of the history of contingent valuation Carson (Carson, 2011) provides reference to 8000 papers and studies all over the world. In recent years there have also been several applications of contingent valuation in Estonia (e.g. Reimann, et al. 2011; Pädam, Ehrlich 2011; Nõmmann, et al. 2020; Ehrlich 2021). Comprehensive accounts of the method are found in Mitchell and Carson (Mitchell, et al., 1989) and Alberini and Kahn (Alberini, et al., 2009).

A contingent valuation study on urban green spaces was conducted in 2019. The survey is based on 720 questionnaires and the sample structure was representative of the Estonian adult population. The sociometric structure of the sample is shown in Table 1. The distribution of respondents with a positive WTP is presented in the table separately.

Questionnaires that left some questions unanswered but the sociometric section was filled in correctly were used to analyze the questions for which the questionnaires contained information. Therefore, in the analysis of different questions, the samples are slightly (by only a few answers) different. The exact sample size for each question is given in the tables.

Table 1. Distribution of respondents by sociometric indicators

		All respondents		Respondents with positive WTP	
		Number of respondents	Per cent	Number of respondents	Per cent
Gender	Man	318	44,2	278	42,6
	Woman	402	55,8	374	57,4
	TOTAL	720	100	652	100
Education	1 - Basic	72	10,0	65	10,0
	2 - Secondary	331	46,0	296	45,4
	3 - Higher	317	44,0	291	44,6
	TOTAL	720	100,0	652	100,0
Age	18-23	96	13,3	89	13,7
	24-29	84	11,7	75	11,5
	30-39	138	19,2	122	18,7
	40-49	134	18,6	125	19,2
	50-59	135	18,8	124	19,0
	60-69	69	9,6	63	9,7
	70 or older	64	8,9	54	8,3
	TOTAL	720	100,0	652	100,0
Income (EUR)	alla 500	100	13,9	85	13,0
	501-800	150	20,9	129	19,8
	801-1000	131	18,2	126	19,3
	1001-1300	161	22,4	149	22,9
	1301-2000	120	16,7	111	17,0
	üle 2000	57	7,9	52	8,0
	TOTAL	719	100	652	100

Whereas one of the aims of the CVM study was to find the financial equivalent of non-market services in the urban ecosystem, the structure of the questionnaire was more complicated than typical CVM survey. In addition to the typical parts of the CVM questionnaire, such as the simulated market scenario, the willingness to pay question (discrete choice format) and the sociometric part of the respondents, the questionnaire also included additional questions on the use and sufficiency of urban green areas. To link WTP to individual services of urban ecosystems, respondents were asked to rank urban ecosystems (Table 9) and ecosystem services (Table 10) according to their subjective preferences. In addition to the questions mentioned above, the questionnaire contained 4 additional questions: 1)“How often do you visit the green areas of the city?“ (Table 2); 2)„Do you think that there are green areas in Estonian cities…“ (Table 3); 3)„If you think that there are too few green spaces, what types of green spaces should be added as a matter of priority?“ (Table 4); 4)„Do you consider it permissible to build houses in public green areas?“ (Table 5).

4. Results and discussion

4.1 Results of additional questions

The distribution of answers to the given variants of question „How often do you visit the green areas of the city?“ is presented in the table 2.

Table 2. Answers to the question „How often do you visit the green areas of the city?“

Predefined answer options	Number of respondents	Percentage of respondents
Almost every day	188	26,1
At least once a week	233	32,4
Once a month	206	28,6
I do not visit green areas	93	12,9
Total	720	100,0

The frequency of visiting urban green areas shows the importance of these areas in the everyday life of city inhabitants. About a quarter of respondents visit green areas almost every day. The share of residents who visit green areas at least once a week is the highest, almost 33 percent. 29 percent of the population visits green areas on average once a month. The share of those who do not visit green areas at all is remarkably small, about 13 percent. Given that the natute of the visit to the green areas was not defined in the questionnaire, the question of what the residents consider to visit the green areas remains a question. It can be assumed that visits to green areas are mainly considered to be visits where the visit to the green area is the main purpose of the trip or walk. If this is true, many exposures to green spaces, such as going to work through the park or bringing a child home from kindergarten along an alley of trees, remain undefined as a visit to green spaces. Thus, the actual exposure of urban dwellers to green areas may be even higher than the answers directly show.

The distribution of answers to question „Do you think that there are green areas in Estonian cities….“ is given in Table 3.

Table 3. Answers to the qestion „Do you think that there are green areas in Estonian cities….“

Predefined answer options	Number of respondents	Percentage of respondents
Too many	38	5,3
Optimally	442	61,4
Too few	240	33,3
Total	720	100,0

Two thirds of the city's residents have a clear opinion on this issue – the amount of green areas are optimal in Estonian urban areas. One third of the respondents consider the number of green areas to be too small. Just five percent of respondents feel there are too many green spaces in cities. It can be concluded from the answers that the majority of Estonian urban residents are satisfied with the (at least) quantity of green areas.

The distribution of answers to the given variants of question „Which type of green spaces should be added as a matter of priority in urban space?“ is presented in the table 4.

Table 4. Answers to the qestion „Which type of green spaces should be added as a matter of priority in urban space?“

Predefined type of landscaping	Number of respondents	Percentage of respondents
Parks	185	41,1
Lawns and flower buds	69	15,3
Gardens	72	16,0
Tall landscaping and alleys	124	27,6
Total	450	100,0

As the distribution of answers to the question „Which type of green spaces should be added as a matter of priority in urban space?“ shows, more than 41 percent of those who answered the question consider it necessary to add parks as a matter of priority. This shows that the residents are most in need of parks. Parks are followed by tall landscaping and alleys with about 28 percent. The share of those who consider it necessary to add lawns and flower buds to landscaping is approximately equal, 16 and 15.3 percent, respectively. From this distribution of the answer, it can be concluded that residents who want more landscaping in cities consider it necessary to add large forms of landscaping, such as parks and alleys. Slightly less than one third of the respondents prefer to add flower clumps and gardens as a priority.

The answer options for question „Do you consider it permissible to build houses in public green areas?“ and the distribution of answers between them are given in Table 5.

Table 5. Answers to the question „Do you consider it permissible to build houses in public green areas?“

Predefined answer options	Number of respondents	Percentage of respondents
Certainly not	437	61,3
Yes, if the buildings are beautiful	174	24,4
Yes, if the developer pays the city enough	102	14,3
Total	713	100,0

A total of 713 respondents answered this intriguing question. An absolute majority, more than 61 percent of respondents, chose the answer "Certainly not", which indicates that building a public green space is considered unacceptable under any circumstances. The reason for this attitude is probably that people already have negative experiences with the reduction of public green space due to construction, and people feel that their well-being is at risk. Provided that the buildings built in the public green space are aesthetically acceptable, about 24 percent of the respondents accept the construction. Only a little over 14 percent of respondents consider the criterion that "the developer pays the city enough" to be acceptable as a construction condition.

In general, it can be said about the building houses to the public green space that almost two thirds of people do not agree with the conversion of public green space into land covered by buildings. Those who agree with the construction consider it important that the buildings are beautiful. Only 14 percent of people consider pure financial criteria when deciding on building to public green space.

4.2 The CVM study

In the present study, the WTP question was worded as follows: „If you think that green spaces in Estonian cities are important and you consume the services of urban green space ecosystems, how much would you personally be willing to pay for the preservation and maintenance of urban green spaces per year?“ The arithmetic distribution of individual willingness to pay according to the sociometric indicators of the respondents is presented in Table 6.

Table 6. The arithmetic distribution of individual WTP and difference from average

		Average WTP, EUR	Relative difference from the total average, per cent
Gender	Man	16,5	96,1
	Woman	17,7	103,1
Education	Basic	12,8	74,4
	Secondary	15,4	89,5
	Higher	20,1	116,8
Age	18-23	16,3	94,7
	24-29	18,0	104,8
	30-39	16,5	96,1
	40-49	19,9	115,8
	50-59	16,7	97,4
	60-69	17,7	102,9
	70 and older	13,7	79,5
Average net income in month, EUR	Less than 500	12,3	71,3
	501-800	13,9	80,6
	801-1000	16,4	95,4
	1001-1300	16,5	96,1
	1301-2000	22,0	127,9
	Over 2000	28,3	164,6
Total average		17,2	100,0

The arithmetic mean WTP of all respondents was € 17.2 per year. Looking at the WTP by sociometric indicators, it can be argued that different indicators affect payment amount to different degrees. Gender has a relatively modest effect on WTP. The WTP for women is on average 1 euro higher than for men (16.5 euros and 17.5 euros, respectively). Willingness to pay is positively dependent on education, ranging from 12.8 eur (respondents with basic education) to 20.1 eur (respondents with higher education).

It is not possible to draw a definite trend on the relationship between age and WTP on the basis of arithmetic analysis. The lowest (13.7 euros) WTP is in the age group over 70 and the highest in the 40-49 age group (19.9 euros). In contrast, income has a significant influence on WTP. Arithmetic analysis shows that the higher the income, the higher the WTP. It is interesting to note that in the four smaller income ranges, the WTP remains lower than the average WTP of the whole sample. In the two largest income ranges of 1301-2000 euros/ month and over 2000 euros/ month, WTP is 22 euros (127.9 percent of the average) and 28.3 euros (164.6 percent of the average), respectively. These are the largest differences from the average WTP across all sociometric indicators.

The statistical analysis of CVM resukts is carried out in three steps. In the first step we use a OLS regression to assess the influence of sociometric variables to the decision to pay or not to pay. In the second step, an OLS regression is applied to the sub-sample that has a positive WTP in order to determine the relationship between the stated payment amount and the sociometric indicators. Finally the positive WTP replies are used as an input for finding the aggregated consumer surplus for Estonian green urban areas. The statistical analysis is based on 719 fully completed questionnaires.

4.2.1 The effect of sociometric indicators on the payment decision.

The OLS regression allow us to assess the influence of socio-metric variables on the decision to pay (WTP>0) or not to pay (WTP=0). An OLS regression analysis was performed to determine the dependence of the payment decision on sociometric indicators of respondents. The results of the analysis are shown in Table 7.

Table 7. The influence of socio-metric variables on WTP >0, OLS model

Variable	Coefficient	Std. Error	t-Statistic	Probability
CONSTANT	1.765345	0.059297	29.77120	0.0000
AGE	-0.005223	0.006078	-0.859288	0.3905
EDUCATION	-0.006946	0.018264	-0.380327	0.7038
GENDER	0.068486	0.022368	3.061821	0.0023
INCOME	0.021045	0.008048	2.615013	0.0091
Summary statistics	Adjusted R-squared=0.014464 Number of observations=719			

The results of the analysis show that the payment decision depends on gender and income (see Table Y column probability). Women are more likely to have a positive WTP than men, and higher-income respondents are more likely to have a positive willingness to pay than lower-income respondents. The effect of age and education on the WTP decision is not statistically proven.

4.2.2 Dependence of the amount of the payment on sociometric indicators

The effect of sociometric indicators on the amount of payment was analyzed by regression analysis using the least squares method (OLS). The regression results are shown in Table 8.

The regression result suggests that all socio-metric variables, except age, have a significant impact on the amount of WTP. The size of the WTP is most strongly correlated with income (see table 8 column probability). The effect of gender on the amount of WTP has also been statistically proven. Women are more likely to state a higher WTP than man once the payment decision has been done. The level of education also positively correlates with the WTP, the higher the level of education, the higher the amount of WTP. As to age, the analysis did not reveal a statistically significant effect on the amount of WTP. While gender and income had a statistically significant effect on both the payment decision and the WTP amount, the third sociometric factor education, influencing the size of the WTP had no effect on the positive WTP desicion.

Based on the obtained results, it can be stated that the willingness to pay for urban landscaping and thus also the demand for urban landscaping is higher for women and persons with higher income.

Table 8. The influence of the socio-metric indicators to the WTP amount, OLS results

Variable	Coefficient	Std. Error	t-Statistic	Probability
CONSTANT	1.618731	3.166502	0.511205	0.6094
AGE	-0.319173	0.324561	-0.983397	0.3257
EDUCATION	1.615238	0.975300	1.656145	0.0981
GENDER	2.794636	1.194459	2.339667	0.0196
INCOME	2.635317	0.429747	6.132246	0.0000
Summary statistics	Adjusted R-squared=0.072927 Number of observations=719			

The European Environemntal Agency (EAA) raises the question who benefits most from urban green space? https://www.eea.europa.eu/publications/who-benefits-from-nature-in

Based on the literature, it is concluded that green and blue spaces are particularly beneficial for the health and well-being of certain socio-economic and demographic groups. Overall, people of lower socio-economic status reap greater benefit from urban green space than more privileged groups, especially in terms of reducing stress and improving mental health (Ward Thompson et al., 2016; Marselle et al., 2020).

Of the sociometric indicators asked in this CVM study, only income can be directly linked to people's socio-economic ststus. It could be assumed that if the welfare of lower-income residents is more affected by the city's green areas, it should also be reflected in greater willingness to pay. However, the present CVM study shows that both the payment decision of individuals and the amount of payment are positively correlated with income. At the same time, the possibility remains that income is a very sensitive indicator for the payment decision and thus does not allow individuals to express the impact of green areas on well-being monetarily in proportion to the increase in welfare. In any case, the thesis that urban green areas are more important for less secured people needs further research.

Some authors have pointed out that gender also seems to influence the use of green space. Studies from Sweden suggesting that women seem to attach more value to green areas than men (Fredman et al., 2019; Ode Sang et al., 2020). The present study confirms this statement, women's willingness to pay is higher than men's, which is also confirmed by regression analysis.

4.2.3 Estimation of total demand

The estimation of the aggregated demand curve for the preservation and maintenance of urban green spaces of Estonian`s adult population is based on the actual distribution of WTP amounts obtained from the survey (Figure 1.) The results are generalized to the proportion of the population with positive WTP, which is 90,5 per cent i.e. about 969000 persons 18 years of age or older in Estonia as of January 1st, 2019. In calculations, one respondent corresponds to 1486 inhabitants.

Based on the distribution of WTP (discrete choice), the exponential model is the most appropriate functional form, for presenting the demand curve is

$$WTP = ae^{-bX}$$

where WTP is the euro value of the willingness to pay; X is the number of people in thousands willing to pay this amount; and a and b the parameters under estimation.

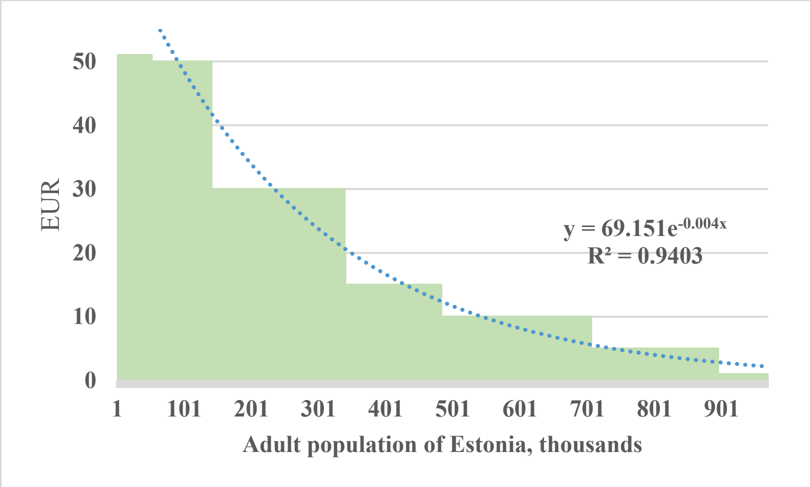

Figure 1. The demand curve of Estonian adult population for the preservation and maintenance of urban green spaces.

By integrating the curve one can find the total demand of the adult population for the preservation and maintenance of urban green spaces:

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

Where $x_1 = 0$ and x_2 are the number of people with positiive WTP i.e. about 969000. Replacing the value of parameters α and β, the estimated aggregated WTP amount (i.e. consumer surplus CS) is calculated as

CS ≈ α/β = 69,151/0,004 = 17287,75 ≈ 17288 thousand EUR/year.

Thus, the annual demand for urban green spaces by the Estonian adult population expressed through WTP is approx. 17,29 million euros per year.

4.3 Monetary value of urban ecosystem services

Finding monetary value for ecosystem services is an indispensable prerequisite for the accounting and statistics of ecosystem services. Under the auspices of the SEEA, a global standard for the accounting of ecosystem services is being developed.

The SEEA is a statistical system that brings together economic and environmental information into a common framework to measure the condition of the environment, the contribution of the environment to the economy and the impact of the economy on the environment. The SEEA contains an internationally agreed set of standard concepts, definitions, classifications, accounting rules and tables to produce internationally comparable statistics (https://seea.un.org)

The SEEA EA is one of the new standards in development in System of Environmental Economic Accounting. (System of Environmental- Economic Accounting—Ecosystem Accounting: Final Draft. (https://unstats.un.org/unsd/ statcom/52nd-session/documents/BG-3f-SEEA-EA_Final_draft-E.pdf). The SEEA Ecosystem Accounting (UN SEEA EA) constitutes an integrated and comprehensive statistical framework for organizing data about habitats and landscapes, measuring the ecosystem services, tracking changes in ecosystem assets, and linking this information to economic and other human activity. The United Nations Statistical Commission adopted the SEEA Ecosystem Accounting at its 52nd session in March 2021. This adoption follows a comprehensive and inclusive process of detailed testing, consultation and revision. Today, ecosystem accounts have already been used to inform policy development in more than 34 countries. The institutional network of ecosystem economic accounting has been discussed in more detail by Ehrlich (Ehrlich, 2021).

Urban ecosystem services are an important part of the ecosystem services that need to be monetarily evaluated. The presence of different ecosystems in the urban area made it difficult to compile the CVM questionnaire and to interpret the results later. The aim of this study is to find monetary equivalent for different services of different urban ecosystems separately. To achieve this, respondents were asked to rank (according to subjective importance) different urban ecosystems in addition to urban ecosystem services (see table 4). By dividing the total willingness to pay between ecosystems and ecosystem services (both ranked according to subjective preferences), it was possible to find monetary equivalent to all services of all studied urban ecosystems. Preliminary information about monetary value of urban ecosystem services is published in the paper „Contingent valuation as a tool for environmental economic accounting: case of Estonia (Ehrlich, 2021).

Of the urban ecosystems ranked on the basis of subjective preferences (table 4), large parks are unrivaled (23.3% of total value, WTP 4 million euros). In second place are small parks (17.3%, WTP 3 million euros) and in third place urban forests (15.9%). The last places in the list are relatively smaller urban green areas Lawn *strips and flower pots by the sidewalks* (10.5%) and *Lawn strips by the roadrand between lanes* (10.0%). The ranking of privately-owned gardens is very similar to them (also 10.5%). The result urban ecosystem ranking shows that people appreciate in urban ecosystems higher larger green areas in public use.

Table 9. Relative importance of urban ecosystems and and the corresponding WTP (Ehrlich 2021).

Urban Ecosystem	Importance	% total value	WTP (thous. EUR)
Big parks (e.g. Kadriorg in Tallinn)	1.	23.3	4028.3
Small parks in the City centre (e.g. Hirvepark in Tallinn)	2.	17.3	2985.9
Forests within the city borders (e.g. Stroomi forest in Tallinn)	3.	15.9	2747.6
Tall landscaping (trees, alleys) by the road	4.	12.6	2176.5
Privately owned gardens	5.	10.5	1815.3
Lawn strips and flower pots by the sidewalks	6.	10.5	1810.3
Lawn strips by the road and between lanes (e.g. Sopruse av. in Tallinn)	7.	10.0	1723.9
TOTAL		100.0	17287.75

By dividing the total willingness to pay between ecosystems and ecosystem services (both ranked according to subjective preferences), it was possible to attribute monetary value to all services of all studied urban ecosystems (Table 10)

Table 10. Distribution of the WTP between urban ecosystems and ecosystem services according to their subjective importance.

	Big parks	Small parks in the City centre	Tall land-scaping (by the roads)	Forests within the city borders	Privately owened gardens	Lawn strips and flower pots by the sidewalks	Lawn strips by the road and between lanes	TOTAL, thous. EUR	% of total value
City air purification	600,94	445,44	409,88	324,69	270,81	270,06	257,17	2578,99	14,92
Photosynthesis (oxygen production)	448,50	332,45	305,91	242,33	202,12	201,56	191,93	1924,80	11,13
Providing recreation and leisure opportunities	439,20	325,56	299,57	237,31	197,93	197,38	187,95	1884,90	10,90
Traffic noise reduction	413,24	306,32	281,86	223,28	186,23	185,71	176,85	1773,49	10,26
Habitat supply for biological species (e.g. birds)	411,52	305,04	280,68	222,35	185,45	184,94	176,11	1766,07	10,22
Ensuring the diversity of urban space	389,85	288,98	265,91	210,64	175,69	175,20	166,83	1673,10	9,68
Urban microclimate regulation and carbon sequestration	390,18	289,22	266,13	210,82	175,83	175,35	166,98	1674,52	9,69
Offering aesthetic pleasure (flower buds, alleys)	326,62	242,10	222,78	176,47	147,19	146,78	139,77	1401,72	8,11
Providing shade for people (e.g. from wind and sun)	317,07	235,03	216,26	171,32	142,89	142,49	135,69	1360,74	7,87
Providing opportunities for environmental education	291,13	215,80	198,57	157,30	131,20	130,83	124,59	1249,43	7,23
TOTAL, thous. EUR	4028,25	2985,94	2747,56	2176,51	1815,32	1810,30	1723,87	17287,75	100,00

The overall results of the city's CVM are presented in Table 10. This summary table is a matrix compiled based on urban ecosystems and ecosystem services ranking. The table shows a monetary equivalent of all ecosystem services of all urban ecosystems studied. In the first place is *City air purification* by *Big parks* (601 thousand euros/year). In the last place is *Providing opportunities for environmental education* by *Lawn strips by the road and between lanes* (125 thousand euros/year).

Although the monetary equivalent of the highest rated ecosystem service of the highest rated urban ecosystem differs more than four times from the lowest rated ecosystem service on lowest rated ecosystem, however, it can be argued that the differences between urban ecosystem services are not as large as might have been expected. This shows that people's preferences vary quite a bit, one prefers lawns, the other large parks and the third flower buds. But all these ecosystems are important for the urban green space.

Conclusion

Urban ecosystem services play a very important role in the welfare of the city's inhabitants. The urban ecosystems offer a wide range of both regulatory and cultural ecosystem services, from air purification and traffic noise reduction to recreational and aesthetic experiences. From the point of view of economics, such ecosystem services are non-market and not related to financial turnover in the sense of economic accounting. At the same time, finding a monetary equivalent for non-market ecosystem services is key issue, what is precondition to develop a global standard for statistics on ecosystem services.

One of the most common methods of monetary valuation of non-market values is contingent valuation (CVM) which involves finding the monetary equivalent of the non-market value under study through the hypothetical willingness to pay of individuals. In current study, the CVM method was used to find the monetary equivalent of non-market services of urban ecosystems. Given that the aim was to find a monetary equivalent for all the services of all surveyed urban ecosystems, in addition to declaring willingness to pay, respondents were asked to rank the urban ecosystems and ecosystem services presented in the questionnaire on the basis of subjective preferences. Dividing the total willingness to pay among all the surveyed services of urban ecosystems according to the respondents' preferences allowed to compile a matrix containing the monetary equivalent of the value of all services of all surveyed ecosystems. In addition, a total demand curve was constructed and the total annual demand for urban ecosystem services was identified. Regression analysis was used to determine the dependence of individuals' payment decisions and payment amounts on sociometric indicators.

The total annual demand of the Estonian adult population for urban ecosystem services is 17.2 million euros. The amount of payment depends positively on the level of education and income. Women are also more willing to pay than men. The group with the highest willingness to pay consisted of individuals whose net monthly income exceeded 2,000 euros. Their average willingness to pay exceeded 28 euros, which is 165 percent compared to the average. Of the urban ecosystems, the respondents considered large parks to be the most important, followed by small parks and urban forests. Among the ecosystem services, the respondents considered the most important for the city to be air purification, oxygen production and the provision of recreational opportunities. Thus, for example, the service with the highest financial value, approx. 600000 eur/year, received the ecosystem service of large parks for the purification of urban air, and the service with the lowest value are nature education opportunities by the urban ecosystem „lawn strips by the roads and between lanes“, which received value approx. 125000 eur/year. It is worth noting that there is a relatively small difference in the monetary values of different services provided by different ecosystems. It can be noted that all urban ecosystems are important to respondents and their preferences depend to a large extent on the subjective tastes of individuals. In conclusion, the monetary equivalent of the value of urban ecosystem services, determined using the conditional valuation method, is a valuable input to ecosystem services statistics.

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