Comparison of methods for the valuation of the nature education ecosystem service

Kaia Oras (Statistics Estonia), Sjoerd Schenau (Statistics Netherlands), Patrick Bogaart (Statistics Netherlands), Kätlin Aun (Statistics Estonia), Grete Luukas (Statistics Estonia), Üllas Ehrlich (Tallinn University of Technology)

1 Purpose of the discussion paper on London Group 2021

In this paper we will discuss the feasibility of valuing the ecosystems service 'nature education', various options of the calculation and the meaning of the results from the viewpoint of the guidelines of the UN SEEA EA.

Nature education is one of the many services that ecosystems provide to societies as a cultural service. Whereas some valuation principles for several ecosystem services are already rather well-developed, not much attention has been paid to the principles of valuation of the provisioning of nature education as an ecosystem service. The System of Environmental-Economic Accounting –Ecosystem Accounting (SEEA EA) dvoes not provide detailed guidelines and recommendations on the topic. Therefore, several questions regarding the definition, scope and methods for quantification of this service have been considered in work we carry out currently. The topic was already discussed at a London Group meeting in 2019 and since then we have worked on the topic and would suggest possible valuation methodology.

2 Definition of the service and guidelines in UN SEEA EA

According to CICES v5.1 the cultural ecosystem service of nature education is described under code 3.1.2.2 - intellectual and representative interactions with natural environment. Based on the CICES classification the project group working on ecosystem services topics in Estonia has agreed on a following definition: "*The value of the ecosystem as an educational service provider is expressed by its ability to participate in nature education.*" The important criteria for the inclusion of the activity as an education ecosystem service was the direct association of the educational activity with the natural ecosystem. The ecosystem component was restricted to the nature education service provided directly in the ecosystem (i.e. the process of theoretical and practical learning of the relevant nature studies in which the information obtained from the ecosystem is involved). An indirect use, such as visiting a biodiversity/natural history museum is excluded from the scope. In the future also possibility to include the time debrief of the field visit would be analyzed.

The agreed scope of nature education service includes institutionally organized nature education, self-learning is not included. The distinction between formal nature education (e.g. during school classes) and informal or private nature education was not made.

The methodology to calculate the monetary value of ecosystem services including nature education ecosystem service has been developed during two grant projects and description of applied methodologies has been added to methodology reports of **2020** [1] and **2021**[2].

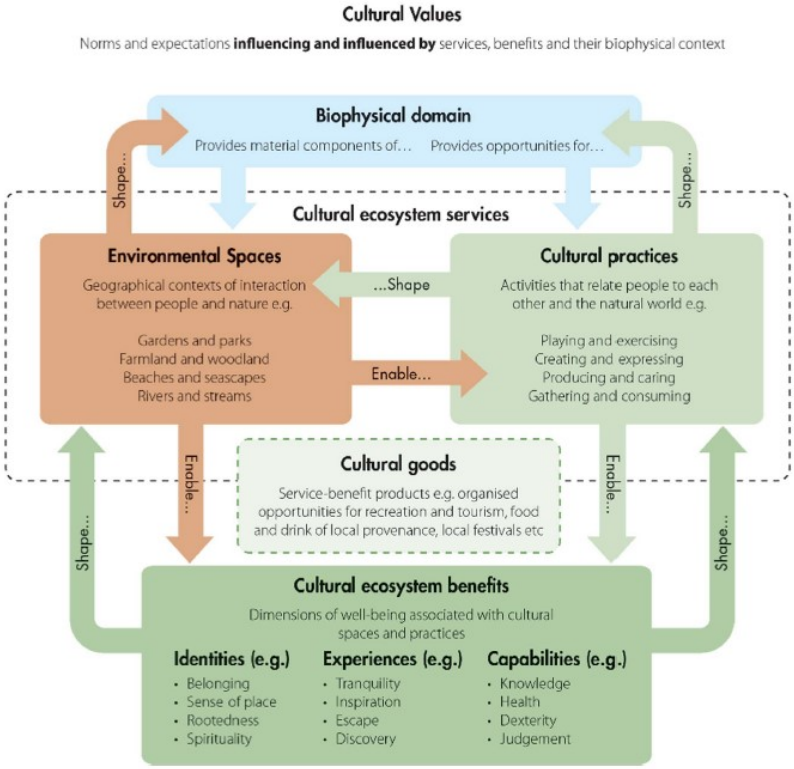
Several studies, for example Böhnke-Henrichs et al. (2013) and Fish et al. (2016) conclude that ecosystems are contributing just partially to the provisioning of cultural services (including educational) and that the challenge is to single out the part of the service that ecosystem contributes. An empirical

[1] Eurostat grant no 831254-2018-EE-ECOSYSTEMS, Statistics Estonia, Development of the land account and valuation of ecosystem services regarding grassland ecosystem.

[2] Eurostat grant no 881542— 2019-EE-ECOSYSTEMS, Statistics Estonia, Development of the ecosystem accounts.

framework provided by Fish et al. emphasizes that the ecosystem plays the role of the "enabler" and society plays the role of the "shaper" in supplying cultural ecosystem services. The framework is presented in Figure 1. This framework explains how to incorporate distinctive contributions of society and ecosystems in case of cultural (including nature education) ecosystem services. This ecosystems based approach supports both the conceptual complexity and varying geographical contexts. The framework is distinguished by its emphasis on the co-production and reciprocity of culture-nature relationships.

Figure 1. Incorporation the distinctive contributions of society and ecosystems in case of cultural (and also education) ecosystem services. Source: Fish et al (2016)



The System of Environmental-Economic Accounting –Ecosystem Accounting (SEEA EA) defines education, scientific and research services as follows: "*Education, scientific and research services are the ecosystem contributions, in particular through the biophysical characteristics and qualities of ecosystems, that enable people to use the environment through intellectual interactions with the environment. This is a final ecosystem service*." However, as the SEEA EA provides conceptual guidance, it does not provide clear guidelines and recommendations how to compile and value this particular ecosystem service. With regard to valuing cultural ecosystems, it is stated in SEEA EA: "*For cultural services, generally, it is necessary to consider their monetary valuation from a demand or consumption perspective. The most common methods for recreation related services are revealed preference methods based on the travel cost method, including payments for entry or related services. Methods for estimating the value of other cultural services include hedonic pricing where, for example the value of visual amenity services and local recreation services may be determined from the assessment of local house prices."* As the number of students and hours spent on nature sites were used as input data, it can be said that the guidelines of SEEA EA were followed and the monetary value of nature education service was considered from a consumption perspective.

3 Work done in Estonia on valuation of nature education ecosystem service

Among other cultural ecosystem services the distinctive feature of educational services is that the financial costs of providing an educational service are relatively well defined and can be expressed as a specific amount of money. This is valid for both public education expenditure and investments into infrastructure at sites of nature education, where the learning process takes place in direct contact with ecosystems. The role of the ecosystem in providing nature education can be evaluated in several ways.

Statistics Estonia has been testing both revealed and stated preferences based methods to approximate the value of the nature education service.

We think that the values of nature education as ecosystem service can be found using three revealed preferences based methods which are all based on actual expenditures that are made on mostly independent components of the ecosystem service:

1. **The monetary value of education**, calculated with the expenditure transfer approach is considered proportional to the cost that society spends to provide education and is attributed to the ecosystems on the basis of hourly lesson prices.
2. **Maintenance of nature sites**. This second expenditure approach is based on survey results and includes expenditures and investments made for maintaining nature sites for providing nature education and also sales revenue of companies which supply the nature education service but do not own or have expenditures for the maintenance of the sites.
3. **Travel costs**. This third approach includes only travel costs of students to reach the learning area.

Summation of all three separate values was considered appropriate if the double counting, if any exists, would be removed and, especially, if the three approaches are consistent with each other such that aggregation is meaningful.

3.1 Monetary value of education

Finding the monetary value of ecosystem education services through spending of institutional education is based on the assumption that general education is a public service aimed for creating and improving the quantity and quality of human capital. The measure of the value of education is thus an increase in human capital through education, which, however, is difficult to express in monetary terms. Given that the vast majority of education is free of charge to consumers, it can be classified as a non-market public good, whose monetary equivalent can be obtained by using non-market valuation techniques. One such is the incurred expenditure method, which is an indirect method of economic valuation of non-market goods and values. According to this approach, the monetary value of education is considered proportional to the cost to society of providing education. This approach follows the logic how general government production is calculated in the SNA (sum of all costs) and is therefore consistent with SNA. The disadvantage of the method is that the value of education calculated in this way is very likely to be lower than the value of human capital created by education. The strength of this method is that it is based on actual costs, which are well described in official statistics.

Available data allows the total cost of institutional education to be attributed to the ecosystem through its share of hours in contact with the ecosystem. An important assumption for this approach is that the trips of nature program should already be included in the official study programs so that time spent in direct contact with the ecosystem would make up a share of the total appointed curriculum of nature subjects in school. Our study does not fill this assumption very well as our data about nature trips was collected as an extracurricular or hobby school activities.

However, bearing this caveat in mind, calculations were made by applying the method to estimate the value of nature education service of Estonian ecosystems by the total cost of hours of being in direct contact with the ecosystem. According to the expenditure transfer approach, the financial equivalent of nature education service of Estonian ecosystems is approximately 6.62 million EUR per year. It was calculated as follows:

Nature education service value=a*b*c

where a - average time spent on nature studies directly in ecosystems (h);

b – number of students in nature education programs;

c – cost of one student hour, €. Calculated based on public expenditure on institutional education per year, number of students in institutional education (all levels considered) and average total number of lessons per student per year.

3.2 Expenditures related to site maintenance and sales

The second expenditure based method for valuing nature education as an ecosystem service, considers mainly (as the method described in previous chapter) that expenditures made to provide nature education service reflect the value that society is ascribing to the service. The expenditures of those providing the nature education service are considered as the value of service. This approach considers the expenditures of nature education service suppliers who own and maintain nature sites and also sails revenue of nature education service suppliers who do not own a nature site. Assumption was made that the sales revenues cover at least the expenditures made. These values are based on survey results.

Also SEEA EA guidelines regarding the SNA approaches of valuing non-monetary transactions (p 5.4.3) were considered. UN SEEA EA suggest that if market prices are not observable, valuation according to market price equivalents should provide an approximation to market prices. In such cases, market prices of the same or similar items when such prices exist will provide a good basis for applying the principle of market prices, provided the items are traded currently in sufficient numbers and in similar circumstances. This option is not relevant for educational service of the ecosystems. Where no sufficiently equivalent market exists and reliable surrogate prices cannot be observed, the SNA identifies a second-best procedure for use, namely, the cost of production approach (p 5.45), in which the value of the non-monetary transaction is deemed to be equal to the sum of the costs of producing the good or service, that is, the sum of intermediate consumption, compensation of employees, consumption of fixed capital (depreciation), other taxes (less subsidies) on production, and a net return on capital (2008 SNA, para. 6.125).

Discussions with the experts have revealed that considering the whole expenditure as ecosystem input is questionable, as it would represent the economic input to the production of the service (incidentally, although the ecosystem does ‘provide’ or supply the services). It has been also decided that it is important to distinguish the costs of the maintenance of nature education areas and providing facilities and the expenditures of service provision (specialized producers without the “real estate”). Expenditures data are available which reflect in some way the value that society is putting on the educational experience.

In order to calculate the total value of nature education service current expenditures, sales revenues and other incomes for supporting service providers were aggregated. Overlapping expenditure data was excluded as data taken into calculations was a) the current expenditures of service providers that own/manage nature sites, b) sales revenue and other income of service providers that use but do not own the sites. Total value of nature education service was ca 2 million euros according to the expenditures of the providers of nature education service.

3.3 Expenditures related to travel costs

The travel cost method has been used to estimate the value of the component of nature education associated with expenditure to reach the learning area. This method is usually used to value recreational uses of the environment. The model is commonly applied in benefit cost analyses and in natural resource damage assessments where recreation values play a role (Champ, et al 2003). The travel cost model

is a demand based model for expressing a demand for recreational site or sites. Although the demand for a site can be modelled as an aggregate or market demand, the common practice is to estimate demand function on the level of the individual and to calculate site values by adding up individuals` values for the site (Myrick Freeman III, 2003).

Although the travel cost based approach has been developed specifically to measure recreational value, our study attempts to use it to assess the educational value of the ecosystems. This is possible because visiting ecosystems for educational purposes also involves travel costs.

It is important to note that in this work, the estimation of the value of the ecosystem service of education based on travel costs is not a classic application of the travel cost method. Although actual travel costs are used to determine the monetary value of an ecosystem service, the approach used is not based on individual`s demand and the demand curve constructed on that basis.

According to the methodology, trip cost is the sum of expenses required to make a trip possible. Typical trip cost includes: travel cost, access fees, equipment cost and time cost (Champ, et al 2003).

In order to provide nature education in contact with the ecosystem, students usually travel by bus. The difference from the classical application of the method lies in the fact that the trip is not paid by the students but by the tour organizer, which is either a school or a hobby school (usually method uses individual expenditures). Typically, there are no access fees and equipment costs for any of such trips. Making calculations of time cost for students is also debatable because students have no income. Thus, travel expenses for students for educational purposes are the bus rental cost, typically paid by the tour organizer.

In Estonia, the cost of renting a bus suitable for student transportation depends on the duration of rental and not on the distance travelled. The total annual travel cost of providing institutional nature education in Estonia is 2.024 million EUR. It was calculated as follows:

Nature education service value=a*b

where a - average travel costs for one student (€);

b – number of students in nature education programs.

3.4 Combination of approaches

Different approaches for finding expenditures measure different components of the nature education service. In general we suggest that the values calculated with the expenditure transfer approach, expenditure based approach and travel cost could be summed as these describe different aspects of the service and different expenditures/costs are used as input. Also all three approaches can be regarded as a form of production, therefore by summing the values the total production of nature education value can be calculated. In our earlier study we suggested to use only the residual value of expenditure based approach and travel cost but after the last grant project it was agreed to sum up the full value of all three approaches as the expenditures made do not expand the output of ecosystem service but rather show how much the users are willing to pay for the service. The residual value concept is rather used for provisioning services, where human-made input is important to get the output (in order to get the output one must make expenditures, this is not the case for nature education service).

The value of nature education ecosystem service was 10.17 million EUR in 2019. The calculated value was distributed between ecosystem types using visitor rates and ecosystem composition of nature education sites. Final results by ecosystem types are presented in table 1.

Table 1. Monetary value of nature education service by ecosystem type, EUR

Ecosystem type	Value of the ecosystem service 2019, €	
Forest	4 276 697	
…oligo-mesotrophic boreal forests		1 267 194
…mesotrophic boreal forests		919 428
…eutrophic paludifying forests		534 985
…drained peatland forests		377 489
…oligotrophic boreal heath forests		301 647
…mixotrophic and ombrotrophic bog forests		275 393
…eutrophic boreo-nemoral forests		260 822
…eutrophic alvar forests		172 053
…minerotrophic swamp forests		99 626
…oligotrophic paludifying forests		63 929
…forest on reclaimed pits		4 133
Artificial area	2 333 923	
…other artificial areas		1 191 529
…buildings and facilities		620 020
…green space		522 373
Grassland	1 116 371	
…semi-natural grasslands		620 786
…cultivated grassland		480 464
…shrubbery		13 994
…heaths		1 127
Wetland	931 157	
…peat bogs		681 181
…transition mires		132 327
…fens		108 647
…abandoned peatlands		9 003
Cropland	869 168	
…crops		830 894
…horticultural land		37 824
…permanent crops		450
Inland waterbodies	579 776	
…lakes and ponds		476 733
…rivers and streams		103 043
Coasts	54 571	
Other	10 257	
Total supply		**10 171 920**

3.5 Productivity change method

Productivity change method (UN SEEA EA 9.37) would be an additional valuation option to explore as it is the most consistent with the way government productivity is defined. It would be interesting to see how the value found by productivity change method would be positioned among expenditure based methods already assessed.

According to SEEA EA (UN SEEA EA 9.37, page 194) "*the value of the service is derived in three stages. First, the marginal product (contribution) of the ecosystem service is estimated as the change in the value of production (1) consequent upon a marginal change in the supply (2) of the ecosystem service. Second, the marginal product is multiplied by the price of the marketed good to derive a marginal value product for the ecosystem services. Third, this marginal value product is multiplied by the physical quantity of the provided ecosystem service to obtain the value of the ecosystem service*."

According to the SEEA EA (p. 194) the productivity change method could be used for provisioning ecosystem services. The question is to what extent it can applied to cultural services as well.

Some relevant questions that need to be addressed are:

1. *What should be considered as the value of production(1) and the supply (2) of the ecosystem service in case of nature education? Is this value of production equal with the monetary value of nature education ecosystem service, and is the supply of the ecosystem service equal with the total hours spent on nature studies directly in ecosystems or something else?* — Education is provided by the government; according to the SNA 2008 (System of National Accounts 2008 6.130, page 169) production by the government sector of non-market services is by definition equal to all expenses. Therefore, the production value of education is equal to the expenditure of education. The share of nature education within all of education (expenses) can therefore be interpreted as the supply of this ecosystem service.
2. *How to calculate the change in production and in the supply in order to calculate the marginal product?* — This will depend on the type of nature education. If it is extra-curricular, then educational expenses could be broken up into fixed costs (related to school buildings etc.) and variable costs (e.g. wages) and, assuming that the extracurricular activities require no additional fixed costs, the variable costs can be taken as marginal expenditure and hence marginal production. If nature education is part of the curriculum, then, given the fixed volume of education in terms of time, it would make more sense to distribute the fixed costs across all educational activities and thus assume a constant marginal production that is equal to the share of the activity in terms of time.
   For the other components the situation is different: e.g. for maintenance costs (3.2) a production value is being already used and for travel costs (3.3) it can be assumed that travelling to nature education sites can be considered as additions to the normal operation of travel companies, and thus the production value can be regarded as marginal production.
3. *This example involves three different expenditure approaches summed up. Should the productivity change method be used for all three approaches separately (using the same input data) and results should be summed up to get the total value, or should the method be used once (without considering different expenditures) to calculate the value of nature education ecosystem service?* — It can be argued that in all three components of nature education a definitive “marginal production value” can be identified. Because of the differences between the nature of that production and the degree to which it is “marginal” differs between the components, the (marginal) production should be computed separately and only then summed up.

Summarizing, it can be argued that (i) the (marginal) production value of all three components of nature education can be defined and quantified, such that the production change method can be applied to this ecosystem service, and (ii) that this value and method is entirely consistent with the three expenditure based revealed preference methods, and (iii) productivity change method and expenditure based approach will yield identical values.

3.6 Stated preference method

As a stated preferences based method, the contingent valuation method (CVM) was used. Stated preference method is widely used in estimating the non-market values of nature. The strength of the method is that it measures welfare that ecosystem services provide to individuals. The disadvantage of the method is that it does not provide exchange values which can be compared to SNA data, which currently makes the integration of the values found by this method difficult with environmental accounting.

Stated preference method was used to assess the values of the ecosystem services of following ecosystems: grassland, forest, wetland and urban ecosystems. In order to evaluate the non-market values of services of these ecosystems, independent CVM studies were performed, one for each ecosystem. In order to assess several non-market services of one ecosystem in one CVM survey, respondents were asked to rank the given ecosystem services according to their subjective importance

in addition to their declaration of willingness to pay. Based on the preferences received, the declared willingness to pay for ecosystem services was divided between the individual services on the list. Ecosystem services that were included in the survey varied according to the ecosystem, for example forest ecosystem survey included services such as photosynthesis (oxygen production), air and water purification, climate regulation, habitat supply for biological species, preserving soil fertility, ensuring landscape diversity, enabling pollination and honey collection, provision of genetic resources and medicinal plants, provision of berries, mushrooms, providing opportunities for environmental education and providing recreation and leisure opportunities services. The sample sizes used for the CVM studies are shown in Table 2. The sample structure was representative of the Estonian adult population.

Table 2. Performed CVM studies and their corresponding sample sizes

Ecosystem	Number of responses to be considered	The share of positive payment decisions, %	Total willingness to pay, million EUR/year
Forest	660	90	23.9
Bog	400	89	12.3
Urban	720	91	17.3
Grassland	414	82	18.8

The willingness to pay (WTP) value of nature education ecosystem service was estimated for forest, wetland, urban and grassland ecosystems. The results can be seen in Table 3. Total WTP value of nature education service was 4.9 million EUR in 2019.

Compared to the nature education ecosystem value calculated with expenditure approaches the WTP value is quite small but it has to be considered that it does not include all ecosystem types but forest ecosystem has probably the highest value and it is included.

Table 3. WTP values of nature education ecosystem value, 2019, million EUR

Ecosystem	WTP value
Forest	1.4
Bog	0.9
Grassland	1.3
Urban	1.3
Total	**4.9**

4 Discussion and proposal

Nature education ecosystem service value was calculated with exchange and welfare based methods. Exchange based methods included expenditure approaches that measured different costs that were payed to produce nature education ecosystem service. Total value was equal to the sum of all costs. Only the nature education service provided directly in the ecosystem was included and preparation time and coverage of the subject in the classroom was not considered. Possibility to include the time debrief of the field visit would be analyzed in the future as these hours also contribute to the “production” of nature education service.

Welfare based method was calculated using the results of willingness to pay survey. It was seen that the ecosystem service value of WTP was much lower than that of expenditure approaches (4.9 and 10.2 million euros respectively).

The values derived with exchange and welfare based methods cannot be summed up as these might overlap in some aspects but also because the focus and logic of these methods are different. But both methods provide important information – exchange based methods show how the society has paid in monetary terms for the service and changes in WTP reflect people’s changing valuation of the educational aspect of nature. This could be explored more in detail in the feature because of its potential value for policy development (e.g. more attention to nature education in the curriculum).

4.1 Proposal

We propose that the production change method provides a consistent and coherent approach to expenditure based revealed preference methods for ecosystem service valuation. Since it can be argued that the production change method has a stronger theoretical foundation than the (sometimes ad-hoc) expenditure based methods, we propose to use this as the preferred method for these cultural ecosystem services where it can be applied. These would be limited to those services where either commercial activities or government expenditure are the major components of economic value.

In case of natural ecosystems the CVM results could remain in as background information, - the values are rather low. More effort should be invested in analysing how this information relates to the exchange based method, and how monetary values can be combined.

5 References

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