Recreation ecosystem service, calculation of the contributions from different ecosystems

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Introduction and the scope of the paper

Rather straightforward way to quantify actual supply of the recreation ecosystem service and the allocation of the values to ecosystem types is introduced. Advantages compared to one of the alternative service concepts is given. Drawbacks of the method are also outlined.

The ecosystem recreational ecosystem service is defined as opportunities for enabling nature related tourism/recreation. The ecosystem service can be expressed as a number of visits or stays, walked/biked/hiked kilometres, time spent on different sport activities taking place in natural areas, also fishing or hunting. In addition to knowing the total number or average of the above-described indicators, the contribution of different ecosystem types to the indicator is also necessary and an important step while compiling accounting for the ecosystem service. Knowing the ecosystem contribution of ecosystems by type or location gives more useful data and is also the basis of the supply table of ecosystem services by ecosystem types.

In this paper recreational ecosystem service is discussed from the point of view of the end users – households and non-residents – as beneficiaries and the indicator to represent the service is defined as visits for recreational activity to registered recreation areas and trails which are managed by State Forest Management Centre and Estonian Health Trails Foundation. The paper describes a method how ecosystem contribution could be allocated to ecosystem types when visitation data is location based. Recreation service in monetary values is used as an example, but the approach can be applied regardless the unit of measurement. In the study, monetary value of recreation, which was found by time use method (read further in ANNEX 1), was allocated to ecosystem types based on data of visited locations (trails) and their visitation rates. The method used for the allocation of the values to ecosystem types is rather straightforward and reflects the actual supply of the service in the ecosystem types where it is used. The biggest drawbacks of the method are data availability and the need for high computational power which increases with the size of the analysed area.

There are different approaches how the service itself and the contribution of ecosystem assets can be assessed. One of the alternatives is given in the new proposed module of ecosystem accounts for Regulation (EU) No 691/2011, where the service is defined as the number of overnight stays in hotels, hostels, camping grounds, etc. that can be attributed to visits to ecosystems as an indicator for nature-based tourism-related services. Eurostat has proposed using the presence of accessible and attractive ecosystems found by applying Recreation Opportunity Spectrum (ROS) developed by JRC[2] in the respective administrative units to isolate ecosystem contribution. The service is then proposed to be spatially allocated to ecosystem types by the relative extent of ecosystem types in ROS accessible and attractive ecosystems. The methods for finding ecosystem contribution and spatial attribution in itself can be applied also to other indicators of recreation.

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[1] This work has been a joint effort of environmental accountants of Statistics Estonia, Statistics Netherlands and scientist of Tallinn Technical University.

[2] Zulian, Grazia & Polce, Chiara & Maes, Joachim. (2014). ESTIMAP: a GIS-based model to map ecosystem services in the European Union. Annali di Bottanica. 4. 1-7. 10.4462/annbotrm-11807.

Spatial analysis of recreational visitations

Contribution of ecosystem types to the service value was found by performing spatial analysis. First, information on visitation rates and spatial data of nature recreation sites was collected. Acquired spatial data included:

a) Spatial data for health trails in Estonia (provided by NGO Estonian Health Trails Foundation),
b) Spatial data for recreation areas which are managed by the SFMC.

Initially spatial data was received as polyline type of data which we converted to polygon type of data by additionally creating buffer zones of up to 20m. Data for recreation areas from the State Forest Management Centre was initially obtained as polyline, point and polygon data.

Data for recreation areas and trails from the State Forest Management Centre and Health trails from NGO Estonian Health Trails Foundation was treated by creating buffers around the object with radii of 500 m to account for the areas/ecosystems that support nature recreation service at the site but do not necessarily intersect with the site/trail directly. In the process SMFC point and line objects were converted to polygons.

The health trails related to the provisioning of recreation service was obtained from webpage terviserajad.ee which both needed to be separately digitized and/or corrected. Estonian Health Trails Foundation is a private (sponsored) NGO that manages and maintains more than a hundred health tracks in different parts of Estonia. The trails are mainly located on a state land. They also keep track of attendance, using counters in a few dozen tracks. For the remainder of the trails, the number of visitors were estimated by experts from Estonian Health Trails Foundation.

In the calculations of the supply of the service, three different categories of trails/areas were distinguished based on visitation rates and time spent on the location: SMFC trails in nature areas, Health Trails in nature areas and Health Trails in urban areas which obtained different values (Table 1). According to the SFMC estimations, 2.6 million people crossed their managed nature trails in 2019. 0.58 million people visited the trails which are managed by the Estonian Health Trails Foundation in nature areas and 3.3 million people visited the trails in urban areas in 2019.

The trails were separated into the three categories and monetary value of recreation service for each category was calculated (read further in ANNEX 1 about monetary valuation of the service). The value found for each category was further divided between the objects of one category based on weighted distribution by object area (area of the polygon of the trail with its buffer), i.e. the value for each trail of SMFC was calculated as a share from 84.5 million euros based on the area of the trail polygon, 18.8 million euros was distributed between trails of NGO Health Trails in nature areas and 32.2 million euros between trails of NGO Health Trails in urban areas. Separating the trails into categories and applying weighted distribution for the trail objects by area was adopted instead of weighted distribution by number of visits because of the differences in the detail of the visitation data. The latter could have provided more accurate results but applying weighted distribution for the trail objects by area was also found to be a good approximation.

Table 1. Monetary value of recreational ecosystem service, 2019 €

	Number of visits	**Time spent on visit and transportation (h)**	**Monetary value of leisure time (€/h)**	**VALUE of the service (thousand €)**
SMFC trails in nature areas	2 600 000	5	6.5	84 500
Health Trails in nature areas	578 600	5	6.5	18 805

Health Trails in urban areas	3 297 500	1.5	6.5	32 151
TOTAL				135 455

By overlaying the ecosystem unit base map and nature recreation sites/trails data (with buffers), the values were further allocated to ecosystem assets that intersect with the buffered site/trail object based on the share of the area of ecosystem assets. Trails can pass through or neighbour very different map units, therefore some of the linear map units were excluded as service supplying ecosystems, e.g., roads, railroads, powerline and some map units were limited to contribute to the supply of service only in the buffer radius (i.e., 500 m), such as rivers, ditches, forest rides.

Ecosystem service value of recreation by ecosystem types was obtained by summing the individual values of each asset belonging to ecosystem type. The results are presented in Table 2. More detailed results can be seen in ANNEX 2. The spatial allocation of unit values of assets is shown in Figure 1.

Table 2. Ecosystem service value of recreation by ecosystem types in 2019.

Ecosystem type	**Value of the ecosystem service 2019, thousand €**
Forest	65 315
Grassland	13 478
Cropland	13 832
Wetland	21 787
Artificial area	8 963
Coasts	899
Inland waterbodies	11 033
Other	149
Total supply	135 455

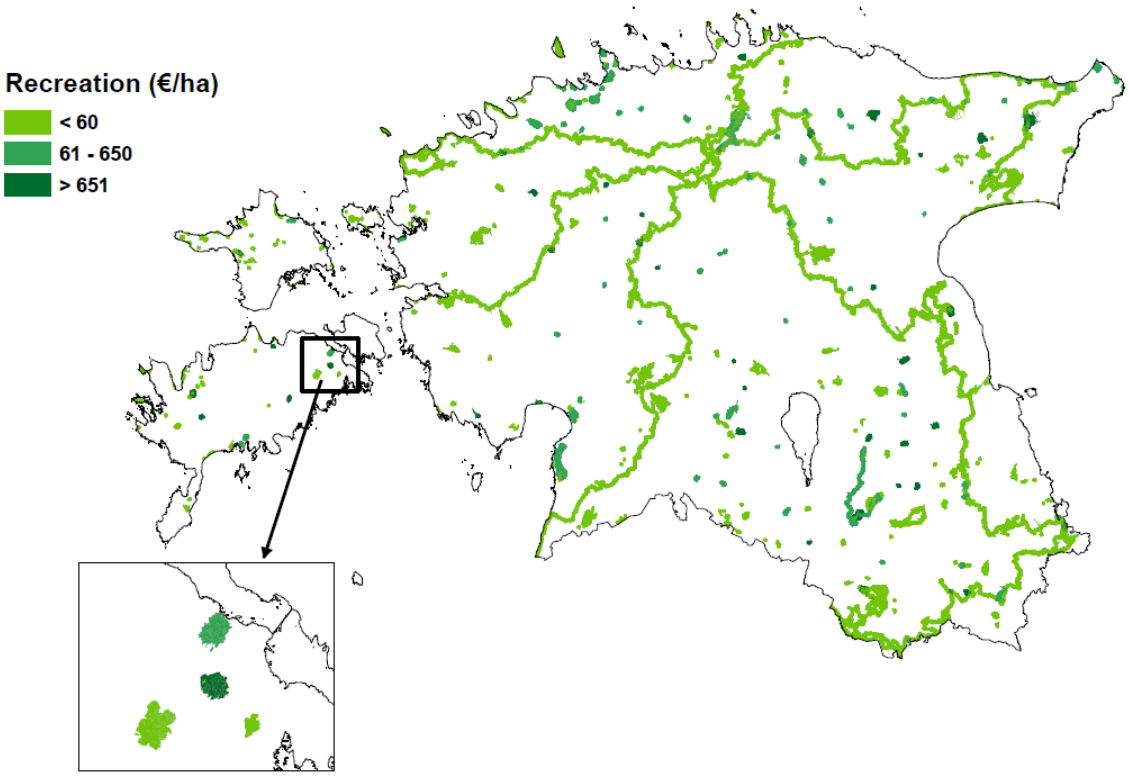

Figure 1. The ecosystem service provisioning areas and values of recreation service. The areas coloured from blue to red represent service provisioning areas according to the unit value (€/ha) supplied by ecosystem assets that was found by valuation of time use. Areas coloured white represent areas (ecosystem assets) that do not supply the ecosystem service in the current scope of the study.

Discussion and conclusion

The used method uses detailed visitation data on visited areas and their visitation rates. As so, it reflects the actual supply of the service in the ecosystem types where it is used. Using visitation data makes it a rather straightforward method compared to, for example, finding recreation service potential which is derived from ecosystem-based potential and applying distance modelling between the supply (considering only high-quality recreation service areas) and demand locations as is described by Vallecillo et al. (2019)[3]. The spatial analysis in the proposed method of using visitation data requires some computational power and knowledge of GIS analysis, but much less than approaches that use distance modelling etc.

The modelling approach can also more easily generalize the data and could lead to misinterpretations. For example, the method proposed by Eurostat[4], where ecosystem contribution is found by the share of accessible and attractive areas in administrative units based on Recreation Opportunity Spectrum (ROS), provides a rather high number of visitations and also somewhat distorted distribution of the service supply from ecosystem types in a way that service supply is not attributed to locations in certain

[3] Vallecillo, S., La Notte, A., Zulian, G., Ferrini, S., Maes, J., 2019. Ecosystem services accounts: Valuing the actual flow of nature-based recreation from ecosystems to people, Ecological Modelling, Volume 392, 2019, Pages 196-211, ISSN 0304-3800, https://doi.org/10.1016/j.ecolmodel.2018.09.023.

[4] Eurostat, Unit E-2: Environmental statistics and accounts; sustainable development. Recreation-related ecosystem services. Third proposal. Task force on ecosystem accounting 15-16 September 2022.

ecosystem types where people actually spend time in nature. According to methodology based on visitation data just half of the recreation services could be attributed to forest ecosystems while in case of modelling based on nature tourism, around 80%. Please have a look at the datasets in Annexes 2 and 3 for comparisons. The assumptions are the source of the problem: the indicator overnight stays include the overnight stays in the cities, but ROS accessible and attractive areas do not include settlements and their green areas, due to which the number of overnight stays in cities are actually attributed to natural ecosystems outside the cities. This does not reflect the real situation because cities by default do not include ROS attractive natural areas, meaning people have no contact with these and not all people accommodated in the city travel outside the city during that specific trip. Hence, regarding the methodology using accommodation data, we are of the opinion that this is quite arbitrary attribution of the actual turnover to ecosystems, and it has little to do with the real value of ecosystems (= the monetary equivalent of the well-being raised by ecosystems).

It may be considered that visitation data already includes the info on the areas that visitors deem attractive or suitable for recreation and their accessibility. However, as the method is not based on the condition, naturalness nor recreational potential of ecosystems, estimating the changes in the dynamic of the provided service in relation to the ecosystem condition, capacity and its resilience to the stress would be difficult. In this regard visitation data can only show the delayed effect of decreased visits regarding the sustainable use of ecosystems but the causes may stay hidden without further analysis.

Coming back to the main idea of wanting to capture the actual supply of the recreation service, then the biggest drawback when applying the proposed method is the availability of the visitation data. When the data is available, the proposed method is generally a good approach between comprehensibility and complexity to find the contribution of ecosystem types to the actual supply of the service.

ANNEX 1. Monetary valuation of recreational ecosystem service using time use method

Ecosystems provide attractive environments for leisure activities. The ecosystem recreational ecosystem service is defined as opportunities for/enabling nature related tourism/recreation. In this report, we discuss recreational ecosystem service from the point of view of the end users – households and non-residents – as beneficiaries and the service is defined as visits for recreational activity to registered recreation areas and trails (State Forest Management Centre, Estonian Health Trails Foundation).

The most widely used method for the economic evaluation of ecosystem recreational service is the travel cost method (e.g. Champ et al. 2003), which is based on the individual expenditures of the recreational service users. The limiting factor of using the travel cost method is that the consistent implementation of the method requires a large number of users of the recreational services to be interviewed.

Another possible approach to estimate the ecosystem service value of a recreational service is valuation by time use. This approach is based on the assessment of the monetary value of the time involved in using the service and assessing the monetary value of time for ecosystem service. The use of the time-based method requires data on the number of users of the recreational service, the time spent on using it and monetary value of an hour of leisure time.

Estimations of monetary value of time are most often encountered in cost-benefit analysis of transport projects where time saving is an important factor (Meunier, Quinet, 2014)[5]. Various studies have quantified travel time unit costs and the value of travel time savings, based on analysis of business costs, traveller surveys, and by measuring behavioural responses by travellers faced with a trade-off between time and money. For example, when offered the option of paying extra for a faster trip (Transportation cost…)[6]. However, the use of the monetary value of time is not limited to transport projects, but is also applicable to the evaluation of other time consuming activities and associated values.

When evaluating a recreational ecosystem service, using time value, the monetary value of the leisure (non-working) time must be first determined. While the value of working time is generally related to the individual's income, different approaches are used to determine the value of leisure time. There are two approaches for monetary valuation of leisure time, which are either subjective valuation of people to the value of their leisure time or a fixed percentage of the value of working time which is associated with income.

For finding the average time value, we used data from the European Union conducted study within the Heatco project analyzing the practice of cost-benefit analysis in 25 EU countries (Heatco 2006)[7]. The corresponding value for Estonia is 4.99 €. The calculations in current study are based on the value of Heacto's recommended time plus one-third due to GDP growth during last ten years. Thus, the monetary value of one hour leisure time used in the following calculations is equal to 6.5 €.

Estonia has an extensive system of hiking and health trails. Considering the population density in Estonia, hiking and exercise and sports tracks (so called health trails) can be divided into two categories: those in densely populated areas (urban) and those in less densely populated areas (nature). In the case of urban health trails, the time taken to get to and from the trail is one hour, plus the time spent on the trail is 0.5 hours. The duration of one visit to trails which are in nature is considerably longer. For

[5] David Meunier, Emile Quinet. Value of Time estimations in Cost Benefit Analysis: the French experience.. Transportation Research Procedia 8 (2015) 62-71.

[6] Transportation Cost and Benefit Analysis II – Travel Time Costs. Victoria Transport Policy Institute (www.vtpi.org).

[7] Heatco. Developing Harmonised European Approaches for Transport Costing and Project Assessment. Deliverable 5 Proposal for Harmonised Guidelines. (2006). [WWW] http://heatco.ier.uni-stuttgart.de/

nature trails, it takes a total of 3 hours for a visit (1.5 hours at one end) and an average of two hours on the trail.

In case, when the recreational value of ecosystems is calculated only using the time spent in contact with nature (excluding travel time), the average time-based monetary value per visit is 3.25 € (0.5 h*6.5 €) for urban trails and 13 € (2 h* 6.5 €) for nature trails.

According to the SFMC estimations, 2.6 million people crossed their managed nature trails in 2019. 0.58 million people visited the trails which are managed by the Estonian Health Trails Foundation in nature areas and 3.3 million people visited the trails in urban areas in 2019.

Table 3. Monetary value of recreational ecosystem service, 2019 €

	Number of visits	**Time spent on visit and transportation (h)**	**Monetary value of leisure time (€/h)**	**VALUE of the service (thousand €)**
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Health Trails in urban areas	3 297 500	1.5	6.5	32 151
TOTAL				135 455

The time use based recreational value, calculated on the basis of SFMC nature trail visitors is approximately 84.5 million €. The time use based value of recreational service considering trails which are managed by the Estonian Health Trails Foundation is 51 million €.

Adding up the total time spent on the tracks which are managed by the SFMC and the Estonian Health Trails Foundation, we get 135.5 million €. Thus, using the time value 6.5 €/hour, the annual value of the ecosystem recreational service in Estonia is estimated to be 135.5 million €.

ANNEX 2. Ecosystem service value of recreation by ecosystem types, national methodology in 2019.

Ecosystem type	Percentage of the value, %	Value of the ecosystem service 2019, thousand €	
Forest	48.2	65 315	
…drained peatland forests	5.1		6 966
…mesotrophic boreal forests	11.5		15 515
…eutrophic alvar forests	1.3		1 771
…oligotrophic boreal heath forests	2.5		3 372
…oligo-mesotrophic boreal forests	15.6		21 129
…oligotrophic paludifying forests	0.7		953
…minerotrophic swamp forests	1.3		1 811
…eutrophic boreo-nemoral forests	2.1		2 871
…mixotrophic and ombrotrophic bog forests	3.2		4 316
…eutrophic paludifying forests	4.7		6 413
…forest on reclaimed pits	0.1		198
Grassland	10.0	13 478	
…cultivated grassland	3.7		5 054
…heaths	0.1		97
…semi-natural grasslands	5.9		8 049
…shrubbery	0.2		278
Cropland	10.2	13 832	
…horticultural land	0.1		150
…crops	10.1		13 652
…permanent crops	0.0		29
Wetland	16.1	21 787	
…fens	1.9		2 574
…transition mires	1.2		1 596
…peat bogs	12.8		17 388
…peat extraction sites	0.1		130
…abandoned peatlands	0.1		99
Artificial area	6.6	8 963	
…green space	0.9		1 193
…buildings and facilities	1.0		1 381
…other artificial areas	4.7		6 389
Coasts	0.7	899	
Inland waterbodies	8.1	11 033	
…lakes and ponds	7.0		9 539
…rivers and streams	1.1		1 494
Other	0.1	149	
Total supply	100.0		135 455

ANNEX 3. Nature-based tourism-related service supply by ecosystem types, illustration of the methodology proposed by Eurostat[8]

Region	**Estonia (EE0)**			
Step 1: Tourism statistics by degree of urbanisation				
		Total stays	Reporting country	Foreign country
Total		6.630.315	2.455.763	4.174.552
Cities		3.694.497	*724.085*	*2.970.412*
Towns and suburbs		1.318.923	*604.484*	*714.439*
Rural areas		1.616.895	*1.127.194*	*489.701*
Step 2: Ecosystem contribution				
Default: presence of ecosystems				
Recreation opportunity spectrum				
	% surface ROS categories 5-6-8-9	Total stays	Reporting country	Foreign country
Total	58%	3.855.914	1.428.169	2.427.745
		Percentage	58%	58%
Alternative: degree of urbanisation				
	Ecosystem contribution			
	Percentage	Total stays	Reporting country	Foreign country
Cities	20%	738.899	144.817	594.082
Towns and suburbs	60%	791.354	362.690	428.663
Rural areas	90%	1.455.206	1.014.475	440.731
Total		2.985.459	1.521.982	1.463.477
Percentage		45%	62%	35%
Step 3: Step 3: Ecosystem types (starting from default option step 2)				
Option 1: weighted distribution based on ROS				
		Total stays	Percentage of total	
Supply				
Settlements and other artificial areas		0	0%	
Cropland		0	0%	
Grassland (pastures, semi-natural and natural grassland)		360.796	9%	
Forest and woodland		2.716.702	70%	
Heathland and shrub		17.443	0%	
Sparsely vegetated ecosystems		766	0%	
Inland wetlands		312.913	8%	
Rivers and canals		9.589	0%	
Lakes and reservoirs		430.094	11%	
Marine inlets and transitional waters		0	0%	
Coastal beaches, dunes and wetlands		7.612	0%	
Marine ecosystems (offshore coastal shelf and open ocean)		0	0%	
Use				
Exports		2.427.745	63%	
Household final consumption		1.428.169	37%	
		3.855.914		
Option 2: uniform distribution				
		Total stays	Percentage of total	
Supply				
Settlements and other artificial areas		0	0%	
Cropland		0	0%	
Grassland (pastures, semi-natural and natural grassland)		393.186	10%	
Forest and woodland		2.955.949	77%	
Heathland and shrub		11.181	0%	
Sparsely vegetated ecosystems		466	0%	
Inland wetlands		247.722	6%	
Rivers and canals		4.072	0%	
Lakes and reservoirs		239.198	6%	
Marine inlets and transitional waters		0	0%	
Coastal beaches, dunes and wetlands		4.139	0%	
Marine ecosystems (offshore coastal shelf and open ocean)		0	0%	
Use				
Exports		2.427.745	63%	
Household final consumption		1.428.169	37%	
Total		3.855.914		

[8] Eurostat, Unit E-2: Environmental statistics and accounts; sustainable development. Recreation-related ecosystem services. Third proposal. Task force on ecosystem accounting 15-16 September 2022.