Estonian Environment Agency

Report on the assessment methodology of ecosystem services in the CleanEst project

Compiler:

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The methodology for mapping of ecosystem services of marine and inland waters has been developed in Estonia in 2016 in the cooperation of Peipsi CTC, University of Life Sciences, Tallinn University, University of Tartu, Estonian Environment Agency, SEI Tallinn and Norwegian Institute for Nature Research (Kosk et al., 2016)[1]. In that project the most important ecosystem services provided by water bodies were selected, matrices for a quick evaluation of the provision of services and indicators for mapping various aspects of the services were developed. In the CleanEst project that methodology is taken as a reference, it will be developed further and applied on selected water bodies in the Viru sub-catchment. The methodology for mapping of ecosystem services will be extended to include also socio-economic assessment along with the assessment of the monetary value of services. The selection of water bodies includes those, which will presumably experience a change in the provision, consumption and value of ecosystem services because of project actions.

The classification of ecosystem services in Kosk et al. (2016) is based on the most widely accepted classification of ecosystem services, developed by the European Environmental Agency, the CICES classification[2]. That classification is required to be used in LIFE projects also by the European Commission[3]. Since the work of Kosk et al. (2016), a newer CICES classification (v5.1) has been published. Therefore, the newer classification is used in the CleanEst project and the list of ecosystem services provided by water bodies has been adjusted compared to Kosk et al. (2016). In the initial stage of the CleanEst project the focus is on the development of the assessment methods for services provided by riverine ecosystems, as these make up the largest share of water bodies affected by the CleanEst project. In the next stages also the assessment methods for lacustrine ecosystem services will be developed. Assessment methods for marine ecosystem services will not be developed in the CleanEst project, due to the scope of the CleanEst project. Most adjustments in the list of riverine ecosystem services compared to Kosk et al. (2016) include merging or dividing services. In addition, some services, thought to be relevant enough, but absent from the list, have been added (Table 1). Because of these modifications, the list of relevant ecosystem services provided by riverine ecosystems has increased from 16 to 22.

Table 1. Differences in the list of relevant riverine ecosystem services between the CleanEst methodology and Kosk et al. (2016) methodology

CleanEst methodology	**Kosk et al. (2016) methodology**	**Justification**
Animal and plant material collected for the purposes of maintaining or establishing a population	Not included	Fish and crayfish collection both for relocation or breeding is practiced actively in Estonia.
Provisioning service: Surface water used for aquaculture	All non-drinking uses of water are lumped together as the provisioning service: Surface water used for non-drinking purposes	There are clear differences in the provision of these two services depending on the water quality
Regulating and maintaining service: Regulation of the chemical condition of freshwater by buffer zones on shores	Not included	In the CleanEst project ecosystem services should (according to the project proposal) be assessed on the shores of water bodies as well.
Regulating and maintaining service: Maintaining alluvial soil formation	Not included	In the CleanEst project ecosystem services should (according to the project proposal) be assessed on the shores of water bodies as well.

[1] https://www.kik.ee/sites/default/files/uuringud/empost_aruanne_all.pdf
[2] https://cices.eu/
[3] https://ec.europa.eu/easme/sites/easme-site/files/life_ecosystem_services_guidance.pdf

Regulating and maintaining service: Dilution and meditation of wastes or toxic substances in groundwater	Not included	It is provided by karstic rivers and the karstic River Erra receives attention in the CleanEst project
Regulating and maintaining service: Maintaining drainage water discharge	Not included	The service is highly relevant in Estonia
Cultural service: Conditions supporting active recreation	All active and passive means of recreation (excl. recreational fishing and crayfish catching) are lumped together as the cultural service: Conditions supporting recreation	Distinguishing these two services simplifies the assessment of the provision and consumption of these services, because of several forms of recreation that would otherwise have to be taken into account under a single service.
Cultural service: Conditions supporting passive recreation	All active and passive means of recreation (excl. recreational fishing and crayfish catching) are lumped together as the cultural service: Conditions supporting recreation	Distinguishing these two services simplifies the assessment of the provision and consumption of these services, because of several forms of recreation that would otherwise have to be taken into account under a single service.
Cultural service: Conditions supporting recreational fishing and crayfish catching	Considered as separate services: Conditions supporting recreational fishing and Conditions supporting crayfish catching	Treating crayfish catching as a separate service is not justified, as it is too insignificant practice in Estonia.
Cultural service: Conditions that enable aesthetic experiences	Conditions that enable aesthetic experiences and inspiration for creative work were lumped together as a single service	Distinguishing these two services is justified as CICES v.5.1 lists them separately the consumption of these two services is clearly different.
Cultural service: Maintaining protected and vulnerable species	Regulating and maintaining service: Maintaining the habitat of protected and vulnerable species	The main motivation why certain species are declared protected is their bequest value, which is not always directly correlated to how endangered or crucial for the functioning of the ecosystem they are.

In Kosk et al. (2016) the DPSIR indicator system from the European Environmental Agency was suggested to be used for mapping of ecosystem services. It consists of five interconnected indicator blocks:

- D – driving force;
- P – pressure;
- S – state;
- I – impact;
- R – response.

These indicators are connected in the following way: the demand for a service or the driving force (D) initiates the consumption of or the pressure (P) on the service, which causes changes in the provision or state (S) of the service. That manifests in the ecosystem, changes the processes taking place in the ecosystem (as well as its structure and functions), which provide services to the society. If a service loses its value for the society, the well-being of the society suffers and that is measured with the impact indicator (I). If the change in provision or state of the ecosystem and its impact has been detected, measures of response (R) can be taken. The reason for taking measures is to decrease the pressure (P) on or the consumption of the service caused by the driving force (D). That cycle enables the ecosystem and it services to restore in a way that benefits can increase (Figure 1).

In the current methodology, the indicator system has been simplified and the indicators for the driving force, impact and response have been left out and only the status (provision) and pressure (consumption) indicators are considered. These two are the most essential for characterising the functioning of ecosystem services and data for these indicators is either readily available or is obtainable with more or less effort. The indicators for driving force should reflect the demand for a service. As the data on these indicators is lacking in Estonia and it is not possible to measure these as water body specific, then including these in the current methodology is not rational. The impact indicators are not dealt with as it is basically impossible to measure the direct and discrete impact for the society of some, especially regulating and maintaining and cultural services. The response indicators are also not considered.

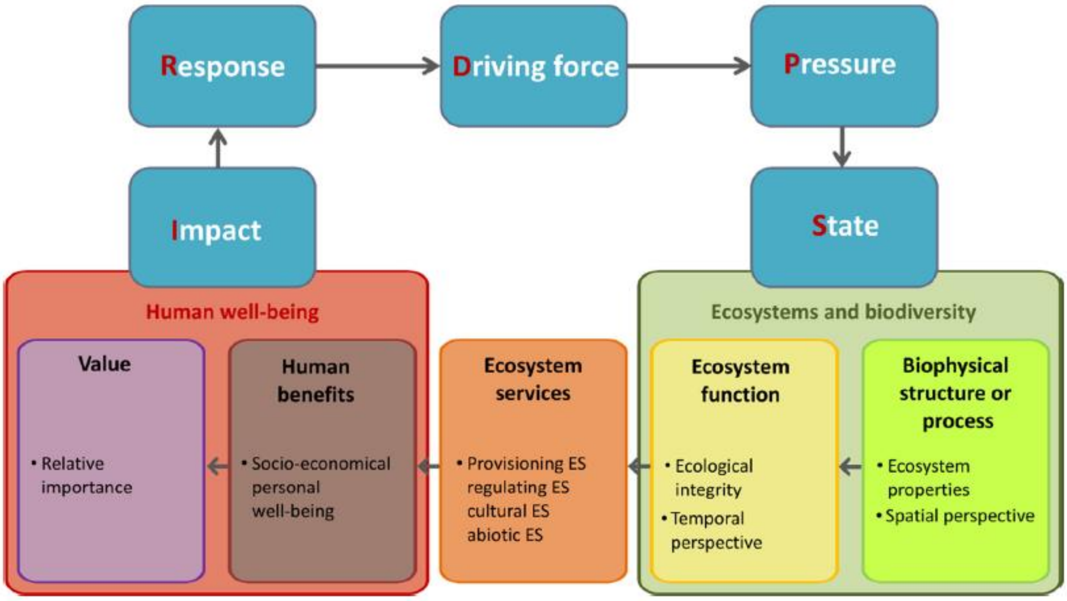

Figure 1. The connection between DPSIR environmental indicators system and ecosystem services (Kosk et al. 2016, ref. Mononen et al, 2015[4]).

Therefore, the PS-indicators are interpreted in the assessment of ecosystem services in the CleanEst project as follows:

- P-indicator characterises the pressure on the service and/or the amount of consumption of the service. For provisioning and cultural services, that indicator is therefore called as the consumption indicator. For the maintaining and regulating services, that indicator measures only the anthropogenic pressure on the functioning of that service and not the consumption component. The reason is that there is no direct human consumption of maintaining and regulating services, as the benefits provided by these services assure a suitable environment for human existence in general. In fact, the consumption of a service indicates anthropogenic pressure on a service as well, as too intense consumption could wear the service out, but for the sake of comprehensibility and usage of economic terms, the indicator is called consumption indicator for the services with measurable consumption.
- S-indicator characterises the status of the service or the provision or the service or the functioning of the service. The better the status of the service, the better it functions and the higher is its provision. For the sake of comprehensibility and usage of economic terms, the indicator is called as the provision indicator for all services.

According to the indicator classification of the European Commission funded MARS project[5] the S-indicator corresponds to the *Capacity* indicator, which shows the potential of the ecosystem to provide ecosystem

[4] Mononen L., Auvinen A.-P., Ahokumpu A.-L., Ronka M., Aarras N., Tolvanen H., Kamppinen M., Viirret E., Kumpula T., Vihervaara P. 2015. National ecosystem service indicators: Measures of social–ecological sustainability. *Ecological Indicators*, doi:10.1016/j.ecolind.2015.03.041

[5] https://publications.jrc.ec.europa.eu/repository/bitstream/JRC94681/lbna27141enn.pdf

services. The P-indicator generally corresponds to the *Flow* indicator (excl. for regulating and maintaining services), which shows the actual use of the ecosystem services.

The list of indicators in the ecosystem services assessment methodology for the CleanEst project is based (with some modifications) on the list of indicators in Kosk et al. (2016) (Table 2).

Table 2. Relevant riverine ecosystem services and their consumption or pressure (P), provision or status (S) and impact (I) indicators. NB. The list of indicators is preliminary and may be subject to change in the course of the project. The asterisk (*) denotes services that will be included in the socio-economic assessment of the CleanEst project (see page 8)

*Fish stock for professional fishing	P Amount of professional catch from the river (t/yr) S Fish stock (t/yr) S Number of smolts of migratory fish (pcs/yr)
*Animal and plant material collected for the purposes of maintaining or establishing a population	P Number of animals caught for relocation or breeding material (pcs/yr) S Fish stock (t/yr) S Number of smolts of migratory fish (pcs/yr)
Surface water for drinking	P Abstraction of surface water for drinking water (m^3/s) S Average minimal monthly discharge that exceeds environmental flow (m^3/s) S Accordance of water quality to quality requirements of water used to produce drinking water (quality class)
*Surface water for aquaculture	P Abstraction of surface water for aquaculture (m^3/s) S Average minimal monthly discharge that exceeds environmental flow (m^3/s) S Accordance of water quality to quality requirements of water used for aquaculture (grade)
Surface water used for other non-drinking purpose	P Abstraction of surface water for industrial, cooling, irrigation or agricultural water (m^3/s) S Average minimal monthly discharge that exceeds environmental flow (m^3/s)
*Surface water used as an energy source	P Number of hydropower plants (no) P Capacity of hydropower plants (MW) S Hydro-energetic potential of the water body (MW) S Legal possibility for building hydropower plants (yes/no)
*Maintaining nursery populations and habitats	P Hydromorphological status P Water quality status S Ecological status (according to WFD) S Area of surface water dependent terrestrial ecosystems (ha)
*Dilution and meditation of wastes or toxic substances in surface water	P Point source pollution (point-source pollution index) P Nutrient load via diffuse pollution N+P (diffuse pollution index) S Water quality status
*Dilution and meditation of wastes or toxic substances in groundwater (in karst areas)	P Water quality status S Groundwater meeting the requirements of the thresholds of the chemical status of the groundwater body in a 2 km radius of the swallowing area (yes/no)
Hydrological cycle and water flow regulation (including flood control)	P Share of impermeable surface in the shore area of the water body (%) P Level of ditching of the alluvial plain (m/ha) S Frequency of floods causing economic loss(pcs/10yr)

Maintaining drainage water discharge	P Share of the water body with restrictions for establishing or renewing land improvement systems (%) S Area of improved land for which the water body is the recipient (ha) S Share of water body length that has been declared as recipient for land improvement systems (%) S Number of storm sewer outlets to the water body (pcs)
*Regulation of the chemical condition of freshwater by living organisms (buffer zones on shores)	P Share of recently (in 4–5 years) clear-cut land in the shore area of the water body (%) P Share of non-natural land cover in the shore area of the water body (%) S Share of full-grown forests in the shore area of the water body (%) S Share of natural land cover in the shore area of the water body (%)
Maintaining alluvial soil formation	P Share of non-natural land cover in alluvial plains (%) S Historical area of alluvial soils (ha) S Share of natural land cover in alluvial plains (%)
*Conditions supporting active recreation	P Number of organised canoeing/kayaking, etc. trips on the water body (pcs/yr) P Number of people using the water body for swimming (pcs/yr) P Number of hikers/walkers on the shore area of the water body (pcs/yr) S Length of the water body suitable for canoeing/kayaking, etc. (km) S Number of dams on the section of the water body suitable for canoeing/kayaking, etc. (pcs) S Number of swimming places on the shore of the water body (pcs) S Length of roads/trail suitable for walking/hiking on the shore area of the water body (m)
*Conditions supporting recreational fishing and crayfish catching	P Number of recreational fishers (pcs/yr) P Number of crayfish catchers (pcs/yr) S Attractiveness for fishing (grade) S Legal possibility for recreational fishing (yes/no) S Crayfish abundance (grade) S Legal possibility for crayfish catching (yes/no)
*Conditions supporting passive recreation	P Number of users of rest stop sites on the shore of the water body (pcs/yr) P Number of nights spent in accommodation facilities near the water body (pcs/yr) P Number of unique nature observations in the shore area of the water body (pcs/yr) S Number of rest stop sites and accommodation facilities on the shore of the water body (pcs) S Number of accommodation facilities on the shore of the water body (pcs) S Share of natural land cover in the shore area of the water body (%) S Number of residential properties adjacent to the water body (pcs)
Conditions that enable scientific investigation	P Number of scientific publications (pcs) P Number of public monitoring data (pcs) S *All water bodies are considered equally valuable for scientific investigation therefore no indicator is determined.*

*Conditions that enable education and training	P Number of educational trips related to the water body (pcs/yr) S Number of educational programmes in nature and public schools related to the water body (pcs)
*Conditions that enable aesthetic experiences	P Number of photos in the web depicting the water body per 1000 landscape photos (pcs/1000 photos) S Number of scenic sites on the water body (pcs)
Conditions that enable creative work	P Number of literature, movies, paintings representing the water body (pcs) S *All water bodies are considered equally valuable for scientific investigation therefore no indicator is determined.*
Provision of cultural, religious and national symbols	P Number of visitors of natural symbolic sites (pcs/yr) S Number of natural symbols (pcs) S Number of folklore items related to the water body (pcs)
*Maintaining protected and vulnerable species	P Hydromorphological status P Water quality status S Amount of protected species (index) S Status of protected species (grade) S Share of salmonid habitats of the water body length (%)

For comparative mapping of the provision or consumption of ecosystem services, the quantified indicator data has to be transformed (normalised) to a common scale. Kosk et al. (2016) have suggested using a five-step scale: 0 – does not provide that service; 1 – provides insignificantly; 2 – provides moderately; 3 - provides significantly; 4 – provides very significantly. In the CleanEst project, the same scale will be used. It is comparable to the scale suggested to be used in LIFE projects by the European Commission[6]. Though, according to that scale, „zero“ should indicate unknown provision, „one“ very poor/bad/non-functional provision, and „five“ very good/high provision. Therefore, the two scales are shifted by one unit, but are both five-step scales in their essence.

Kosk et al. (2016) does not provide suggestions for normalising indicator data for the five-step scale. Therefore the class limits for each indicator will be developed, based on available data and expert decision, during the CleanEst project. If the provision or consumption of a service is described by more than one indicator (e.g. the provision of the service „Maintaining protected and vulnerable species“), then the general value will be calculated using weights of each specific indicator. The weights will be applied using expert decision.

If the normalised values for the provision and consumption of each ecosystem service per each assessed water body have been derived, the ecosystem services index – ÖSTI (Kosk et al. 2016) can be calculated. It allows evaluating which water bodies provide less and which more ecosystem services and helps to pinpoint the water bodies whose provision of ecosystem services requires the largest involvement.

$$\ddot{O}STI = \frac{\sum_i^n(x)}{n*4}, \text{ where} \qquad (1)$$

n – number of evaluated ecosystem services, *x* – the value of i-th ecosystem service (according to Kosk et al., 2016, simplified for the evaluation scale of 0 to 4).

The assessment methodology of ecosystem services in the CleanEst project is integrated with the assessment of the socio-economic impact of the project. It means that the socio-economic assessment is based on the changes in the value of the ecosystem services. Therefore, the monetary value of the ecosystem services or the change in that value during the project will be used as the indicators for the project's socio-economic effect. The general framework of the integrated ecosystem services and socio-economic assessment is shown

[6] https://ec.europa.eu/easme/sites/easme-site/files/life_ecosystem_services_guidance.pdf

in figure 3. Though all riverine and lacustrine ecosystem services of the water bodies directly affected by the project actions will be mapped in the CleanEst project before, during and after the project, the socio-economic assessment will include only those services, whose impact or value will likely change as a result of the project actions. These 14 services are marked with an asterisk in table 2.

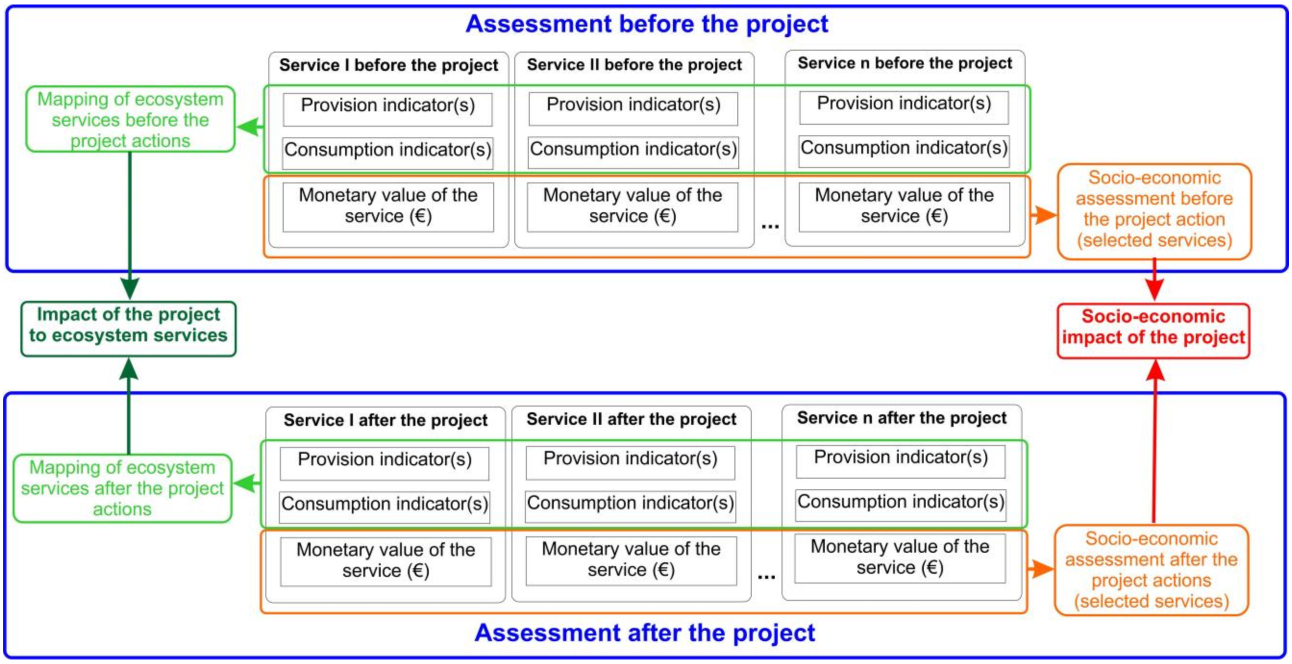

Figure 3. The general framework of integrated ecosystem services and socio-economic assessment in the CleanEst project.

Marko Vainu from the Estonian Environment Agency (KAUR) is responsible for developing and applying the methodology for mapping of ecosystem services. Olav Ojala from the Ministry of the Environment, with the contribution of Üllas Ehrlich from Tallinn University of Technology, is responsible for developing and applying the methodology for socio-economic assessment. The whole methodology and results of its application will be discussed and harmonised in the CleanEst ecosystem services working group, which includes, in addition to the three persons already mentioned: Timo Kark (KAUR), Aija Kosk (Estonian University of Life Sciences – EMÜ), Vallo Kõrgmaa (Estonian Environmental Research Centre – EKUK), Einar Kärgenberg (KAUR), Liisi Marits (Environmental Board), Mart Reimann (Tallinn University), Sander Sandberg (State Forest Management Centre), Indrek Tamm (EKUK), Mart Thalfeldt (KAUR), Uudo Timm (KAUR), Jaanus Terasmaa (Tallinn University), Herki Tuus (Ministry of the Environment) and Sirje Vilbaste (EMÜ).