ANNEX 8: SELECTING METHODOLOGICAL APPROACH

For the aim of selecting the most appropriate methodological approach, a literature review was conducted to provide a better understanding of the multiple benefits of using RBs for sewerage treatment in WWTPs. Approach was selected based on a systematic research of different scientific platforms and international document sources related to NBS. The correlation between the RBs functionality, their ecosystem services, and final direct and indirect benefits was defined.

The following figure shows the cascade relation between function, service, and final benefits, which form the basis for our methodology.

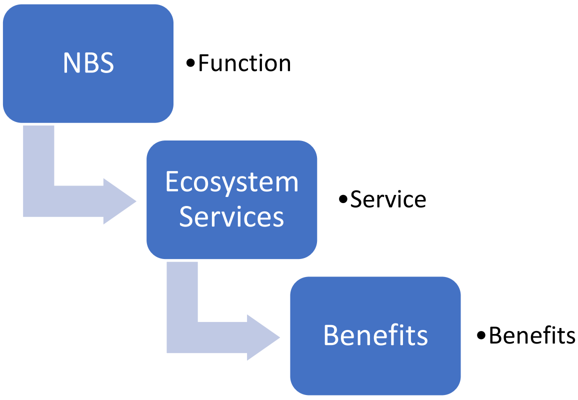


Figure 1: The Ecosystem Service Cascade

1.1 Defining values and benefits

Quantitative and qualitative methods were applied to assess the direct and indirect benefits of NBS for wastewater treatment. The starting point was to define the economic values of the NBS used to estimate immediate benefits and further apply qualitative methods to assess the indirect ones.

Nature-Based Solutions (NBS), particularly wastewater treatment plants with RBs for sustainable development, is not a new concept. Many examples exist from around the world, but still accelerating and scaling up progress in implementing NBS remains a challenge. The challenge partly relates to a lack of knowledge of the application, benefits, and limitations of NBS in water and wastewater management.

As the quantity/amount of renewable resources (i.e., water, phosphorus, nitrogen, etc.), it is essential to use them more sustainably. It is to assure that they will not become non-renewable resources by time if they must be used at a rate higher than their natural capacity to replenish back. Economist, 2007, reveals the "scarcity" in economic terms means that "needs and wants" exceed the resource availability in meeting them.

Natural resources, in which rivers and lakes take part, are strongly related to nature-based solutions, such as wetlands, reed beds, ponds, etc. They do not have their market price because of that, they are known as nonmarket goods. These resources (water, lakes, dams) are getting their economic value from the purchaser and user's preference and willingness to pay (WTP) for them rather than to live without them when they will get scare (Brouwer R., Pearce D., 2005). "Willingness to Pay is the maximum amount of money that people are willing to pay for an improvement of a particular good/service. Willingness to Accept (WTA) is the minimum amount of money that one accepts as a compensation for a reduction of goods/services. WTP (and to some extent, WTA) are widely being applied to conduct CBA studies«[1].

For accurate decision-making in policy and project-prioritizations, the need for economic valuation of natural resources and their environmental services is essential. It is a must to know what is being exchanged against what, then the policymakers and the stakeholders can make a trade-off for an environmental asset.

Based on direct and indirect benefits approaches, the value to a nonmarket environmental asset has to be assigned by knowing willingness to pay or accept principles for individuals, where the market fails to reveal this information.

1.2 Value transfer methods

For estimating the economic values of RBs systems, it is possible to apply the benefit transfer method to transfer the existing benefit estimates from one relevant study to another. Information on the value of NBS services can be used to support decision making regarding the use and management of ecosystems.

Estimating the economic and non-economic values for the RBs begins with an understanding of the many different services the environment can provide and the contributions these services make to the wellbeing of beneficiaries.

In the next figure, the economic value of a good or service is illustrated. It is determined by the demand for the supply of that good or service in a correctly functioning market. »The monetary measure of the wellbeing associated with its production and consumption can be defined as an economic value of a good or service«.

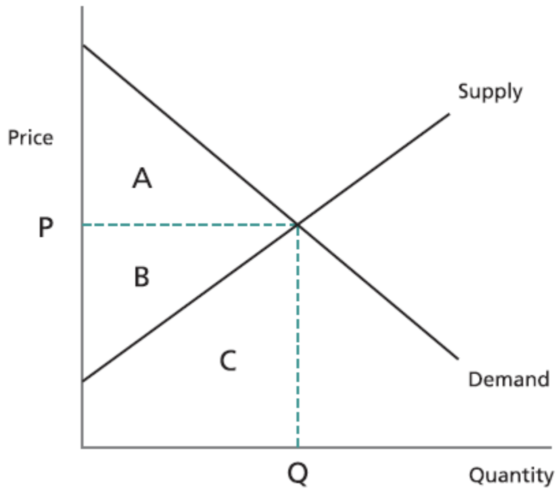


Figure 2: Producer and consumer surplus[2]

[1] Cost-Benefit Analysis of Wetland Alternatives on the Vege River, Ani Shamyan, Lars Hansson, IIIEE, LU Rikard Liden(SWECO VIAK), Olof Persson (SWECO VIAK) Sweden, June 2008

[2] Guidance manual on value transfer methods for ecosystem services, Luke Brander, Paulo A.L.D, Nunes and Eric D. Mungatna, UNEP

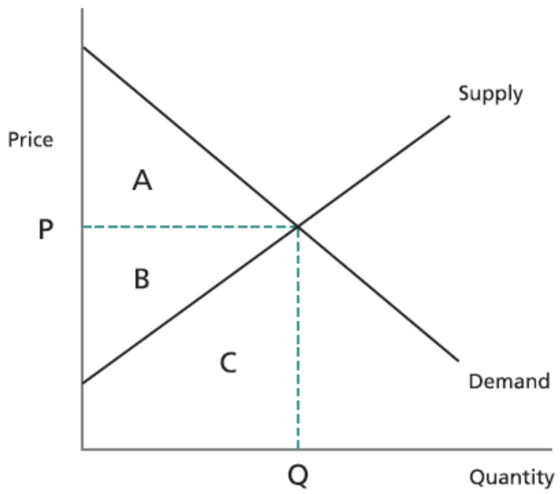


Figure 2 shows:

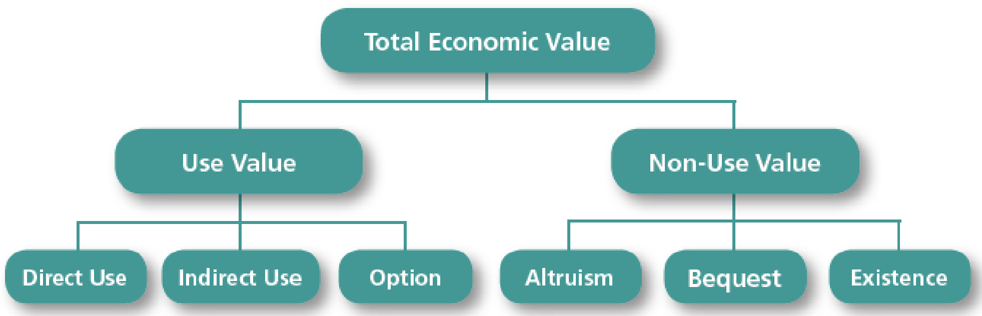
- demand for a good traded in a market at quantity ‘Q’;
- a supply curve for good trade in a market at a price ‘P’;
- the **consumer surplus** represented by area ‘A’;
- the **producer surplus**, depicted by ‘B’ (the amount that producers benefit by selling at a market price that is higher than the lowest price that they would be willing to sell for);
- the area ‘C’ represents production costs (which differ among producers and over the scale of production);
- the sum of areas A and B labeled as the ‘surplus’.

We must consider that the demand and supply curves are assumed to be linear for our literature review, but this will not usually be the case in practice.

The market price (P) reflects consumers’ marginal **willingness to pay (WTP)** for one additional unit of the product at the market equilibrium quantity of services Q, or conversely, the marginal **willingness to accept (WTA)** one-unit fewer.

In the case of ecosystem services not traded in a market, alternative approaches to establish a price or marginal willingness to pay for the ecosystem service need to be used.[3]

The concept of **Total Economic Value (TEV)** of an ecosystem is used to describe the sum of the components of utilitarian value derived from that ecosystem. The fundamental values of TEV are represented in the next figure.



[3] Guidance manual on value transfer methods for ecosystem services, Luke Brander, Paulo A.L.D, Nunes and Eric D. Mungatna, UNEP

Figure 3: The components of Total Economic Value[4]

The selection of appropriate units in which to transfer values is important and depends on the ecosystem service under consideration:

- the nature of the available value information from existing studies;
- and the available information for the policy site.

Some ecosystem service values may be expressed more straightforwardly and meaningfully in one set of units than another.
Example 1: “Recreation values or non-use values may be directly estimated and expressed per person rather than per unit of ecosystem area.”
Example 2: “Services such as support to commercial fisheries, pollination of crops and carbon sequestration are not straightforwardly expressed in per beneficiary terms but can be described per unit area of an ecosystem.”

Value transfer methods can be divided into three main types[5] for transferring information from a study site and adjusting that information to reflect the policy site:

- **Unit value transfer: „**Uses values for ecosystem services at a study site, expressed as a value per unit (usually per unit of area or beneficiary), and combined with information on the number of units at the policy site to estimate policy site values. Unit values can be adjusted to reflect differences between the study and policy sites (e.g., income and price levels)”.
- **Value function transfer:** “Uses a value function estimated for an individual study site in conjunction with information on parameter values for the policy site to calculate the value of an ecosystem service at the policy site. A value function is an equation that relates the value of an ecosystem service to the characteristics of the ecosystem and the beneficiaries of the ecosystem service. Value functions can be estimated from a number of primary valuation methods including hedonic pricing, travel cost, production function, contingent valuation and choice experiments”.
- **Meta-analytic function transfer:** “Uses a value function estimated from the results of multiple primary studies representing multiple study sites in conjunction with information on parameter values for the policy site to calculate the value of an ecosystem service at the policy site. A value function is an equation that relates the value of an ecosystem service to the characteristics of the ecosystem and the beneficiaries of the ecosystem service. Since the value function is estimated from the results of multiple studies, it can represent and control for greater variation in ecosystems, beneficiaries, and other contextual characteristics”.

With such kind of methods. anyone involved in conducting economic assessments of ecosystem services can understand the key methodological and practical issues involved in using value transfer.

1.2.1 Unit function transfer

The transfer of information from one site to another is represented in the figure below. The figure shows two similar watersheds. In the case that we have existing information about the value of this ecosystem service for the first watershed (study site), we can use this information to estimate the value of the ecosystem service in the second watershed (policy site). The values of the ecosystem service at each site may be assumed to be similar given that the two sites are similar in terms of the

[4] Guidance manual on value transfer methods for ecosystem services, Luke Brander, Paulo A.L.D, Nunes and Eric D. Mungatna, UNEP
[5] Guidance manual on value transfer methods for ecosystem services, Luke Brander, Paulo A.L.D, Nunes and Eric D. Mungatna, UNEP

area of upstream forest, the amount of rainfall and the number of beneficiaries living downstream, etc.

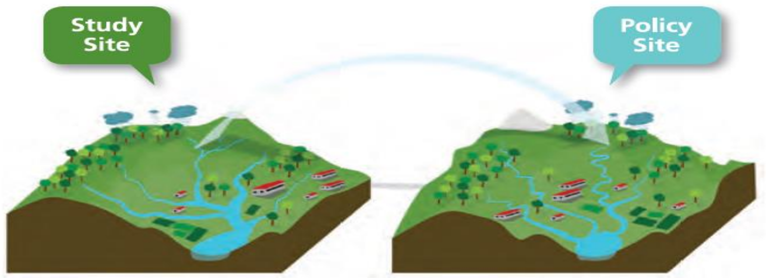


Figure 4: Value function transfer[6]

There are steps in conducting value transfer that should be followed. On the next figure the main steps in conducting value transfer are shown.

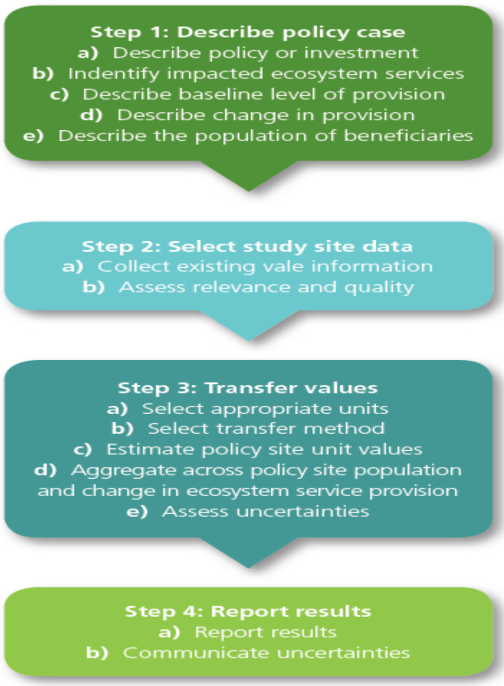


Figure 5: The main steps in conducting value transfer[7]

Values for ecosystem services can be estimated and presented both in terms of the beneficiaries that enjoy those services and or in terms of the ecosystems that supply them. Accordingly, values can be transferred either in terms of beneficiaries (e.g., Euro per person equivalent for reduced 1 kg of BOD5) or ecosystems (e.g., EuroHa-1. The selection of appropriate units in which to transfer values is essential. It depends on the ecosystem service, the nature of the available value information from existing studies, and the available data for the policy site.

1.2.2 Value function transfer

The value function transfer approach uses a value function estimated for an individual study site in conjunction with information on the policy site's characteristics to calculate the value of an ecosystem service at the policy site. A value function is an equation that relates the value of an ecosystem service

[6] Guidance manual on value transfer methods for ecosystem services, Luke Brander, Paulo A.L.D, Nunes and Eric D. Mungatna, UNEP

[7] Guidance manual on value transfer methods for ecosystem services, Luke Brander, Paulo A.L.D, Nunes and Eric D. Mungatna, UNEP

to the characteristics of the ecosystem and the beneficiaries. Value functions can be estimated using several primary valuation methods, including:

- hedonic pricing;
- travel cost;
- production function;
- contingent valuation;
- and choice experiments.

In all cases, the value function is estimated using a regression analysis. »A regression analysis is a statistical approach to empirically modeling the relationship between a dependent variable (e.g., WTP per household) and one or more explanatory variables (e.g., household income, distance to ecosystem, frequency of visits, number of substitute ecosystems)«.

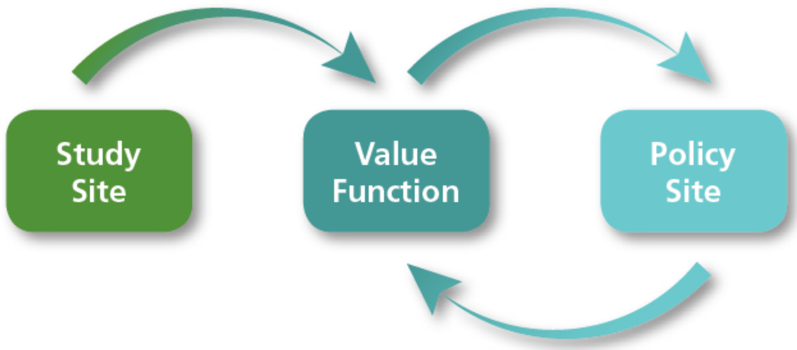


Figure 6: Value function transfer[8]

The detailed description of value function transfer follows on from the general explanation of the steps in performing value transfer (i.e., the explanation here adds detail to Step 3b described above). The main four steps[9] in conducting a value function transfer are:

Step 1. »From the available primary valuation studies, select an estimated value function that relates the value of ecosystem service to the characteristics of the ecosystem and its beneficiaries. Value functions will often be reported in the form of a regression output table, in which the dependent (or explained) variable is the value of ecosystem service, and the explanatory variables include measures of ecosystem and beneficiary characteristics«.

Step 2. »Collect information for the policy site on each of the explanatory variables in the value function and for the change in the number of units in which the dependent variable is defined (e.g., number of households, number of visits, hectares of ecosystem). Information on the explanatory variables at the policy site (e.g., household income, distance to ecosystem, frequency of visits, number of substitute ecosystems) can be obtained from a variety of sources, including public statistics, surveys, technical reports, and GIS data«.

Step 3. »Input the policy site data on the explanatory variables into the value function to estimate a unit value for the ecosystem service at the policy site. This involves multiplying the policy site data for each explanatory variable by the estimated coefficient for each explanatory variable

[8] Guidance manual on value transfer methods for ecosystem services, Luke Brander, Paulo A.L.D, Nunes and Eric D. Mungatna, UNEP

[9] Guidance manual on value transfer methods for ecosystem services, Luke Brander, Paulo A.L.D, Nunes and Eric D. Mungatna, UNEP

reported in the value function and then summing across explanatory variables to obtain an estimate of the dependent variable at the policy site (i.e., the unit value)«.

Step 4. »Multiply the estimated unit value by the change in a number of units at the policy site to compute the aggregate change in the value of the ecosystem service«.

1.2.3 Meta-analytic function transfer

Meta-analytical function transfer is similar to the value function approach, but the value function, in this case, is estimated from the results of multiple primary valuation studies representing numerous study sites. The meta-analytic value function is used in conjunction with information on parameter values for the policy site to calculate the value of an ecosystem service at the policy site.

Since a meta-analytic value function is estimated from the results of multiple studies, it can represent and control for more significant variation in the characteristics of ecosystems, beneficiaries, and also methodological aspects of the primary valuation studies.

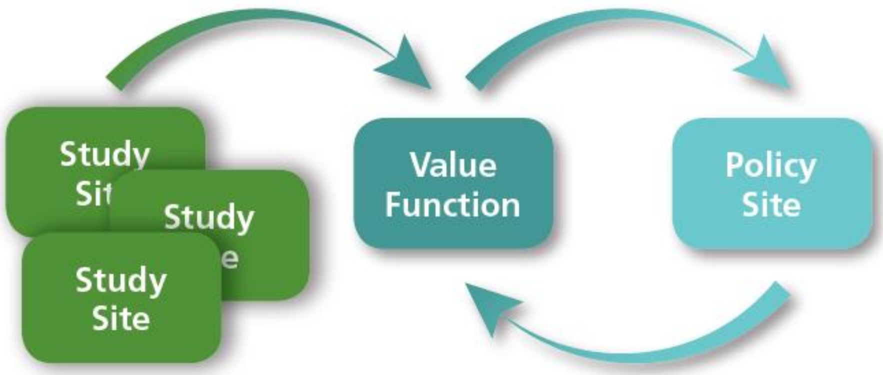


Figure 7: Meta-analytical function transfer[10]

The main four steps[11] in conducting a meta-analytic value transfer are:

Step 1. »Obtain or estimate a meta-analytic value function for the ecosystem service of interest. The main steps in conducting a meta-analysis of primary valuation results to estimate a value function are«:

a) »From the available primary valuation studies, construct a database containing information on the value of the ecosystem service of interest«.

b) »Value information presented in the primary valuation literature may be reported in different physical and temporal units. Values should be standardized into the same set of units (e.g., Euro per household per month, Euro per hectare per year) so that they can be directly

[10] Guidance manual on value transfer methods for ecosystem services, Luke Brander, Paulo A.L.D, Nunes and Eric D. Mungatna, UNEP

[11] Guidance manual on value transfer methods for ecosystem services, Luke Brander, Paulo A.L.D, Nunes and Eric D. Mungatna, UNEP

compared and analysed. Similarly, value estimates are likely to be reported in different currencies and for different years and price levels«.

c) »For each primary value estimate included in the database, include information on the valuation method used, type of ecosystem service valued, base level of provision, change in provision, characteristics of the ecosystem (e.g., size, quality), and the characteristics of beneficiaries (e.g., number, household size, income, age)«.

d) »In addition to information obtained directly from each primary study, information on each study site can be added using secondary data sources including spatially defined data using GIS. Examples of such additional data include population density, income, the abundance of other ecosystems in the vicinity of the study site, landscape fragmentation, and distance to population centers«.

e) »Estimate a multiple regression equation with the standardized value as the dependent variable and measures of study, ecosystem and beneficiary characteristics as explanatory variables«.

Step 2. »Collect information for the policy site on each of the parameters (explanatory variables) in the meta-analytic value function and for the number of units in which the dependent variable is defined (e.g., number of households, hectares of ecosystem)«.

Step 3. »Input the policy site parameter values into the meta-analytic value function to estimate a unit value of the ecosystem service at the policy site«.

Step 4. »Multiply the estimated unit value by the number of units to compute the value of the ecosystem service at the policy site«.

1.2.4 Summary of selected VTM

The unit, value function, and meta-analytic function transfer methods can be summarized with their respective strengths and weaknesses. The choice of which value transfer method to use to provide information for a specific policy context depends mainly on the availability of original valuation estimates and the degree of similarity between the study and policy sites. Table 1 summarizes the strengths and weaknesses of analyzed value transfer methods.

Table 1: Value transfer methods: strengths and weaknesses[12]

VTM	Approach	Strengths	Weaknesses
Unit value transfer	Select appropriate values from existing primary valuation studies for similar ecosystems and socio-economic contexts. Adjust unit values to reflect differences between study and	Simple	Unlikely to be able to account for all factors that determine differences in values between study and policy sites. Value information for highly similar sites is rarely available.

[12] Guidance manual on value transfer methods for ecosystem services, Luke Brander, Paulo A.L.D, Nunes and Eric D. Mungatna, UNEP

	policy sites (usually for income and price levels).		
Value function transfer	Use a value function derived from a primary valuation study to estimate ES values at policy site(s).	Allows differences between study and policy sites to be controlled for (e.g. differences in population characteristics).	Requires detailed information on the characteristics of policy site(s).
Meta-analytic function transfer	Use a value function estimated from the results of multiple primary studies to estimate ES values at policy site(s).	Allows differences between study and policy sites to be controlled for (e.g. differences in population characteristics, area of ecosystem, abundance of substitutes etc.). Practical for consistently valuing large numbers of policy sites.	Requires detailed information on the characteristics of policy site(s). Analytically complex.

Based on the literature review and available information on the characteristics of study and policy sites **"unit value transfer method"** for assessing direct and indirect benefits of RBs in Mojkovac has been chosen.

1.3 Seven-stage framework

The seven-stage framework for assessing and implementing the co-benefits of nature-based solutions in the pilot site of Mojkovac would be taken into account, as shown in the figure below.

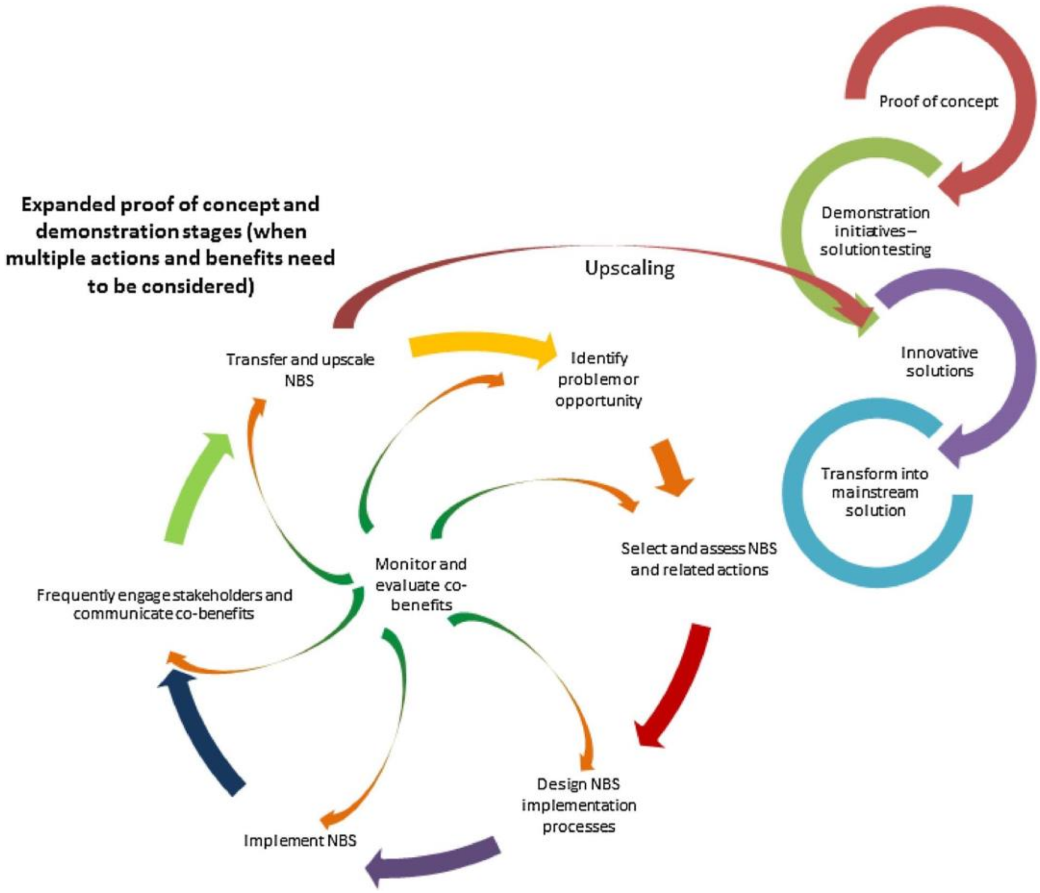


Figure 8: Seven-stage framework for assessing and implementing NBS[13]

On the left side of the scheme, successful NBS projects that could be implemented are described, and on the right side, we show how the solutions generated through these projects could be innovated. The idea of a circular and flexible scheme is making each stage not totally independent from the others and not necessarily in the same sequence. The seven stages[14] are:

1) Identify problem or opportunity;
2) Select NBS and related actions;
3) Design NBS implementation processes;
4) Implement NBS;
5) Frequently engage stakeholders and communicate co-benefits;
6) Transfer and upscale NBS,
7) The transversal stage of monitor and evaluate co-benefits.

The current case study analyses the quality of sludge treated on sludge drying reed beds under Alpine conditions, taking into account the final destination of the sludge produced. It is based on the existing WWTP Mojkovac and their three basic groups of units:

- Pre-treatment wastewater units;
- Wastewater treatment units;
- Sludge treatment units.

[13] A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas, Christopher M. Raymonda,⁎, Niki Frantzeskakib, Nadja Kabischc, Pam Berryd, Margaretha Breile, Mihai Razvan Nitaf, Davide Genelettig, Carlo Calfapietrah,I, (2017) 15-24

Referring to the existing situation of sludge treatment with natural dewatering by RBs, the first six stages of the *„Seven-stage framework for assessing and implementing NBS"* are ensured. The next important step is to evaluate the benefits by engaging the main stakeholders.

As shown in the following table, it is important to assess the most relevant challenge area with:
- Specific indicators;
- Type of indicators; and
- Unit of measurement for the need of direct and indirect benefit.

Table 2: Examples of different types of indicators for assessing the impacts of NBS (Wetlands, RBs and etc.) across different challenge areas[15].

Challenge area	Example of indicators	Type of indicators	Unit of measurement
Climate Mitigation and Adaption	Net carbon sequestration by urban forests (including GHG emissions from maintenance activities)	Environmental (chemical)	t C per ha/y
Water Management	Economic benefit of reduction of stormwater to be treated in public sewerage system	Environmental (monetary)	Cost of sewerage treatment by volume (€/m^3)
Coastal Resilience	Area remaining for erosion protection	Environmental (physical)	km^2 or m^2
Green Space Management	Species richness of indigenous vegetation	Environmental (physical)	A count, magnitude or intensity score of indigenous species per unit area
Air Quality	Annual amount of pollutants captured by vegetation	Environmental (chemical)	t pollutant per ha/y
Urban Regeneration	Index of ecological connectivity (integral index of connectivity)	Environmental (physical)	Probability that two dispersers randomly located in a landscape can reach each other
Participatory Planning and Governance	Quality of the participatory or governance processes	Social (process)	Perceived level of trust, legitimacy, transparency and accountability of process
Social justice and Social Cohesion	Accessibility to public green space	Social (justice)	% of people living within a given distance from accessible, public green space
Public Health and Well-being	Level of involvement in frequent physical	Social (physiological)	Number and % of people being physically active (min. 30 min 3

[15] A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas, Christopher M. Raymonda,⁎, Niki Frantzeskakib, Nadja Kabischc, Pam Berryd, Margaretha Breile, Mihai Razvan Nitaf, Davide Genelettig, Carlo Calfapietrah,I, (2017) 15-24

Challenge area	Example of indicators	Type of indicators	Unit of measurement
	activity in urban green spaces		times per week) in urban green space
Economic Opportunities and Green Jobs	Net additional jobs in the green sector enabled by NBS projects	Economic (productivity)	New jobs/specific green sector/y

Reed beds (RBs) for sludge drying established at Mojkovac were constructed to favor environmentally-friendly options, issues linked to economic justification and added value, and attached to the indirect and direct benefits. Different types of indicators for assessing the impacts of NBS (RBs) across different challenge areas will be reviewed and systematized.