URBAN GreenUP

D7.13: Ex-post ESA monetary evaluation of NBS in front runner cities

WP 7 , T 7.1

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Technical References

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0 Executive summary

Task 7.1 of WP7 aims to valuate ex-ante and ex-post the impacts generated by NBS in Front-runner cities involved in Urban GreenUP project. The ex-post economic valuation has been performed using the benefit transfer approach (see deliverable 7.3).

The benefit transfer is a procedure for taking the estimates of economic benefits (or values in general) gathered from one site and applying them to another. Benefit transfer can potentially be used to estimate values for any ecosystem service, if there are primary valuations of that ecosystem service from which to transfer values.

1 Introduction

WP7 of Urban GreenUP project is focused on exploitation and market deployment as well as on the ex-post economic valuation of NBS in Front-runner cities: Valladolid, Liverpool, and Izmir. Specifically, Task 7.1 aims to define the methodology for the economic valuation performance of NBS based on the ecosystem services approach and to adopt this approach to perform the ex-ante economic valuation of NBS. This deliverable describes:

- the methodology used for the ex-ante valuation performance of NBS;
- the ex-post economic valuation performance of NBS in front-runner cities: Valladolid, Liverpool, and Izmir.

The main target groups of this deliverable are the partners of the Urban GreenUP project, front-runner and follower cities. The deliverable can also be of interest for other cities, their technical and business partners, who wish to acquire information on economic valuation of NBS impact generated in cities and on Urban GreenUP specific approach on this.

1.1 Contributions from other partners

The following Table describes the main contributions from participant partners in the development of this deliverable.

Partner	Contribution
UB	Research activities on NBS projects, criteria & dimensions for NBS economic valuation Analysis of the NBS and identification of the ecosystem services provided by them Literature review on case studies for the economic valuation of NBS Benefit transfer technique performance
VAL and city technical partner	Front-runner cities and their technical partners have contributed in the definition and population of the set of KPI for NBS.
LIV and city technical partner	Front-runner cities and their technical partners have contributed in the definition and population of the set of KPI for NBS.
IZM and city technical partner	Front-runner cities and their technical partners have contributed in the definition and population of the set of KPI for NBS.

Table 1: Contribution form project partners

1.2 Connection with other project activities

The following table summarises the main relationship of this deliverable to other activities (or deliverables) developed within Urban GreenUP Project and that should be considered along with this document for further understanding of its contents.

Partner	WP	Relation
ACC	WP1	Definition of the NBS catalogue
VAL	WP2	Definition and implementation of NBS. Monitoring and analysis of the performances.
LIV	WP3	Definition and implementation of NBS. Monitoring and analysis of the performances.
IZM	WP4	Definition and implementation of NBS. Monitoring and analysis of the performances.
GMV	WP5	Definition of the KPI for the NBS monitoring program

Table 2: Relation to other project activities

2 ES valuation

2.1 Methodologies for the ES valuation

The valorisation and implementation of nature-based solutions (NBS) is crucial to ensure the proper functioning of ecosystems at different scales, from the global one to the urban and local ones (Croci et al. 2021). NBS, being a core part of planning strategies and interventions in urban plans, operationalise the concept of ecosystem services (ES) (Potschin et al., 2015), where ES represent a connecting concept between the natural and the human world (Braat & de Groot, 2012). In order to provide sufficient detail about the relationship between the natural capital and the socio-economic system, the following definition of ES can be adopted:

ES represent the flows from natural capital stocks that are generated as response to an active or passive human demand. Thus, ES are the final outputs from ecosystem structures, processes, and functioning that are then directly (actively or passively) benefited by people (modified from Culhane et al., 2019 and Almenar et al., 2021).

Thus, based on their type, ES can contribute directly (e.g., food production) or indirectly (e.g., pollination) to human well-being. A good understanding of the economic value generated by ES can facilitate the adoption of effective policies and measures to preserve and enhance them consistent with sustainable development (Croci et al., 2021; Dasgupta et al., 2021). However, given the non-excludability and non-rivalry nature of natural capital, most ES are not traded on markets and the monetary valuation of an ES is traditionally absent from economic accounting. This is why the complexity of the economic valuation of ES also affects the economic valuation of the benefits provided by ES generated by NBS (Croci et al., 2021). In fact, to estimate the benefits generated by implemented NBS, it is necessary to gauge the value of all the ES provided by the considered NBS.

ES, providing several benefits spanning from improvement of air quality, climate regulation, and flood risk reduction to cultural services, support human society in coping simultaneously with several social, economic, and environmental challenges (Simpson, 1998; Carter, 2011; WWF, 2013; Camps-Calvet et al., 2016; Majidi et al., 2019). Therefore, the selection of the appropriate ES valuation methodology is crucial in capturing the multi-functionality and “hidden value” of ES, with the aim of assessing the full social value generated by them.

Different approaches and initiatives have been developed and experimented for the economic valuation of ES (Croci et al., 2021). The System of Environmental–Economic Accounting – Ecosystem Accounting (SEEA-EA) adopted by the United Nations Statistical Commission (United Nations, 2014) hinges around natural capital and the services it provides, considering their changes over the accounting period (Croci et al., 2021). The SEEA-EA provides internationally recognized statistical standards and principles designed to record the physical extent and condition of ecosystems, the related provision of ES and their values into national accounting systems. The Mapping and Assessment of Ecosystems and their Services (MAES), developed by the European Commission Joint Research Centre (JRC; European Commission, 2013), proposes a set of indicators to assess ES at the national level. The ‘wealth/well-being equivalence theorem’, recently proposed by Dasgupta (2021), suggests comprehensive indicators of sustainable economic development moving beyond standard macroeconomic indicators such as Gross Domestic Product. The most recent IPBES Values Assessment (2022) includes an understanding of the relationships between different worldviews and values attributed to natural capital, a presentation of the diversity of nature's values, and guidelines for implementing methods and approaches for assessing multiple values of nature and its benefits, including biodiversity. In this values assessment, natural capital is understood by IPBES in an inclusive way, encompassing multiple perspectives and conceptions, such as the perspectives of indigenous peoples and local communities. This inclusive view is reflected in IPBES's suggestion that, whenever possible, different methods of valuing natural capital and ES should be combined as they provide complementary information about the diversity of nature values that, when integrated, can better inform policy decisions (IPBES, 2022). Moreover, The Economics of Ecosystems and Biodiversity (TEEB; Sukhdev et al., 2010) provides guidance, with emphasis at the local level, on the economic valuation of market and non-market values of ES (IPBES, 2022) that can support the implementation of environmental policies (IPBES, 2022). The latter approach, entails considering the Total Economic Value (TEV) yielded by ES (Croci et al., 2021).

The TEV framework is a monetary valuation approach based on the consideration of ES as flows of benefits from ecosystem components to humans (Pandeya et al., 2016). As explained in D 7.3 Guidelines for the use of ESA in different contexts, the TEV is defined as "the sum of the values of all service flows that natural capital generates both now and, in the future, – appropriately discounted" (Muradian et al., 2010). Indeed, the term ‘total’ in ‘total economic value’ represents the sum of categories of values measured in terms of marginal changes of the natural capital stock, captured via assessing the varying quality and quantity of environmental goods and services as part of the dynamic socio-ecological system, and not over ecosystem components in a constant state (Pascual et al., 2010).

Therefore, the TEV framework can be employed to capture all elements of utility gained from ES, taking into account all the services provided by ecosystem components. The TEV framework makes this possible as it considers both the value that humans receive from ES when they make use of the natural capital for their own consumption, and the value people attribute to it in relation to intangible benefits not derived from any exploitation (Croci et al., 2021; Pandeya et al., 2016). Thus, the TEV also considers the “hidden” components of environmental goods not accounted for by markets (Croci et al., 2021). In order to successfully integrate these different types of values, the TEV framework generally distinguishes between use and non-use values, each further unbundled into different value categories that, when summed, provide the Total Economic Value (TEV) (TEEB, 2010). To estimate the economic value of ES, several monetary valuation techniques have been developed for eliciting the different types of value just presented (Pandeya et al., 2016). Following the TEV framework, three main approaches are used to value ES namely direct market valuation, revealed preferences, and stated preferences. While in the first approach values are based on market transactions directly related to ES, in the second and third approaches values are derived from parallel market transactions which, in the case of revealed preferences, are indirectly associated with the ES to be valued and, in the case of stated preferences, are associated with the creation of hypothetical markets based on people's willingness to pay (Croci et al., 2021; De Groot et al., 2006; Pandeya et al., 2016; Pisani et al., 2021; Selivanov & Hlaváčková, 2021; Sukhdev et al., 2010). Through the analyses carried out in

D 7.3, a total of 15 methodologies were identified, divided according to the different valuation approach:

1. Direct market valuation: Market prices, Replacement costs & damage, Cost avoided, Production function approaches;
2. Revealed preferences: travel costs and hedonic prices;
3. Stated preferences: Contingent valuation, Choice modelling, Deliberative monetary valuation, Questionnaire, In-depth interview, Focus group, Citizens' juries, Health-based valuation method, Q-Methodology.

The methodologies can be used to measure "use value" and "non-use value" of considered ES. An interpretative framework has been created to clarify the linkages between the TEV framework, ES, and the economic valuation approaches and methodologies that can be adopted (Figure 1).

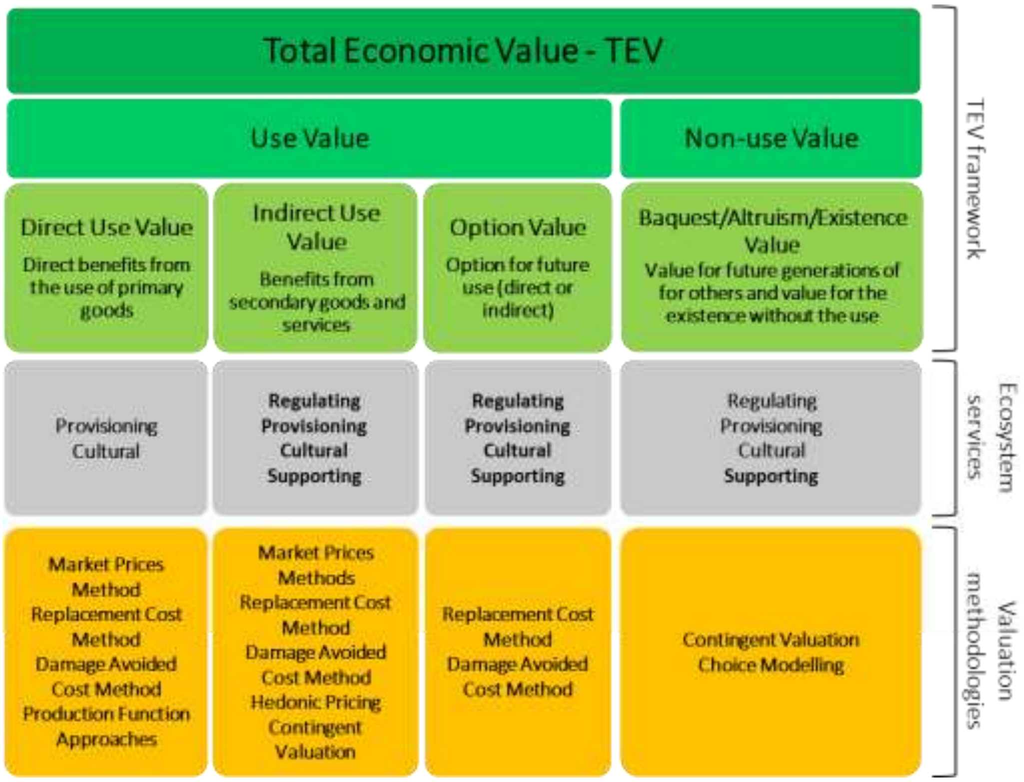

Figure 1. Methodologies for the estimation of the different types of values (adapted from Pascual et al., **2010 and EC, 2013).**

More detailed information about the methodologies for the ES valuation, can be found in the deliverable 7.3 “Guidelines for the application of the ESA methodology”.

The advantage of monetary valuation methods is that impacts are expressed in common units (e.g., currency) that can be compared directly, reflecting impacts in terms of human well-being (ISO, 2019). The various contexts in which economic valuation of ES can be useful include increasing awareness of the value of the environment, revealing the distribution of costs and benefits, designing the most effective tools for adaptive environmental management, setting appropriate fees for the use of ES, calculating potential returns on investment for projects that impact the environment, comparing the costs and benefits of different uses of the environment, and calculating environmental damages and establishing compensation (NRC, 2005; Pascual et al., 2010; Small et al., 2017).

However, given the diversity of existing methodologies and tools for ecosystem service valuation, it is critical to implement appropriate procedures to determine the methods and/or tools which are suitable for the specific study needs. The choice of appropriate assessment methods can also be partly determined by the fulfilment of requirements that may make the chosen method more suitable for the case study under consideration. According to the recent IPBES Summary for policymakers on the assessment of the diverse values and valuation of nature (IPBES, 2022), it is necessary to consider the trade-offs between three requirements when it comes to the choice of the valuation method: relevance, robustness, and resources.

Ensuring the relevance of the valuation method to be applied means making sure that the chosen method allows for the consideration of different natures and categories of value. In addition, it is necessary for the valuation to be robust so as to provide useful information for decision-making processes that will make use of the produced results. Furthermore, since the valuation process requires the use of resources such as time and financial resources, their availability influences the choice of applying a particular valuation method rather than another. Consequently, it is appropriate to base the choice of the valuation method to be applied on the identification of its strengths and weaknesses, especially in relation to its relevance, robustness and the resources its application requires (IPBES, 2022).

In this regard, IPBES (2022) provides a table to depict, for some of the main valuation frameworks such as TEV (Figure 2) and valuation methods (Figure 3), their performance in terms of trade-offs between relevance, robustness, and resource requirements (Figures 2). In both figures 2 and 3, the methods that perform relatively well, based on a summary of the relevance, robustness, and resource characteristics, are indicated with larger bubbles.

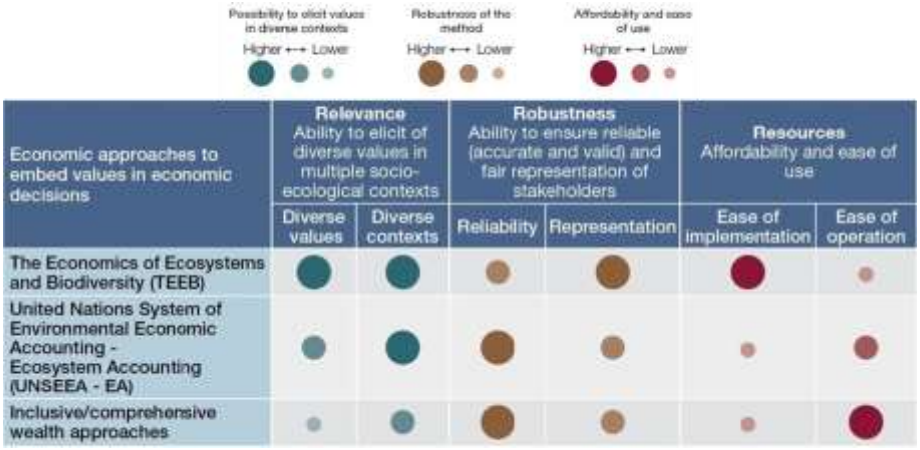

Figure 2: Performance of some of the main valuation frameworks in terms of trade-offs between relevance, robustness, and resource requirements (adapted from IPBES, 2022).

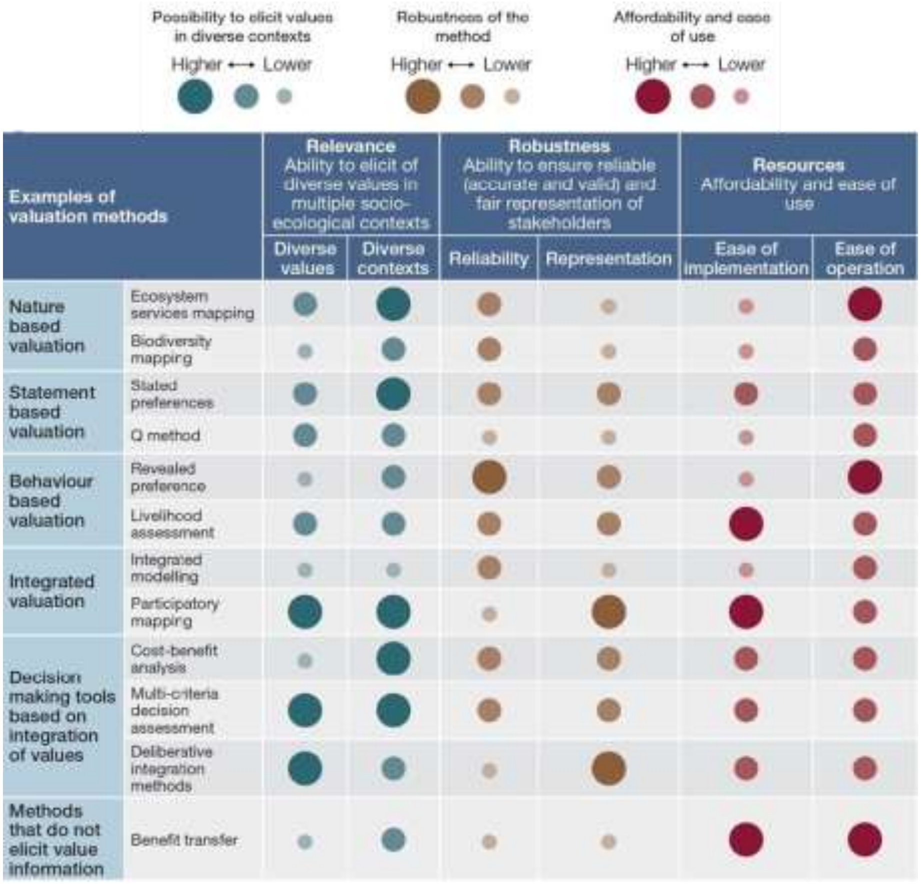

Figure 3: Performance of some of the main valuation methods in terms of trade-offs between relevance, robustness, and resource requirements (adapted from IPBES, 2022).

From Figure 2, it can be seen that TEEB is the valuation approach that performs best since it allows for the consideration of different types of values of nature and ES, allows for the elicitation of values associated with a multiplicity of social-ecological contexts, ensures good representation of stakeholder views and reliability, and is characterized by ease of implementation. These TEEB strengths are precisely ensured by the fact that this approach, as also previously specified, allows for the evaluation of both market and non-market values through the employment of the TEV framework. Whereas, from Figure 3, it can be observed that among the valuation methods there is high variability in balancing relevance, robustness, and resource with the choice of a specific method or combination of them dependent on the application context. To provide an example, among economic methods, revealed preference methods are known to provide reliable information about values, but often derive it only with reference to a specific stakeholder group, considering only one type of value and at the same time requiring many resources such as data and time. In contrast, stated preference methods are generally less reliable but are found to be less resource-intensive and more adaptable to a wide range of stakeholders, value types and decision-making contexts.

In the specific case of this work, based on the benefit transfer methodology applied in the ex-ante NBS valuation (consult D7.2 "Report on ESA monetary evaluation for NBS" for more details) and following the guidance provided by IPBES (2022) just outlined, for the ex-post valuation of the NBS in front-runner cities, the TEV framework was adopted, and the benefit transfer valuation method was chosen to be re-applied. As shown in Figure 5, the benefit transfer method possesses a fair degree of applicability to various contexts, making it a reasonably good method in terms of relevance. However, the strength of the benefit transfer method is its ease of implementation and ease of operation in terms of resources. The characteristics of the chosen benefit transfer method will be detailed in the next section.

2.2 The benefit transfer method

To perform the ex-post valuation of the NBS in the front-runner cities of Valladolid, Izmir, and Liverpool the benefit transfer method has been chosen.

The benefit transfer method is a process for estimating the economic value of ES by taking the estimated values from pre-existing primary studies and applying those results to the context under analysis to predict welfare estimates (Pisani et al., 2021). The one or more sites or contexts from which the estimated values are extrapolated are often called study site, as they have already been studies. The site to which the estimates are transferred to is often called the policy site as the benefit transfer is usually undertaken to perform an economic analysis of proposed policy action (Johnston et al., 2015; NRC 2005).

Benefit transfer results attractive due to its principal advantage, that is it reduces the costs, in terms of time and money, that are needed to assess the benefits of implemented environmental policies utilizing alternative non-market valuation methods within primary research (Johnston et al., 2015; Lam-González et al., 2022). Indeed, the benefit transfer method represent the most feasible option when time, data availability or other constraints render particularly challenging performing a primary study (Johnston et al., 2015).

Benefit transfer can potentially be used to estimate values for any ecosystem service, provided that there are primary valuations of that ecosystem service from which to transfer values. Benefit transfer have been employed widely in national and global ecosystem assessments (e.g., the UK NEA, 2011; EEA, 2010; TEEB, 2010), value mapping applications (e.g., Schaegner et al., 2013) and policy appraisals (e.g., Collier & Dollar, 2002).

The use of benefit transfer is widespread but requires a careful application since its validity and accuracy rely on several conditions. Indeed, the accuracy of benefit transfer depends on the quality of the primary studies from which the estimates are transferred (Johnston et al., 2015). When selecting the primary studies to be used, there is an implicit assumption that the body of literature being considered provides an unbiased sample of the population of empirical estimates and that these estimates provide an unbiased representation of the true values of the ES or resources under analysis. However, if these assumptions prove invalid, this will lead to systematically biased results and what is called selection bias. Although benefit transfers can be subject to a range of potential errors, the scientific literature increasingly recognizes the usefulness and need for the resulting information from its application (Johnston et al., 2015).

Specifically, in applying the benefit transfer method in the context of the present work, the value transfer approach has been used. Value transfer involves the use of a single estimate of value or set of values obtained from previously conducted primary studies and research literature

(Rosenberg et al., 2017). Estimated values can be used "as is" or adjusted using different approaches. In applying the value transfer approach, the transferred unit values can include a single unadjusted estimated value, an estimated value adjusted to the policy site attributes or using expert judgment, an average or median value extrapolated from a set of study sites, or a range of estimates selected from a set of study sites. An important step in implementing the benefit transfer method is to specify the policy option that is to be valued, including baseline values and marginal changes of ES, for which an economic value estimate of economic value has to be conducted (Johnston et al., 2015). Often this information, as in the case of the present work, is made available from work done ex-ante.

One of the first steps in the implementation of a high-quality benefit transfer method is a comprehensive literature review to find adequate, high-quality studies and, therefore, to avoid any biases. Indeed, precisely because of the need to avoid bias in this and subsequent stages of transfer implementation, the collection and evaluation of data can be significantly time-consuming. Typically, the literature review conducted involves the identification of previous empirical studies that relate to the general type of policy effects and assets under study. The resulting set of studies is then subject to a further 'skimming' stage to ascertain their quality and correspondence with the policy site in terms of factors such as socio-economic context, ES assessed, scale of analysis, biophysical characteristics of the site, location, population, and date of analysis (Johnston et al., 2015).

For the ex-post valuation, values of urban ES estimated in assessments conducted in the reviewed scientific literature through the application of different methodologies were used. Figure 6 represents the general steps that have been followed for the realisation of the ex-ante and ex-post valuation.

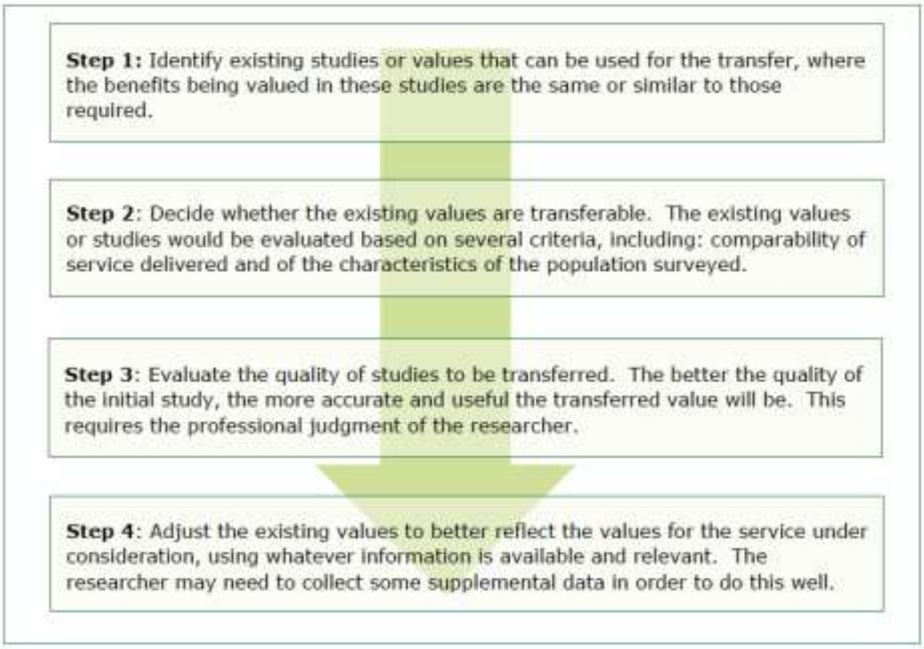

Figure 4 Steps applied for the application of the benefits transfer method (LIFE N2K Wales, 2015)

However, compared to the process followed for the implementation of the benefit transfer method in the ex-ante valuation, for the application of the benefit transfer in the ex-post valuation the number of studies reviewed and analysed in order to identify the needed values has been significantly expanded. As a result, the number of estimate values identified and selected for the ex-post valuation increased significantly. Furthermore, unlike the process followed for the ex-ante valuation, a further step was applied for the ex-post valuation. Indeed, the estimate values selected from the literature were ultimately adapted according to the ES benefits measured through a set of KPIs (previously defined with the support of cites) monitored by the partners for the different cities and NBSs in the period between the ex-ante and the ex-post evaluation. The processes adopted for the values individuation and selection and for the performed valuation will be outlined in more detailed in the next paragraphs and chapters.

3 Ex-post valuation of ES in Urban GreenUP project

The methodology is based on the review of the literature for the identification of the economic values provided by ES generated by six categories of NBS: green roofs, green walls, urban trees, urban parks, SUDs, and urban wetlands. Values identified have been analyzed and systematized based on the ecosystem service values obtained to calculate the TEV for each NBS; finally, the values have been classified according to the following social, economic, and geographical variables: population, economic development of the country and the climate area. Below the different methodological steps have been described. The review has been performed using the online database Scopus through six different search queries, one for each NBS category: green roofs, green walls, urban trees, urban parks, SUDs, and urban wetlands. Each search query returned only those articles which included in either the title, abstract, or keywords the name of the NBS category, "urban", and at least one of the following terms: "economic valuation", "economic evaluation", "monetary valuation", "monetary evaluation", "economic value", "monetary value", "economic analysis", "monetary analysis", "economic assessment", and "monetary assessment".

Different parameters have been applied for the selection of the papers. First of all, only papers in English have been considered; furthermore, the economic valuation had to be carried out by fulfilling three criteria. First, the monetary values must be reported per surface area (or the value per m2 can be inferred from the data included in the paper) in order to identify a comparable set of values and to facilitate the use of the results in benefit transfer approaches. Papers whose economic valuation was per tree or per person or were missing the surface area of the NBS were excluded. An example would be papers adopting the hedonic price method, which usually indicates the increase in property value in terms of the distance from the NBS. Second, the economic valuation must assess the ES of the NBS considered, not the NBS as a whole. This was often the case with contingent valuation studies, where survey participants are usually asked to state their willingness to pay to preserve a certain NBS, without elaborating on the ES provided by it. Third, monetary values must be reported per year. This happens when values are expressed as Net Present Value (NPV), but no information about the discount rate and/or the expected lifetime of the NBS is provided.

In total, 184 papers have been identified by the review. As a first step, duplicates were excluded, which resulted in 169 papers. During title and abstract screening, 69 papers were removed due to the language not being English, document type, and irrelevant research topics. Out of the 100 papers left, 56 were eliminated for failing to meet one of the three criteria mentioned above: i) monetary values were not reported per surface area (17 papers); ii) the economic valuation was carried out with respect to the whole NBS and not to the single ES (21); iii) monetary values were not reported per year (5 papers). Furthermore, 13 papers were excluded because there was no monetary valuation of the NBS. Therefore, 44 studies remained after reading the full text.

Moreover, 31 papers retrieved through the Snowball approach[1] were included for analysis. Overall, the final database contains 75 papers.

To make the identified values comparable and homogeneous with each other, they have been converted to €2020 per square meter, adjusting for inflation measured by the consumer price index (CPI) when necessary[2]. If the year of valuation was missing, the publishing year minus 1 has been considered for inflation purposes. Based on the OECD indicators, purchasing power parity rates have been used instead of the exchange rate when the study took place in a developing country (identified as not being an OECD country). In this way, all differences in price levels have been eliminated. If the values were expressed as NPV, they have been transformed into their corresponding annual cash flow, assuming all cash flows constant throughout the NBS lifespan.

Finally, the database has been used to associate the NBS with all their economic values and to compute the TEV provided by them. Extreme values have been removed within each ES. Outliers have been identified as such values that are outside the interval [Q1 – 1,5 * IQR, Q3 + 1,5 *IQR], where Q1 is the first quartile, Q3 is the third quartile, and IQR is the interquartile range, given by Q3 – Q1. Since all distributions of the values of each ES are positive skewed, only values larger than the upper limit of the interval have been detected. Overall, X values have been deemed outliers, and therefore excluded from the analysis. Given the considerable number of values obtained for each ES considered, minimum and maximum values have been provided. If only one value was available for a certain ES, such figure would be used for both the minimum and the maximum. The minimum values of all the ES of a specific NBS have been then added together to compute the minimum economic value of the NBS. The same approach has been adopted with the maximum values, in order to provide a range for the monetary assessment of the NBS. In this way, it has been possible to calculate a range that identifies the minimum and the maximum TEV delivered by each NBS considered.

3.1 Data set for the benefit transfer valuation

Out of the 75 papers included, almost 40 concern urban trees and green roofs, almost 30 analyse urban park and urban wetlands, and the remaining ones assess SUDs and green walls. Several papers include the economic valuation of more than one ecosystem service provided by the NBS analysed. A total of 249 observations on the economic values provided by NBS were identified. The observations have been systematized in a database that includes the following information: i) NBS analysed, ii) study location (city and country), iii) year of evaluation, iv) ES gauged, v) economic value, vi) methodology adopted if available, and vii) paper’s title and year of publication. The table below summaries the typologies of NbS, the ES valuated per each NbS.

[1] Snowballing refers to using the reference list of a paper or the citations to the paper to identify additional papers.

[2] https://www.inflationtool.com

		Urban parks	Urban trees	SUDs	Green roof	Green wall	Urban orchards	Technological green	Urban wetland	Cycle path
PROVISION	Food provision				X		X			
	Raw materials					X			X	
	Fresh water			X					X	
	Medicinal resources								X	
REGULATION	Carbon sequestration and storage	X	X	X	X	X			X	
	Air quality regulation	X	X	X	X	X			X	
	Regulation of water flows	X	X	X	X		X		X	
	Waste-water treatment			X	X				X	
	Local climate regulation		X	X	X				X	
	Moderation of extreme events			X	X				X	
	Noise reduction				X	X				
	Erosion prevention and maintenance of soil fertility								X	
SUPPORTING	Habitats for species			X	X				X	
CULTUR	Recreation and mental and physical health	X	X		X		X		X	

	Aesthetic appreciation and inspiration for culture, art and design	X	X	X	X	X			X	
	Spiritual experience and sense of place	X								
	Tourism	X							X	
	All							X		

Table 3: NbS and ES values identified in literature

In total, the economic values of 9 different typologies of NbS have been identified considering 71 ES. The methodologies and tools adopted for the economic valuation performance in the case studies are different. The table below reports the list of the methodologies and tools used in the case studies individuated and the number of recurrence of each of them.

Methodology or tool adopted for the economic valuation
Replacement cost
Contingent valuation
Choice modelling
Damage cost avoided
Hedonic prices
In-depth interviews
Market prices
Travel costs
Questionnaires
Q methodology
BeST (Benefits of SuDS Tool)
CITYgreen
GI-Val (Green Infrastructure Valuation Toolkit)
HEAT (Health Economic Assessment Tools)
i-Tree (previously UFORE)
ORVal
The National Green Value Calculator

Table 4: methodologies or tools adopted for the economic valuation in the case studies and number of recurrences

In total 10 methodologies and 6 tools have been used in the case studies individuated. The most used methodology is "damage and avoided cost", followed by the "replacement cost and "hedonic prices" and finally by the "contingent valuation". The tools that have been used more than once in the case studies are: i-Tree and BeST. The variability in the methodologies and tools applied for the valuation of ES generate different values individuated per each ES. For this reason, when possible a range of values has been defined per each ES by using the minimum and the maximum value detected. The economic values have been converted in euros, the value of the ES generated per single unit of measure have been calculated. The values are expressed either in *euro/m2/year* or *euro/tree/year*. In some cases, values with different units of measure have been individuated for a single ecosystem service based on the results of the case studies review. The table summarises the unit of measures used for each ecosystems service.

Ecosystem service	Unit of measure
Carbon storage and sequestration	€/tree
Air quality regulation	
Regulation of water flows	
Local climate regulation	
Aesthetic appreciation and inspiration for culture, art and design	
Food provision	€/m2
Raw materials	
Fresh water	
Medicinal resources	
Carbon sequestration and storage	
Air quality regulation	
Regulation of water flows	
Waste-water treatment	
Local climate regulation	
Moderation of extreme events	
Noise reduction	
Erosion prevention and maintenance of soil fertility	
Habitats for species	
Recreation and mental and physical health	
Aesthetic appreciation and inspiration for culture, art and design	
Spiritual experience and sense of place	
Tourism	

Table 5: ES and unit of measures

Based on this analysis, a matrix has been created to associate the NBS planned in Front-runner cities with the ecosystems provided and their values. The matrix is reported in table 5. The different colour of the cells represents the unit of measure per each ecosystem service: purple - m^2/year; green - tree/year.

NBS category	Urban park	Urban tree		SuDs	Green roof	Green wall	Urban orchards	Technological green	Urban wetland	Cycle path
Food provision					18,93 - 18,93		4,73 €		0,006 - 5,02	
Raw materials						0,02 - 0,02			0,03 - 0,14	
Fresh water				0,18 - 0,18					0,003 - 0,56	
Medicinal resources									0,0002 - 0,006	
Carbon sequestration and storage	0,36 - 2,24 €	0,01 - 2,79	0,17 - 22,4	0,04 - 0,04	0,00017 - 1,02	0,00007 - 0,00008			0,01 - 1,11	
Air quality regulation	0,003 - 0,11	0,01 - 16,01	0,31 - 23,05	0,03 - 0,03	0,11 - 1,84	0,009 - 0,83			0,01 - 0,12	
Regulation of water flows	0,11 - 0,18	0,06 - 0,9	76,02 - 76,02	0,006 - 39,9	0,003 - 4,12		0,006 - 39,90		0,17 - 0,24	
Waste-water treatment				0,03 - 0,03	1,94 - 2,9				0,002 - 11,06	
Local climate regulation	0,03 - 69,34	0,03 - 69,34	4,3 - 14,39	0,02 - 0,03	0,03 - 16,83	0,02 - 6,73			0,01 - 1,8	
Moderation of extreme events				0,57 - 0,6	0,002 - 0,002				0,0022 - 4,42	
Noise reduction					2,03 - 9,1	3,32 - 20,6				
Erosion prevention and maintenance of soil fertility									0,000003 - 1,9	
Habitats for species				0,00033 - 0,0003	0,001 - 0,65				0,004 - 1,08	
Recreation and mental and physical health		0,1 - 0,1			10,7 - 10,7		2,54 - 43,90		0,0044 - 31,02	2,54 - 43,90
Aesthetic appreciation and inspiration for culture, art and		0,16 - 112,24	112-112	0,02 - 4,81	3,24 - 116,93	3,43 €			0,04 - 0,08	
Spiritual experience and sense of place	0,003 - 20,03									
Tourism									0,73 - 2,08	
All								0,51 - 15,14		

m2/year
tree/year

^ the value refers to the ecosystem provided by another NBS, but it has been transferred given the characteristics of the NBS considered and the ecosystem provided

Table 6: ES economic valuation matrix

The matrix includes the values detected in the literature. In some cases, the value of a specific ecosystem service is represented by a single value since only a case study was found for that particular ecosystem service and NBS. In other cases, the values of the ecosystems are represented by ranges since more than one value has been found in the literature. For some NBS (Urban trees and Urban gardens and parks) the values individuated have different units of measurement: m2/year and tree/year. In those cases, to avoid the double counting issue, only the value referred at the trees has been used to perform the ex-post valuation, since the value is more reliable. Furthermore, the values of some ES related at a particular NBS have also been associated with other NBS given their similar structure. Here is the list of the NBS and ES association:

1. The carbon sequestration value related to the NBS "Urban trees" has been associated with the NBS "Urban gardens and parks";
2. The air quality regulation value related to the NBS "Urban trees" has been associated with the NBS "Urban gardens and parks";
3. The climate regulation value related to the NBS "Urban trees" has been associated with the NBS "Urban gardens and parks";
4. The storm water protection value related to the NBS "Urban trees" has been associated at the NBS "Urban gardens and parks", "Rain garden", "Permeable pavement", "Vegetated swale" and "Urban orchards";
5. The water regulation value related to the "Permeable pavement" has been associated with the NBS "Urban gardens and parks" and "Urban orchards";
6. The carbon sequestration, air quality regulation and UIH effect values related to the NBS "green roofs" have been associated with the "green walls";
7. The aesthetic value related to the "green walls" has been associated with the NBS "green walls";
8. The recreational and tourism value related to the "Urban gardens and parks" has been associated with the NBS "Urban orchards" and "Cycle path".

Finally, for a specific category of NBS referred at the "technological green" the value associated with the benefit transfer application relates to the Neonato et al. study (Neonato et al., 2019). The value individuated by Neonato et al. includes all the ES provided by the NBS and it has been calculated through the benefit transfer technique. This value has been used to valuate the most innovative NBS planned in Urban GreenUP since no case studies have been found in the literature. To perform the ex-post valuation, it has been necessary to individuate the correspondences between the NBS (and ES) detected through the literature review and the NBS planned in Valladolid, Liverpool, and Izmir. The NBS planned in Front-runner cities have been analysed to understand their characteristics and to individuate the ES provided by them. In this way, it has been possible to associate the values detected from the literature review and to perform the economic valuation. In almost all of the NBS considered it has not been possible to attribute a value at all the ES provided given the limited number of case studies available. The table below summaries the associations between the NBS detected in the case studies, the NBS planned in Front-runner cities and the ES that have been considered. The correspondence between the NBS individuated in the literature review case studies and the NBS planned in

Urban GreenUP cities have been performed though the accurate analysis of the NBS description to understand and detect which are the ES provided.

NBS in literature review	Corresponding Urban GreenUP NBS
Cycle path	Cycle and pedestrian green route
Green roof	Green roof and green covering shelters
Green walls	Vertical gardens and green walls
Permeable pavement	Cool pavement
Vegetated swale	Grassed swales and water retention ponds
Green roof	Green roof and green covering shelters
Rain garden	Rain gardens; SUDs
Technological green	Electro wetland
Technological green	Floating gardens
Technological green	Green noise barriers
Technological green	Floating reed beds
Technological green	Green shady structures
Technological green	Mobile gardens (trees)
Technological green	Urban garden bio-filter
Urban trees	Cooling and shade trees; Planting and renewal urban trees (including urban catchment forestry); Urban carbon sink; Trees re-naturing parking; Natural wastewater treatment (including green filter area)
Urban gardens and parks	Green resting areas and parklets; Cooling and shade trees; Planting and renewal urban trees (including urban catchment forestry); Urban carbon sink; Trees re-naturing parking; Natural wastewater treatment (including green filter area)
Urban orchards	Urban farming
Urban orchards	Establishment of fruit walls

Table 7: Associations between the NBS detected in the case studies and the NBS planned in Front-runner cities

After that, the values have been associated to each ecosystem service provided by NBS planned in Valladolid, Liverpool, and Izmir and the ex-post valuation based on the benefit transfer technique has been performed. Finally, based on the monitoring data provided by front-runner cities the economic values associated to some NBS and ES have been adjusted in order to better represent the performance of NBS. Considering the availability of the economic values and of the monitoring data, the values adjustments have been applied only for few ES. The following table summaries the adjusted economic values per each front-runner city, NBS and ES.

Valladolid	Air quality regulation for green covering shelters and green wall Local climate regulation for green covering shelters and green wall
Liverpool	Air quality regulation for SUDs, rain garden, urban catchment forest and green travel route.

Izmir	Air quality regulation and Local climate regulation for Arboreal areas, Green Car Park Covering Shelter, Cool pavement, and Green Shady structures

Table 8: Adjusted economic values pe reach NBS and ES

The valuation performed allowed identifying the values generated through the implementation of NBS. Nonetheless, the benefit transfer technique adopted is characterise by some limitations in the results obtained. In particular, the limited number of case studies individuated represents a shortcoming for the ex-post economic valuation performed. In, fact, in several cases it has not been possible to attribute a value to each ecosystem service provided by the NBS considered. Finally, the economic value adjustment has not been applied to all NBS and ES given the limited availability monitoring data.

4 ES monetary valuation in Valladolid

4.1 NBS and ES

The NBS planned by Valladolid will be implemented in three different demo sites: SubDemo site A, SubDemo site B, SubDemo site C. The table below summarised the NBS included in the economic valuation and the related ES that have been associated to them.

	NBS	ES associated
SUB DEMO A	New green cycle lane/Cycle-pedestrian green paths	Recreation and mental and physical health
	Planting 1000 trees	Carbon sequestration and storage, Air quality regulation, Regulation of water flows, Local climate regulation, Recreation and mental and physical health, Aesthetic appreciation and inspiration for culture, art and design, Spiritual experience and sense of place
	Tree shady places/green resting areas	Carbon sequestration and storage, Air quality regulation, Regulation of water flows, Local climate regulation, Spiritual experience and sense of place
	Smarts soils as substrate	N.A.
	Natural pollinator's modules	N.A.
SUB DEMO B	Shade and cooling trees	Carbon sequestration and storage, Air quality regulation, Regulation of water flows, Local climate regulation, Recreation and mental and physical health, Aesthetic appreciation and inspiration for culture, art and design, Spiritual experience and sense of place
	Electro wetland roof	All ES
	Green Roof/Green Covering Shelter/Green Shady Structures	Food provision, Carbon sequestration and storage, Air quality regulation, Regulation of water flows, Waste-water treatment, Local climate regulation, Moderation of extreme events, Habitat fo rspecies, Recreation and mental and physical health, Aesthetic appreciation and inspiration for culture, art and design, Spiritual experience and sense of place
	Compacted pollinator's modules	N.A.
	Urban Garden Bio-Filter	All ES
	Smarts soils as substrate	N.A.
	Green Noise Barriers	All ES
	Green Façade/Vertical mobile garden	Raw materials, Carbon sequestration and storage, Air quality regulation, Local climate regulation, Aesthetic appreciation and inspiration for culture, art and design
SUB DEMO C	Re-naturing parking trees	Carbon sequestration and storage, Air quality regulation, Regulation of water flows, Local climate regulation, Recreation and mental and physical health, Aesthetic appreciation and inspiration for culture, art and design, Spiritual experience and sense of place

	Rain gardens/SUDs for renaturing parking	Fresh water, Carbon sequestration and storage, Air quality regulation, Regulation of water flows, Waste-water treatment, Local climate regulation, Moderation of extreme events, Habitat for species, Aesthetic appreciation and inspiration for culture, art and design
	Urban Carbon Sink	Carbon sequestration and storage, Air quality regulation, Regulation of water flows, Local climate regulation, Spiritual experience and sense of place
	Parking Green Pavement	N.A.
	Natural pollinator's modules	N.A.
	Compacted pollinator's modules	N.A.
	Smarts soils as substrate	N.A.
	Urban orchards	Food Provision, Regulation of water flows, Recreation and mental and physical health

Table 9: NBS and ES valuated in Valladolid

4.2 Ex-post economic valuation

The benefit transfer technique has been performed to identify ex-post the economic value generated through the implementation of the NBS in Valladolid. The economic value of NBS implemented in:

- SUB Demo A is 107.795 - 315.410 euro per year;
- SUB Demo B is 80.356 - 541.047 euro per year;
- SUB Demo C is 137.244 - 1.599.175 euro per year.

The table below summarises the results obtained for the Valladolid case study.

	NBS	ECONOMIC VALUES PER YEAR min-max.	
SUB DEMO A	New green cycle lane/Cycle-pedestrian green paths	8.484 €	146.626 €
	Planting 1000 trees	96.400 €	123.930 €
	Tree shady places/green resting areas	2.912 €	44.854 €
	Smarts soils as substrate	/	/
	Natural pollinator's modules	/	/
	TOT	**107.795 €**	**315.410 €**
SUB DEMO B	Shade and cooling trees	58.210 €	275.738 €
	Electro wetland roof	26 €	757 €
	Green Roof/Green Covering Shelter/Green Shady Structures	19.028 €	217.104 €
	Compacted pollinator's modules	/	/
	Urban Garden Bio-Filter	5 €	151 €
	Smarts soils as substrate	/	/
	Green Noise Barriers	161 €	4.769 €
	Green Façade/Vertical mobile garden	2.927 €	42.528 €
	TOT	**80.356 €**	**541.047 €**
SU B	Re-naturing parking trees	38.560 €	49.572 €

	Rain gardens/SUDs for renaturing parking	896 €	45.620 €
	Urban Carbon Sink	97.060 €	1.495.130 €
	Parking Green Pavement	/	/
	Natural pollinator's modules	/	/
	Compacted pollinator's modules	/	/
	Smarts soils as substrate	/	/
	Urban orchards	728 €	8.853 €
	TOT	**137.244 €**	**1.599.175 €**

Table 10: Economic valuation of the NBS implemented din Valladolid

The table summarises the economic value that can be generated through the implementation of NBS in Valladolid. The analysis performed allowed the calculation also the total value generated per each ecosystem service. The table below summarises the results obtained.

	ES value
Regulating	97.168 € - 1.169.093 €
Provisioning	437 €
Supporting	1 € - 476 €
Cultural	227.441 € - 1.276.319 €

Table 11: ES value in Valladolid

The total economic value generated through the implementation of the NBS in Valladolid is in the range of 325.395 € € and 2.455.632 € based on the results obtained through the application of the ex-post valuation approach.

The high difference between the min. and max. values is because the values used for some ecosystem services have a higher gap. This happens in the case of local climate regulation and Aesthetic appreciation and inspiration for culture, art and design services related to urban carbon sinks and urban parks. In the case of local climate regulation, the min. and max. are very different from each other as NBS can have a different effect on climate regulation based on the characteristics of the city and its geographical location. In the case of the Aesthetic appreciation and inspiration for culture, art and design service, the large gap between the min. max. it is derived from the valuation approaches used to calculate its value. Indeed, to evaluate cultural ecosystem services, the revealed preferences or stated preferences approaches are used. In these cases, the values are derived from parallel market transactions which, in the case of revealed preferences, are indirectly associated with the ES to be valued and, in the case of stated preferences, are associated with the creation of hypothetical markets based on people's willingness to pay. So the value of these services can be very different as it is influenced by socio-cultural factors and the perception of individuals.

For both ecosystem services – local climate regulation and Aesthetic appreciation and inspiration for culture, art and design – the values have been adjusted and the outliers eliminated. Despite these, the gap between the min. max. it remained consistent. This is also reflected in the results obtained for Liverpool and Izmir.

5 ES monetary valuation in Liverpool

5.1 NBS and ES

The NBS planned by Liverpool will be implemented in three different demo sites: SubDemo site A, SubDemo site B, SubDemo site C. The table below summarised the NBS included in the economic valuation and the related ES that have been associated to them.

	NBS	ES associated
SUB DEMO A	New pedestrian and cycleway green route	Recreation and mental and physical health
	Cooling and shade trees	Carbon sequestration and storage, Air quality regulation, Regulation of water flows, Local climate regulation, Recreation and mental and physical health, Aesthetic appreciation and inspiration for culture, art and design, Spiritual experience and sense of place
	SUDS raingarden and HDP	Fresh water, Carbon sequestration and storage, Air quality regulation, Regulation of water flows, Waste-water treatment, Local climate regulation, Moderation of extreme events, Habitat for species, Aesthetic appreciation and inspiration for culture, art and design
	Enhanced nutrient managing and releasing soil	N.A.
	Pollinator verges	All ES
	Pollinator walls vertical	Raw materials, Carbon sequestration and storage, Air quality regulation, Local climate regulation, Aesthetic appreciation and inspiration for culture, art and design
	Floating gardens	All ES
	Hard drainage pavements	All ES
	Green resting areas	Carbon sequestration and storage, Air quality regulation, Regulation of water flows, Local climate regulation, Spiritual experience and sense of place
	Green screens	N.A.
SUB DEMO B	Green travel route	Recreation and mental and physical health
	Road junction pedestrian improvements	N.A.
	Urban catchment forestry and shade trees	Carbon sequestration and storage, Air quality regulation, Regulation of water flows, Local climate regulation, Recreation and mental and physical health, Aesthetic appreciation and inspiration for culture, art and design, Spiritual experience and sense of place
	Hard drainage pavements	All ES

	Pollinator walls vertical	Raw materials, Carbon sequestration and storage, Air quality regulation, Local climate regulation, Aesthetic appreciation and inspiration for culture, art and design
	Green filter area	N.A.
SUB DEMO C	New pedestrian and cycleway green route	Recreation and mental and physical health
	Road junction pedestrian improvements	N.A.
	Urban catchment forestry, Urban Carbon Sink and shade trees	Carbon sequestration and storage, Air quality regulation, Regulation of water flows, Local climate regulation, Recreation and mental and physical health, Aesthetic appreciation and inspiration for culture, art and design, Spiritual experience and sense of place
	SUDS raingarden	Fresh water, Carbon sequestration and storage, Air quality regulation, Regulation of water flows, Waste-water treatment, Local climate regulation, Moderation of extreme events, Habitat for species, Aesthetic appreciation and inspiration for culture, art and design
	Hard drainage (flood prevention)	N.A.
	Enhanced nutrient managing and releasing soil	N.A.
	Pollinator verges	All ES
	Floating gardens	All ES
	Green screens	N.A.

Table 12: NBS and ES valuated in Liverpool

5.2 Ex-post economic valuation

The benefit transfer technique has been performed to identify ex-post the economic value generated through the implementation of the NBS in Liverpool. The economic value of NBS implemented in:

- SUB Demo A is 13.011 - 174.489 euro per year;
- SUB Demo B is 29.734 - 1.502.320 euro per year;
- SUB Demo C is 31.195 - 474.357 euro per year.

The table below summarises the results obtained for the Liverpool case study.

	NBS	ECONOMIC VALUES PER YEAR min. -max.	
SUB DEMO A	New pedestrian and cycleway green route	1.016 €	17.560 €
	Cooling and shade trees	6.141 €	10.325 €
	SUDS raingarden and HDP	372 €	18.403 €
	Enhanced nutrient managing and releasing soil	/	/
	Pollinator verges	3.060 €	90.840 €

	Pollinator walls vertical	272 €	1.264 €
	Floating gardens	30 €	895 €
	Hard drainage pavements	179 €	5.299 €
	Green resting areas	1.941 €	29.903 €
	Green screens	/	/
	TOT	**13.011 €**	**174.489 €**
SUB DEMO B	Green travel route	15.240 €	263.400 €
	Road junction pedestrian improvements	/	/
	Urban catchment forestry and shade trees	12.955 €	1.227.299 €
	Hard drainage pavements	179 €	5.299 €
	Pollinator walls vertical	1.360 €	6.322 €
	Green filter area	/	/
	TOT	**29.734 €**	**1.502.320 €**
SUB DEMO C	New pedestrian and cycleway green route	24.384 €	421.440 €
	Road junction pedestrian improvements	/	/
	Urban catchment forestry, Urban Carbon Sink and shade trees	9.050 €	15.216 €
	SUDS raingarden	731 €	36.806 €
	Hard drainage (flood prevention)	/	/
	Enhanced nutrient managing and releasing soil	/	/
	Pollinator verges	/	/
	Floating gardens	30 €	895 €
	Green screens	**34.195 €**	**474.357 €**

Table 13: Economic valuation of the NBS implemented in Liverpool

The table summarises the economic value that can be generated through the implementation of NBS in Liverpool. The analysis performed allowed the calculation also the total value generated per each ecosystem service. The table below summarises the results obtained.

	ES value
Regulating	22.401 € - 1.203.188 €
Provisioning	221 €
Supporting	/
Cultural	71.588 € - 868.985 €

Table 14: ES value in Liverpool

The total economic value generated through the implementation of the NBS in Liverpool is in the range of 97.816 € € and 2.125.352 € based on the results obtained through the application of the ex-post valuation approach.

6 ES monetary valuation in Izmir

6.1 NBS and ES

The NBS planned by Izmir will be implemented in three different demo sites: SubDemo site A, SubDemo site B, SubDemo site C. Furthermore, the NBS have been grouped based on the typology of intervention: renaturing urban areas, water interventions, singular green infrastructure, and non-technical interventions. The table below summarised the NBS included in the economic valuation and the related ES that have been associated to them.

	NBS	**ES associated**
SUB DEMO A	Arboreal areas	N.A.
	Green Car Park Covering Shelter	All ES
	Cool pavement	Fresh water, Carbon sequestration and storage, Air quality regulation, Regulation of water flows, Waste-water treatment, Local climate regulation, Moderation of extreme events, Habitat for species, Aesthetic appreciation and inspiration for culture, art and design
	Green Shady structures and Smart soil	All ES
	Installation of Parklets	Carbon sequestration and storage, Air quality regulation, Regulation of water flows, Local climate regulation, Spiritual experience and sense of place
SUB DEMO B	Grassed swales and water retention ponds around Bio-boulevard	Fresh water, Carbon sequestration and storage, Air quality regulation, Regulation of water flows, Waste-water treatment, Local climate regulation, Moderation of extreme events, Habitat for species, Aesthetic appreciation and inspiration for culture, art and design
	Natural Pollinator's modules	N.A.
	Smart soil production in climate-smart urban farming precinct	N.A.
	Climate-smart greenhouses	All ES
	Improving Overall Efficiency of urban waste water treatment by using by-products	N.A.
	The Bio-boulevard	N.A.
SUB DEMO C	Planting 4,800 trees	Carbon sequestration and storage, Air quality regulation, Regulation of water flows, Local climate regulation, Recreation and mental and physical health, Aesthetic appreciation and inspiration for culture, art and design, Spiritual experience and sense of place
	Green pavements for Peynircioğlu River	Fresh water, Carbon sequestration and storage, Air quality regulation, Regulation of water flows, Waste-water treatment, Local climate regulation, Moderation of extreme events, Habitat for species, Aesthetic appreciation and inspiration for culture, art and design
	Green fences	N.A.

	Establishment of fruit walls	Food Provision, Regulation of water flows, Recreation and mental and physical health
	Urban Carbon Sink	Carbon sequestration and storage, Air quality regulation, Regulation of water flows, Local climate regulation, Spiritual experience and sense of place
	Cycle and pedestrian route in new Green Corridor	Recreation and mental and physical health
	Culvert works for Peynircioğlu River	N.A.
	Industrial Heritage Route Along the Izmir urban Green Corridor (IUGC)	N.A.

Table 15: NBS and ES valuated in Izmir

6.2 Ex-post economic valuation

The benefit transfer technique has been performed to identify ex-post the economic value generated through the implementation of the NBS in Izmir. The economic value of NBS implemented in:

- SUB Demo A is 174.193 – 402.744 euro per year;
- SUB Demo B is 2.924 - 139.082 euro per year;
- SUB Demo C is 975.503 - 5.217.757 euro per year.

The table below summarises the results obtained for the Liverpool case study.

	NBS	**ECONOMIC VALUES PER YEAR min. -max.**	
SUB DEMO A	Arboreal areas	/	/
	Green Car Park Covering Shelter	699 €	20.742 €
	Cool pavement	170.389 €	331.396 €
	Green Shady structures and Smart soil	194 €	5.753 €
	Installation of Parklets	2.912 €	44.854 €
	TOT	**174.193 €**	**402.744 €**
SUB DEMO B	Grassed swales and water retention ponds around Bio-boulevard	2.465 €	125.456 €
	Natural Pollinator's modules	/	/
	Smart soil production in climate-smart urban farming precinct	/	/
	climate-smart greenhouses	459 €	13.626 €
	Improving Overall Efficiency of urban waste water treatment by using by-products	/	/
	The Bio-boulevard	/	/
	TOT	**2.924 €**	**139.082 €**
SUB DEMO	Planting 4,800 trees	934.171 €	2.340.192 €
	Green pavements for Peynircioğlu River	6.454 €	328.466 €

	Green fences		
	Establishment of fruit walls	698 €	8.499 €
	Urban Carbon Sink	3.700 €	2.013.800 €
	Cycle and pedestrian route in new Green Corridor	30.480 €	526.800 €
	Culvert works for Peynircioğlu River	/	/
	Industrial Heritage Route Along the Izmir urban Green Corridor (IUGC)	/	/
	TOT	**975.503 €**	**5.217.757 €**

Table 16: Economic valuation of the NBS implemented in Izmir

The table summarises the economic value that can be generated through the implementation of NBS in Izmir. The analysis performed allowed the calculation also the total value generated per each ecosystem service. The table below summarises the results obtained.

	ES value
Regulating	574.416 - 3.436.050 €
Provisioning	454 €
Supporting	/
Cultural	572.222 - 2.278.781 €

Table 17: ES value in Izmir

The total economic value generated through the implementation of the NBS in Liverpool is in the range of 1.152.621 € and 5.759.584 € based on the results obtained through the application of the ex-post valuation approach.

7 Conclusions

The ex-post valuation has been performed using the benefit transfer technique to quantify the economic value that will be generated through the implementation of the NBS in Valladolid, Liverpool, and Izmir.

To perform the economic valuation, it has been necessary to:

1. Analyse several case studies in which the ES have been valuated at urban level;
2. Update the repository of economic values created for the ex-ante valuation;
3. Analyse the NBS planned in the three Front-runner cities;
4. Identify the ES provided by the NBS in Front-runner cities;
5. Associate the values individuated to each ecosystem service provided by each NBS;
6. Adjust – when possible – the economic values attributed to the ES provided by each NBS;
7. Perform the valuation.

The results show that the NBS planned can generate several impacts at the urban level and at the same time can help the cities to cope with the significant challenges that are affecting their territories. The table below summaries the ES values generated by the NBS implementation in the three cities.

	VALLADOLID	LIVERPOOL	IZMIR
Regulating	97.168 - 1.169.093 €	22.401 - 1.203.188 €	574.416 - 3.436.050 €
Provisioning	437 €	221 €	454 €
Supporting	1 - 476 €	/	
Cultural	227.441 - 1.276.319 €	71.588 - 868.985 €	572.222 - 2.278.781 €

Table 18: ES values in the Front-runner cities of Urban GreenUP

The valuation performed has two main limits:

- it has not been possible to valuate all the ES provided by NBS planned in Front-runner cities given the lack of data in literature linked in particular with specific categories of ES such as provisioning, supporting and cultural. Between these, Cultural ES are of particular importance given the impacts generated on health and well-being for citizens.
- the case studies individuated have used different tools and methodologies to perform the economic valuation generating different values per ecosystem service;
- the economic min. max. values of some ES have a considerable gap given the approach used for the economic valuation;
- it was not possible to adjust the economic values identified given the lack of monitoring data.

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