



Guidance Packages – Methodology for Ecosystem Services Mapping and Valuation

Slovenia Forest Service



Imprint**Publisher:**

Slovenia Forest service in the URBforDAN: Management and Utilization of Urban Forest as Natural Heritage in Danube cities” project, implemented through Interreg Danube Transnational Programme and co-financed by European Union funds (ERDF and IPA).

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Draft Edition: Slovenia Forest Service, April 2019



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1 Introduction

1.1 Why and what to map?

The main objective of ecosystem services (ES) mapping is to get a good basis for preparation of strategic and operational management plan for urban and peri-urban forests (UPF). Therefore, we mainly focus on mapping the potential of forests to provide ES, which is defined as the amount ES that can be provided or used in a sustainable way in a certain region given current land use and ecosystem properties and conditions, and should be regarded for a longer time period (Syrbe et al. 2017). In the context of our UPF, ES mapping should therefore be based on current use (e.g. existing recreational trails) and potential uses (e.g., where trails do not exist yet, but there are needs/demands and possibilities to build additional infrastructure).

The final product is the map of ES we want to promote in our UPF.

Table 4: FAO Classification of Ecosystem Services

Group of services	Type of ES	ES regarding urban forests
Provisioning services	Food	Non Timber Forest products
Provisioning services	Raw materials	Wood and fibers
Provisioning services	Freshwater	Freshwater supplies
Provisioning services	Medicinal resources	
Regulating services	Local Climate Air Quality	Forests affect air quality
Regulating services	Carbon sequestration and storage	CS in wood
Regulating services	Moderation of extreme events	Influence on extreme events
Regulating services	Waste-water treatment	Root system of trees in the forests
Regulating services	Erosion prevention and maintenance of soil fertility	Forest prevents erosion
Regulating services	Pollination	Natural forests are important habitat for pollinators
Regulating services	Biological control	Forests are reservoir of natural pest eradicators
Regulating services	Regulation of Water Flow	SFM is key to the regulation of water flows
Supporting services	Habitat for species	Forest is important habitat for many species
Supporting services	Maintenance of genetic diversity	Forests are among the most important repositories of terrestrial biological diversity.
Cultural services	Recreation and mental and physical health	Forests can host a wide range of sportive activities
Cultural services	Tourism	Tourism in forests is an important issue
Cultural services	Aesthetic appreciation and inspiration for culture, art and design	Forests have inspired the development of many technologies
Cultural services	Spiritual experience and sense of place	Nature have always had a part in spiritual life

1.2 An overview – process of mapping ecosystem services

Mapping usually consists of several steps, which need to be planned and communicated in advance with all relevant stakeholders. This ensures higher applicability of resulting maps and relevant grounds for socially fair decision making. Four main steps of mapping are:

- defining the aim of mapping,
- definition of indicators,
- estimation of indicator values and mapping their values,
- communicating the process with stakeholders.

There is an important issue of defining elements we wish to map. Generally, there are three aspects of ES assessment, which are commonly referred to as:

- demand (total amount/quality of ES consumer by society),
- flow (actual level of use of the locally-explicit ES), and
- supply (potential or actual capacity of the ecosystem to provide ES).

We can address either one or several of them, however indicators differ between the elements. The process of identification of indicators is crucial and needs to be implemented in a participatory format, where stakeholders can express their views on the most relevant form (qualitative or quantitative) and time scale. Experts are to pinpoint appropriate data sources and indicator estimation/mapping technique:

- direct methods; field measurements, field trials, surveys and questionnaires,
- indirect methods; remote sensing, socio-economic data, proxy indicators, expert judgments, statistical and process-based models.

1.3 Selected ecosystem services

The selection of ecosystem services for mapping and assessment has been done after the analysis of the input data from the seven project partners focus areas.

Table 1. Areas (ha) of relevant ecosystem services in urban forests

	Ljubljana	Zagreb	Belgrade	Vienna	Budapest	Ivano-Frankivsk	Cluj	Total
TOTAL AREA (ha)	651	36	489	290	15	20	41	1.542
FOREST AREA (ha)	636	31	369	165	12	15	41	1.269
ECOSYSTEM SERVICES								
protection		36				15		51
recreation	410	31	*				41	483
water protection		36		70				106
cultural heritage	80		*		1			81
nature protection		36		182				218
education								
tourism	410		*				41	451
climate	635	36			12			683
production	225	31			12	15		284
other		36						36

Table 2. Activities in forests - surface of areas with certain activities related to ecosystem services (ha)

	Ljubljana	Zagreb	Belgrade	Vienna	Budapest	Ivano-Frankivsk	Cluj
TOTAL AREA (ha)	651	36	489	290	15	20	41
FOREST AREA (ha)	636	31	369	165	12	15	41
logging	636	31	361			15	
mushroom collection	636	31			1	15	41
medicinal herbs collection		31			1	15	41
other non-timber forest products collection		31				15	
cycling (km)	15	0,45*	15		0,6*	2	
walking (km)	25	35,77*	13		0,6*	2	
implementation of education programmes			3				
resting /picnic		0,1 ha	17				

The main ecosystem services, which needs to be jointly mapped are:

- Tourism and Recreation (with main activities of cycling, walking and mushroom collection)
- Provisioning – raw materials (wood)
- Provisioning – food (mushroom collection) and medicinal resources (herbs collection)
- Climate protection

2 Mapping of ES

2.1 How to map – main procedure

- Create a group of experts that are familiar with the UPF in your region.
- Use existing information (shape files of different sectoral agencies, stakeholders' survey implemented in the project, information from already implemented workshops, other existing data such as visitor profiles etc.).
- Include stakeholders (e.g. forest owners, biologists, nature conservation agencies, spatial planning departments in charge of recreational infrastructure, cycling groups or clubs etc.).
- Ranking is mainly done by the group of experts, but you can communicate this with your stakeholders (desired/preferred).
- A GIS expert should do the technical part of mapping.

2.2 Experts and stakeholders involvement

ES mapping is conducted in participatory processes with the involvement of local experts. A person qualifies as an *expert* if he or she 1) works in direct contact with the ES in question, 2) personally experiences variance in ES performance depending on season, year and location, 3) has the competence to make ES management decisions that affect the state of the habitat and the actual yield of the ES. Involvement of experts will happen at the following levels:

- Individual consultations

Individual experts are consulted at the early phase of the process during customization of a specific ecosystem service and data pre-processing. Experts help identifying the ecosystem services and can also give advice in the availability of concerning spatial data. After the expert mini workshops, individual consultations are used to calibrate and fine-tune each ES.

- Expert mini workshops

In these events the actual important areas for each ES is presented.

To expert workshops, 2-4 experts should be invited (a group of people who work on different places and are not subordinated to each other).

- Stakeholder workshop

The draft maps are created and calibrated by the individual consultation. After that, the maps are presented in the first stakeholder workshops. In these workshops, feedbacks on the maps are gathered from a wider representation of stakeholders, and a simple validation will be performed.

2.3 Facilitators guide

To help project partners implementing the methods, a detailed 'guide for facilitators' is provided, including the suggested structure of the mini-workshops with detailed description of tasks and timing. We also provide templates to allow structured, well-documented and comparable process across the seven focus areas. These templates will assist PPs in facilitating the mini-workshops and individual expert discussions about simplification of habitats,

assigning ES capacity scores to the ecosystem types, defining further influencing rules, converting the ordinal scale to real measurement units, as well as validating the results shown by the maps.

2.4 Basic GIS Maps

The mapping of ecosystem services starts with the gathering of all existing GIS maps for the appropriate forest area (vector and raster maps) with an emphasis on:

- Protected areas (parks with different status, NATURA 2000, objects of natural heritage, as caves, habitat trees, specially preserved parts of the forest)
- Hydrology (watercourses - categorization in terms of watercourse size, standing water, swamps)
- Inclination map of the terrain (derived from Digital Elevation Model, DEM) - for determining the protective function (above 25 to 35 degrees)
- Recreation areas (footpaths, learning paths, cycling routes, points of view) and tourism (linear structures in the form of a buffer)
- Areas of intensive collection of non-wood forest product (forest fruits)
- Cultural heritage objects
- Various additional maps (if any): areas of special biotopes (nesting sites, quiet zones for wild animals, grassland inside the forest), floods, crawl zones, windbreaks, etc.

Please note: the individual ES area should not be smaller than 0,5 - 1 ha and the ES can be mapped as area, as line or as a point!

3 Criteria for mapping ES in urban forests

3.1 Criteria for mapping provisioning ES

ES considered	Criteria for mapping	Technical criteria for mapping	Ranking of ES importance
11_Timber production	Long-term high harvesting potential	Existing borders of forest stands/ compartments	According to the amount of possible harvested wood (see Slovenian example in the brackets and use it as a guideline, but adopt to your management guidelines): 1 – very important (areas where it is possible to harvest more than 7-8 m ³ per hectare) 2 – important (areas where it is possible to harvest between 5 m ³ and 7m ³ per hectare) 3 – medium importance (areas where it is possible to harvest less than 5 m ³ per hectare) 0 – harvesting is not permitted/allowed
12_Non-timber products	High harvesting potential	Polygons around the gathering area – use your local criteria or expert knowledge	1 – very important (forests managed exclusively for different forest products - for commercial use) 2 – important (high importance for gathering of mushrooms, chestnut, medicinal herbs collection, but for personal use only)
13_Provision of drinking water	Freshwater supply	Polygons - use your local criteria	According to the water protecting regime 1 – inner water protection zones 2 – wider water protection zones

Additional notes: Map agricultural and other non-forest lands within the border of UPF as individual shape layer.

3.2 Criteria for mapping regulating ecosystem services

ES considered	Criteria for mapping	Technical criteria for mapping	Ranking of ES importance
21_Local climate mitigation	Forests that protect settlements from wind, drying, frost; these are mainly forests around exposed settlements and tourist accommodations,	According to expert opinion, studies on local air climate and similar studies	1 – very important 2 – important 3 – medium importance Use your experts for ranking.

	forests around large agglomerations, forests around climate resorts		
22_Local air quality	Forests that protect settlements from pollution; these are mainly forests around exposed settlements and tourist accommodations, forests around large agglomerations, forests around climate resorts	According to expert opinion, studies on air pollution and similar studies	1 – very important (significant contribution to quality of air in the city – e.g. forests inside highway wings, forests in the proximity to major roads, forests as inlands in the built areas) 2 – important 3 – medium importance
23_Protection against noise pollution	Forests that protect settlements from noise pollution	Buffer around sources of noise according to expert opinion, studies on noise pollution	1 – very important 2 – important 3 – medium importance Use your experts for ranking.
24_Regulation of floods	Water retentions, dikes	Buffer of 10-50 m around	Only 1 rank – highly important
25_Protection against erosion	Erosion prevention and maintenance of soil fertility (+ proximity of settlements)	According to expert opinion and expert studies (use your local criteria)	1 – very important 2 – important 3 – medium importance Use your experts for ranking.
26_Waste-water treatment	Zagreb only; use your local criteria	According to expert opinion and expert studies (use your local criteria)	Only 1 rank – highly important

3.3 Criteria for mapping supporting ecosystem services

ES considered	Criteria for mapping	Technical criteria for mapping	Ranking of ES importance*
31_Nature protection/habitats for species	Legally protected forest areas by European or national directives or regional laws, Natura 2000 sites, other	Use criteria from Natura 2000 sites, from IUCN or your local criteria from forest management	1 – very important (priority species, endangered species, rare habitats) 2 – important (e.g. Natura 2000 sites)

	relevant habitats and biodiversity hotspots	plans or nature conservation agencies	3 – medium importance (other)
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3.4 Criteria for mapping cultural ecosystem services

ES considered	Criteria for mapping	Technical criteria for mapping	Ranking of ES importance
41_Recreation and tourism	Forests in the immediate vicinity of towns and major urban settlements, forests along intensively visited walking, hiking, bicycling, mountain-biking and riding trails, forests along European long-distance paths (E3, E4, E6, E7 and E8)	Buffer of 10-50 m around trails (adopt the buffer to the size of your UPF)	<p>1 – very important (highly visited trails – see the criteria for number of visitors bellow, multiple use of trails, trails in the close vicinity of settlements, panoramic trails, trails on ridges etc.)</p> <p>2 – important (the same as for 1, but with a lesser importance)</p> <p>3 – medium importance (less visited recreational trails in more remote areas but still part of UPF, access paths to the main trails)</p>
	Forests near tourist centres and holiday villages, highly visited tourist spots	Polygon around with small buffer according to expert opinion	<p>According to the number of visitors that visit centres (number of visitors should be adopted to your conditions; an example that may help is in the brackets bellow):</p> <p>1 – very important (>≈100 visitors per day)</p> <p>2 – important (≈50-100 visitors per day)</p> <p>3 – medium importance (≈10-50 visitors per day)</p>
	Points of interests such as panoramic towers, entry points	Centroid of 100 m around point (adopt the size of centroid to the size of your UPF)	Only 1 rank – highly important

	Natural sport polygons, outdoor gym	Polygon around with small buffer according to expert opinion	Only 1 rank – highly important
	Adrenalin parks	Polygon around with small buffer according to expert opinion	Only 1 rank – highly important
	Biking downhill polygons <i>And other...</i>	Polygon around downhill trails with small buffer according to expert opinion	Only 1 rank – highly important
42_Scientific / educational	Forest teaching rooms, forest playgrounds	Polygon around with small buffer according to expert opinion	Only 1 rank – highly important
	Educational trails	Buffer 10-50 m around trails (adopt the buffer to the size of your UPF)	Only 1 rank – highly important
43_Cultural heritage	Historical trails	Buffer 10-50 m around trail (adopt the buffer to the size of your UPF)	1 – very important 2 – important 3 – medium importance
	Historical and cultural points of interests	Centroid 50-100 m around (adopt the size of centroid to the size of your UPF)	According to the number of visitors 1 – very important 2 – important 3 – medium importance

Additional notes:

- When mapping recreational ES, please consider weighting if the network of existing recreational infrastructure is suitable regarding the demands for recreation. If not, then think about the potential for new trails and include this potential in the map of ES. Write down in the attribute table – column description if you are referring to the possible/ potential infrastructure.
- Please do not map the ES if they are of marginal importance.

4 Attribute part of ES mapping

Each ES should be mapped as individual layer. For each layer, an attribute table should be created according to the form in table 5. Note that each polygon should have an ID and a code, followed by rank and description. The columns 3 (types of ES) and 4 (Ecosystem services) are for orientation only, you do not need to include them in your attribute table.

Table 5: Code list of ecosystem services

ID ^a	Code	Rank	Types of ES	Ecosystem service	Description ^b
	11	1/2/3/0	Provisioning services	Timber production	Short explanation
	12	1/2	Provisioning services	Non-timber products	Short explanation, e.g. place for medicinal herb collection
	13	1/2	Provisioning services	Freshwater supplies	Short explanation
	21	1/2/3	Regulating services	Local climate mitigation	Short explanation
	22	1/2/3	Regulating services	Local air quality	Short explanation
	23	1/2/3	Regulating services	Protection against noise pollution	Short explanation, like source of noise
	24	1	Regulating services	Regulation of floods	Short explanation, e.g. water retention
	25	1/2/3	Regulating services	Protection against erosion	Short explanation
	26	1	Regulating services	Waste water treatment	Short explanation
	31	1/2/3	Supporting services	Habitats for species / nature conservation	Short explanation, e.g. Natura 2000 site, place for endangered species xxx etc.
	41	1/2/3	Cultural services	Recreation and tourism	Short explanation, e.g. hiking trail, visitor centre
	42	1	Cultural services	Scientific/ educational	Short explanation, e.g. children playground
	43	1/2/3	Cultural services	Cultural heritage	Short explanation

^aEach polygon should have ID (1, 2, 3...)

^bThese descriptions should attach to the criteria for mapping in previous tables – put down concrete activity/ importance of selected area

5 Literature

Forest Ecosystem Services: An Analysis of Worldwide Research, 2018, by José A. Aznar-Sánchez, Luis J. Belmonte-Ureña, María J. López-Serrano and Juan F. Velasco-Muñoz, in *Forests*, 2018, 9, 453

Guidelines on urban and peri-urban forestry, FAO. 2016, by F. Salbitano, S. Borelli, M. Conigliaro and Y. Chen. FAO Forestry Paper No. 178. Rome, Food and Agriculture Organization of the United Nations

Mapping forest ecosystem services, 2017, in book: *Ecosystem Services Mapping*, Chapter: 7.3.3., Publisher: Pensoft Publishers, Editors: Benjamin Burkhard and Joachim Maes, Projects: ESMERALDA - Enhancing ecosystem services mapping for policy and decision making

Manual for elaboration of Forest Management Plans for Forest Management Units, 2008, 2012, Slovenia Forest Service, Department for forest management planning

Mapping and assessment of forest ecosystems and their services – Applications and guidance for decision making in the framework of MAES, 2015, by José I. Barredo, Annemarie Bastrup-Birk, Anne Teller, Miren Onaindia, Beatriz Fernández de Manuel, Iosu Madariaga, Gloria Rodríguez-Loinaz, Pedro Pinho, Alice Nunes, Alzira Ramos, Melanie Batista, Sara Mimo, Claudia Cordovil, Cristina Branquinho, Adrienne Grêt-Regamey, Peter Bebi, Sibyl Hanna Brunner, Bettina Weibel, Leena Kopperoinen, Pekka Itkonen, Arto Viinikka, Gherardo Chirici, Francesca Bottalico, Lucia Pesola, Matteo Vizzarri, Vittorio Garfi, Leonardo Antonello, Anna Barbati, Piermaria Corona, Sebastiano Cullotta, Vincenzo Giannico, Raffaele Laforteza, Fabio Lombardi, Marco Marchetti, Susanna Nocentini, Francesco Riccioli, Davide Travaglini, Lorenzo Sallustio, Inês Rosário, Marius von Essen, Kimberly A. Nicholas, Cristina Máguas, Rui Rebelo, Margarida Santos-Reis, Fernando Santos-Martín, Pedro Zorrilla-Miras, Carlos Montes, Javier Benayas, Berta Martín-López, Tord Snäll, Håkan Berglund, Jan Bengtsson, Jon Moen, Lorenzo Busetto, Jesús San-Miguel-Ayanz, Martin Thurner, Christian Beer, Maurizio Santoro, Nuno Carvalhais, Thomas Wutzler, Dmitry Schepaschenko, Anatoly Shvidenko, Elisabeth Kompter, Bernhard Ahrens, Shaun R. Levick, Christiane Schmullius) EUR 27751 EN; doi:10.2788/720519

What to map? 2017, by Syrbe R.-U., Schröter, M., Grunewald, K., Walz, U. & Burkhard, B. In Burkhard, B., Maes, J. (Eds.). 2017. *Mapping Ecosystem Services*. Pensoft Publishers, Sofia: 151-158.