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CASE STUDY BOOKLET

(Picture by Petar Nikolov)

Mapping and assessment of ES in Central Balkan area in Bulgaria at multiple scales

June 2018

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Enhancing ecosystem services mapping for policy and decision making

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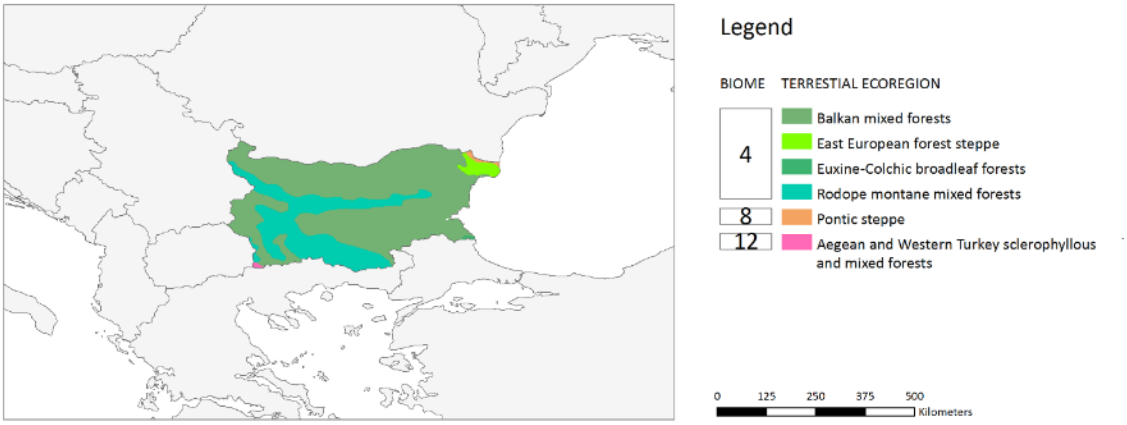
CASE STUDY FACTSHEET

Central Balkan area WS5_cs3

NAME AND LOCATION OF STUDY AREA	Central Balkan area
COUNTRY	Bulgaria

STATUS OF MAES IMPLEMENTATION	Stage 1	**Stage 2**	Stage 3

BIOMES IN COUNTRY		
	1 Tropical & Subtropical Moist Broadleaf Forests	**4 Temperate Broadleaf & Mixed Forests**
	5 Temperate Conifer Forests	6 Boreal Forests/Taiga
	8 Temperate Grasslands, Savannas & Shrublands	11 Tundra
	12 Mediterranean Forests, Woodlands & Scrub	13 Deserts and Xeric Shrublands
	14 Mangrove	



SCALE	national	**sub-national**	**local**
AREAL EXTENSION	**2998.9 km²**		

THEMES				
	nature conservation	climate, water and energy	marine policy	natural risk
	urban and spatial planning	**green infrastructures**	**agriculture and forestry**	**business, industry and tourism**
	health	ES mapping and assessment		

ECOSYSTEM TYPES				
	urban	cropland	**grassland**	**woodland and forest**
	heatland and shrub	sparsely vegetated land	wetlands	rivers and lakes
	marine inlets and transitional waters	coastal	shelf	open ocean

1. Overview of the study area

The study area is located in Central Bulgaria and covers the central part of the Balkan Mountains (Stara Planina) and the surrounding areas (Figure 4.1). The spatial coverage is outlined by following both natural and administrative criteria including all the municipalities that have parts of their areas in the Central Balkan National Park. In total the area covers 2,998.9 km^2 of which 24% is proclaimed for protected areas (37 areas in total). The most important protected area is the Central Balkan National Park (71,825.5 ha) which encompasses 9 other protected areas within its borders. The average altitude is 913 m and ranges from 265 m in the Karlovo plain to 2376 m at the Botev peak (the highest summit in the Balkan Mountains). Although the study area is relatively small, the nature is diverse due to the influence of the Balkan Mountain Range, which leads to the formation of different hydro-climatic conditions in the higher altitudes and in the northern and southern parts of the mountain. There are three types of climate-temperate continental in the north, transitional to Mediterranean in the south and mountainous in the central part and in the areas above 1000 m. The average annual temperatures vary from south to north from 11.1^{o}C to 10.0^{o}C in Troyan and decrease to 0.7^{o}C at Botev peak. The southern part is drier than the northern part. The mean annual precipitation changes from 550 mm to 800 mm and the quantities raise up to 1100 mm with the increase in altitude. The vegetation is characterized by typical altitudinal zoning. In the lower parts, the vegetation is presented by Oak and Oak-Hornbeam forests followed by beech forests in the areas above 800 m and mountain grasslands at the highest parts of the mountain.

The study covers partially the territory of 9 municipalities – Teteven, Anton, Pirdop, Karlovo, Sopot, Sevlievo, Apriltsi, Troyan and Pavel Banya. Only two of them - Karlovo (103,911 ha) and Sopot (5630 ha) are entirely comprised within the study area. There are 82 settlements with total population of 128,626 residents and 58% of the population (74,205 inhabitants) lives in the urban areas. The biggest towns are Karlovo (25,715 inhabitants) and Troyan (23,623 inhabitants).The population of Karlovo municipality is estimated to 50,650 residents and has decreasing trend due to a negative growth rate. The territorial balance of the Karlovo municipality is dominated by forests (51%) and agricultural lands (45%), with 3% urbanized areas, 0.9 % water bodies and 0.4 % transport and energy infrastructure. The significant forest area determines development of timber industry, hunting, educational, and eco-tourism.

The Central Balkan National Park occupies the higher parts of the mountain and ranges in altitude from 550 m to 2376 m. The park is part of the PAN Parks network and is also one of the largest and the most valuable protected areas in Europe ranked at category 2 by IUCN. The Central Balkan National Park belongs to the Rhodope montane mixed forests terrestrial ecoregion of the Palearctic temperate broadleaf and mixed forest. It is home of rare and endangered wildlife species and communities. The flora is represented by 2340 species and subspecies of plants. Forests occupy 56% of the total area. There are 59 species of mammals, 224 species of birds, 14 species of reptiles, 8 species of amphibian and 6 species of fish, as well as 2387 species of invertebrates. The national park includes nine nature reserves protected by strict regime and covering 28% of its territory.

2. Question and Themes

The ES mapping and assessment have been implemented through several activities carried out in the framework of several research projects including regional or national assessment initiatives:

- The very first mapping and assessment activity was realized through a flood hazard assessment project directed to define the supply of and demand for flood regulation in mountain watersheds (Nedkov and Burkhard, 2012; Nedkov et al. 2015).
- A scientific research on water related ES in the northern part of Central Balkan National Park of the watersheds of the River Yantra and River Vidima and the upper part of Ogosta basin located in the western part of Balkan Mountains (Boyanova et al. 2014; 2016).
- The Central Balkan area has been assessed in terms of the area's potential to provide ES that form the current and future basis for the local economy and for the social welfare (Borisova et al. 2015). The analysis focuses on the territory of the administrative units of Apriltsi Municipality and the Mayoralty of Kalofer located in the Central Balkan region (covering 774 km^2). The spreadsheet method in the form of the "matrix" proposed by Burkhard et al. (2009) was used; however, applied to landscapes as basic units for spatial analysis. The evaluation was carried out through expert-based assessment via face-to-face interviews with the local administration and was supported by analysis of the landscape structure, hemeroby assessment, and analysis of strategic documentation. In 2016, the study was expanded to encompass the Karlovo Municipality, in cooperation with a collaborative PhD seminar supported by the projects "The Mountain" (Center of Excellence in the Humanities, Sofia University St. Kl.Ohridski), TUNESinURB, and ESMERALDA. During the seminar, interviews targeting the local population in the Central Balkan area have been conducted and the contingent valuation method (Assenov and Borisova, 2016) was applied.
- A pilot valuation of the ES provided by the forests of the Central Balkan National Park has been conducted with the financial support of EU Environment Operation Program. The results envision the sustainable management of the National Park (Dimitrova et al., 2015).
- The area of Karlovo municipality was a case study in the project "Toward better UNderstanding the ES in URBan environments through assessment and mapping" (TUNESinURB, funded under the FM of EEA 2009-2014). The project aims to create an ecosystem based geo-information system of the ES condition and of the ES provided by the urban ecosystems in Bulgaria, excluding the NATURA 2000 zones. The procedure follows the "Methodology for mapping and assessment of urban ecosystems and their services in Bulgaria" (Zhiyanski et al. 2017). It includes the following stages: a) urban ecosystems mapping; b) assessment and mapping of the ecosystems condition (based on 37 indicators); and c) assessment and mapping of 25 classes of ESs. The results are oriented towards a better understanding of the ES concept and its possible implementation in sectoral policies, spatial planning, and territorial development.

3. Stakeholders' Involvement

Taking into account the fact that the case study area includes the Central Balkan National Park, most of the above-mentioned studies were conducted with the active cooperation with the Central Balkan NP Directorate. The Directorate provided representative statistical information about the activities and functions in the Park. Additionally, the Public Advisory Council at the Park participated in the workshops aiming to promote the importance of the ES investigation (Dimitrova et al., 2015). Municipal authorities and stakeholders from the local business communities, mainly from the fields of tourism and recreation, pastoral farming, and forestry, were involved as experts in the assessment of selected ES (Reared animals and their outputs, Wild plants, algae and their outputs, Fibres and other materials from plants, Algae and animals for direct use or processing, Plant-based resources, Physical use of land-/seascapes in different environmental settings) (Borisova et al. 2015).

4. Initiating Mapping and Assessment

4.1. Identification and mapping of ecosystem type

The identification of ecosystem types is based on the MAES typology (MAES, 2013) at level 2 and CORINE Land Cover data. There are seven ecosystem types identified in the case study area (Figure 4.1) – urban, agricultural, grassland, woodland and forest, heathland and shrub, sparsely vegetated land, rivers and lakes. The largest area is occupied by woodland and forest ecosystems (60% of the case study) followed by agricultural (22%) and grassland 12%). The urban ecosystems cover3.2% of the area while shrub (1.1%), sparsely vegetated areas (0.2%), and rivers and lakes (0.2%) have limited extend.

The MAES typology applied in Bulgaria was further developed at level 3 in the framework of the project Methodological assistance for ecosystems assessment and biophysical valuation (MetEcosMap). Each ecosystem type was divided in subtypes based on the specific natural conditions in Bulgaria and the availability of spatial data. The final version of the typology includes altogether 58 ecosystem subtypes at level 3 which number varies from 3 to 16 between the different ecosystem types (Table 4.1). The subtypes were chosen in correspondence with EUINS habitat classification and the national standards for each ecosystem type. For example the urban ecosystems were defined in correspondence with the National concept for spatial development for the period 2013 – 2025 developed by Ministry of Regional Development. The indices chosen to represent the subtypes correspond to EUNIS nomenclature. For example "J" was chosen for urban ecosystems, "G" for woodland and forest, "D" for wetlands. Woodland and forest typology was even further developed at level 4.

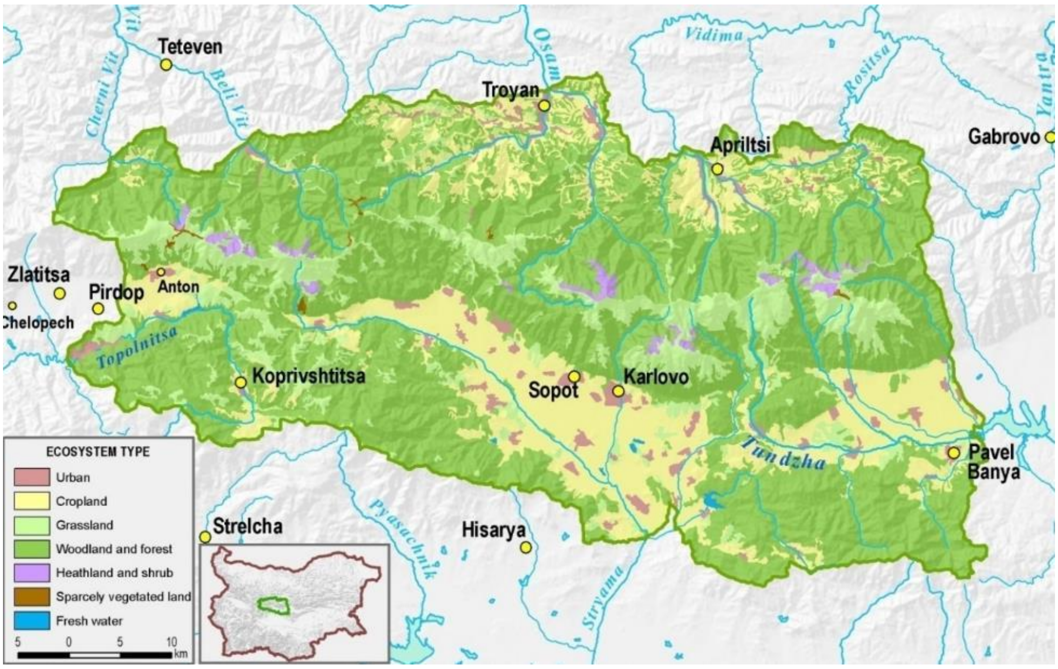


Figure 4.1. *Ecosystem types in Central Balkan case study area*

Table 4.1. Ecosystems typology in Bulgaria

Level 1	Level 2	Level 3 (EUNIS 2) - BG specific
Terrestrial	Urban	J1-10 (10 subtypes)
	Cropland	1-5 (5 subtypes)
	Grassland	1-5 (5 subtypes)
	Woodland and forest	G1-4 (4 subtypes) (level 4)
	Heathland and shrub	F2, 3, 9 (subtypes)
	Sparsely vegetated land	1-5 (5 subtypes)
	Wetlands	D1, 4, 5 (3 subtypes)
Fresh water	River and Lakes	C, J, X (16 subtypes)
Marine	Marine inlets and transitional waters	1-8 (8 subtypes)
	Coastal area	
	Shelf	

The urban ecosystems in the area of Karlovo municipality were identified and mapped at level 3 of the typology (Zhiyanski et al. 2015). At national level, there are 10 urban ecosystem subtypes and seven of which are identified in Karlovo (Figure 4.2).

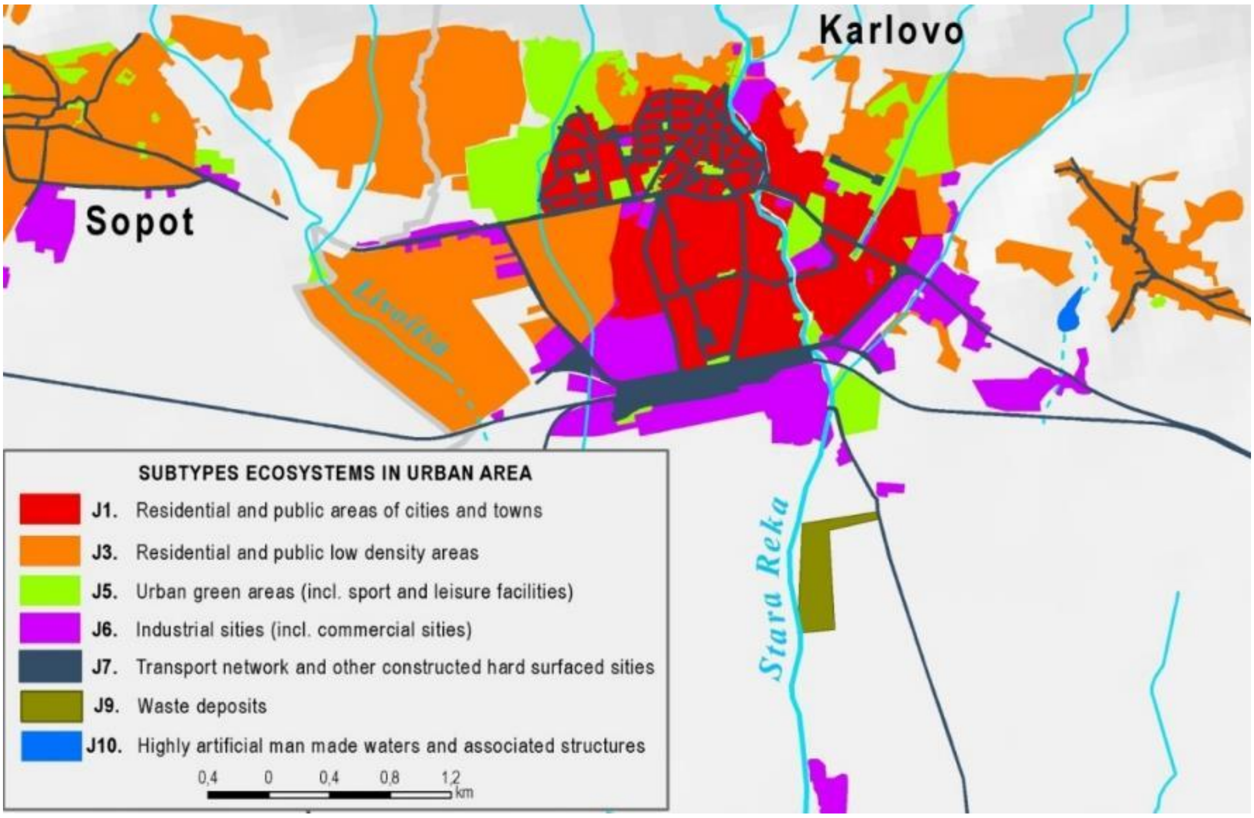


Figure 4.2. Urban ecosystem subtypes in the city of Karlovo.

4.2. Assessing ecosystem conditions

The condition of the ecosystems in the municipalities comprised of the Central Balkan NP was assessed within the study on national assessment of the urban ecosystems. The concept is based on the ecosystem integrity. The methodological framework is described in the project MetEcosMap and the used indicators are presented in Table 4.2.

An operational set of 37 indicators (10 mandatory and 27 recommended) was selected. This set reflects both the geographical conditions and the interactions between people and urban environment as factors that influence the current state of the urban ecosystems. The impacts have been studied in terms of the system's biotic diversity, abiotic heterogeneity, energy, matter, and water budget. Each indicator meets four general criteria: policy relevance, analytical soundness, primary data contribution and measurability, and level of aggregation. For each indicator, according to the type of the initial database, an individual assessment scale that matches the final score of the urban ecosystem state has been developed (scale from 1 - very bad, to 5 - very good). The expert-based assessment of the selected indicators was applied to each unit (GIS polygon) of the urban ecosystem subtypes. The preliminary results show that urban ecosystems in Bulgaria are predominantly in a "moderate" to "good" condition and only individual subsystems (J6 - industrial sites) indicate "bad" condition. The condition of urban ecosystems at national level was mapped in a set of 61 map sheets at scale 1:125000 (Figure 4.3).

Table 4.2. Indicators for ecosystem condition in Bulgaria based on the concepts of ecosystem integrity.

ECOSYSTEM STRUCTURE	**Biotic heterogeneity**	Plant diversity	**ECOSYSTEM PROCESS**	**Energy budget**	Energy balance
		Animal diversity			Entropy production
		Habitat diversity			Metabolic efficiency
		Invasive species			Other energy budget
		Oher biotic heterogeneity		**Matter budget**	Matter balance
	Abiotic heterogeneity	Soil heterogeneity			Element
		Hydrological heterogeneity			Efficiency measures
		Air heterogeneity		**Water budget**	Water balance (input,
		Geomorphological			Water storage
		Other abiotic			Other state indicator
					Efficiency measures

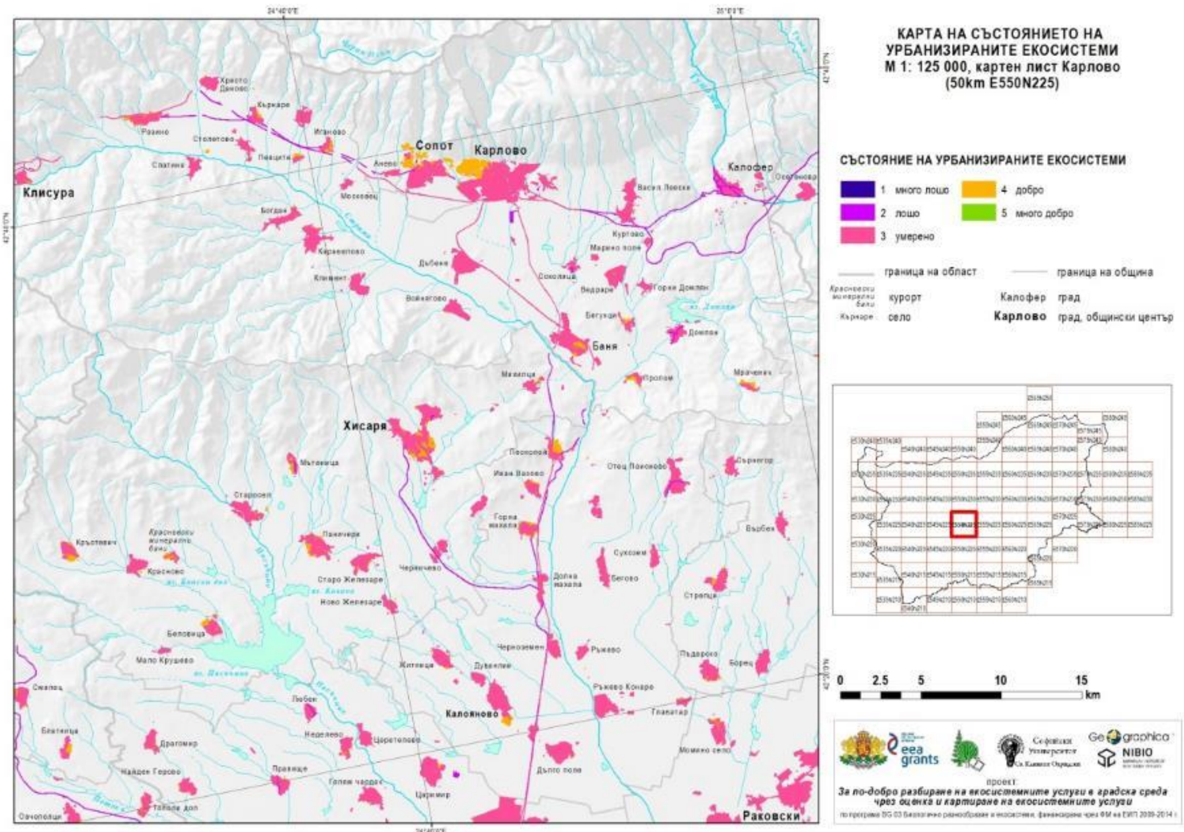


Figure 4.3. Condition of urban ecosystems in Karlovo map sheet (The area of the Central Balkan case study falls within two map sheets – E550N220 and E550N225).

4.3. Selecting Ecosystem Services

Following the above-mentioned activities, several ES identified in the study area have been considered for further analysis. In the project TUNESinURB, 25 urban ES have been selected, mapped and assessed (Annex: Annexes

Table 8.1). The services selected in the other projects and activities partially overlap with the services in TUNESinURB but differ in their spatial dimensions and methods used for mapping and assessment. For the ESMERALDA we focused on seven ES assessed by biophysical, socio-cultural, and economic methods (Table 4.3). Two of them, surface water for drinking and flood regulation, are mapped at multiple scales and represent multiple tiers. Surface water for drinking was assessed during activity 2 (see section 9.2.1) at local scale using hydrological modeling tool which corresponds to Tier 3. The same service in activity 4 was assessed at national level using spatially related statistical data which corresponds to Tier 2. Flood regulation was assessed in activities 1 and 4 which correspond to Tier 3 (hydrologic modeling) and Tier 2 (statistical data) respectively.

Table 4.3. Overview of the ES and related mapping and assessment methods in the Bulgaria case study

Ecosystem Service selected for mapping and assessment	B	S	E
1.1.2.1 Surface water for drinking*	x		
1.2.2.1 Surface water for non-drinking purposes	x		
2.2.2.2 Flood regulation	x		
2.3.5.1 Global climate regulation	x		
2.3.5.2 Micro and regional climate regulation	x		
3.1.1.1 Experiential use of plants, animals and land/seascapes			x
3.1.2.5 Aesthetic*		x	

* ES selected for further discussion during ESMERALDA workshops 5 in Madrid;
B = biophysical methods; S = socio-cultural methods; E = economic methods.

5. Methods for ES mapping and assessment

5.1. Biophysical methods for ES mapping and assessment

Several biophysical methods, which rely on different types of data, have been applied in the study area. The urban ecosystems are mapped and assessed by using the polygons from the GIS database of the ecosystem subtypes as mapping units, expert assessment (Tier 1) and statistical data for quantification (Tier 2). Global climate regulation, micro and regional climate regulation and aesthetic value are mapped and assessed using different kind of quantitative data which correspond to Tier 2. Expert assessment and land cover based units are used for genetic materials and pest control mapping. Some water related ES are assessed by using large scale LULC datasets, topographic and soil data in combination with process-based modelling (Tier 3). Such approach is applied for surface water for drinking and flood regulation.

5.1.1. Mapping of provisioning services

1.1.2.1 Surface water for drinking

Indicator: *Evapotranspiration*

The combination of process based modelling, spread-sheet analysis, and the footprint concept (blue and green footprint) was applied for mapping of freshwater supply. The approach relies on GIS-based hydrological modelling performed through the ArcSWAT tool. This tool utilizes SWAT model in ArcGIS environment and is appropriate for application in medium to large watersheds. The model simulates water balance parameters used to quantify the water retention of different ecosystems within the watershed. The outputs are runoff, infiltration, sediment yield and evapotranspiration. The latter is used as indicator to quantify the amount of water retained of the ecosystems in the watershed and develop a map representing the freshwater supply capacity (Figure 5.1).

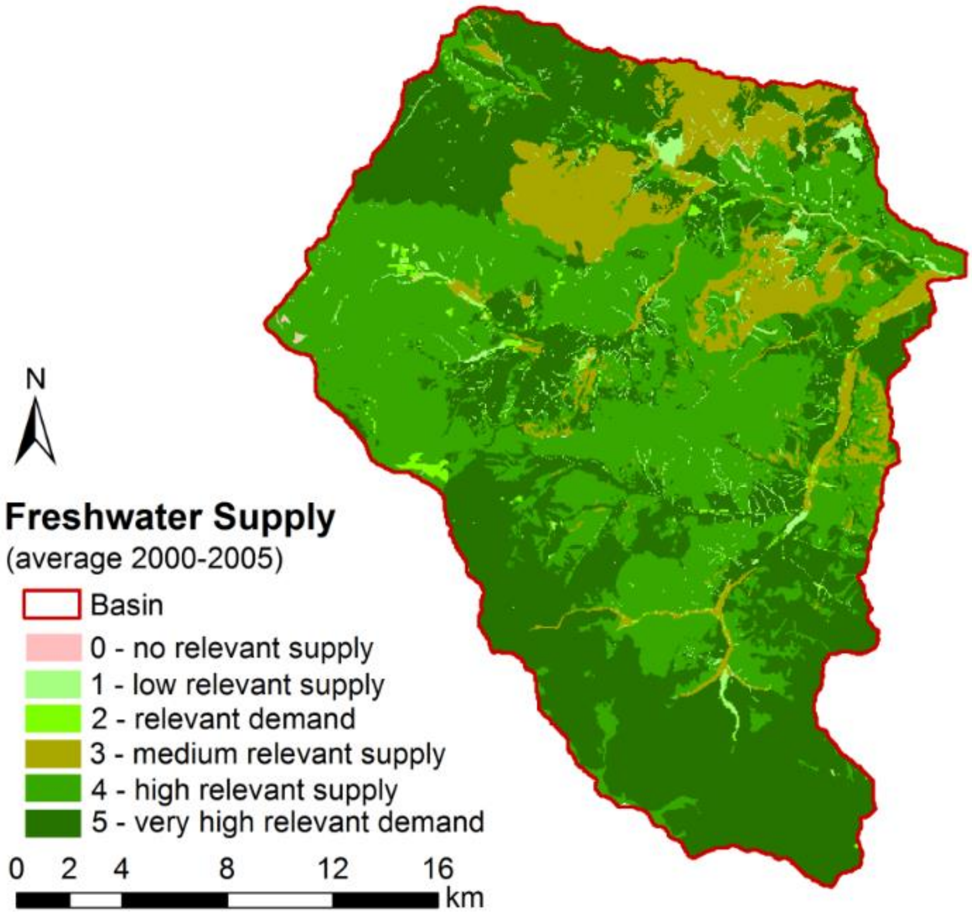


Figure 5.1. Fresh water supply in upper Ogosta river basin.

1.2.2.1 Surface water for non-drinking purposes

Indicator: *precipitation; evapotranspiration; and surface water*

The surface water for non-drinking purpose is assessed at national scale for the urban ecosystems within the frame of TUNESinURB project. It relies on three indicators – precipitation; evapotranspiration; and surface water. The precipitation and evapotranspiration were quantified by using spatial proxy models based on measured point sources and regression relationship between the two variables and the elevation. The third indicator was defined with the presence of surface water body and the information was derived from integrated index of spatial structure of urban ecosystems (Nedkov et al. 2016).

5.1.2. Mapping of regulating and maintenance services

2.3.5.1 Global climate regulation by reduction of greenhouse gas concentrations
Indicator: *carbon storage per ecosystem*
The spatial proxy method was applied for mapping and assessment of global climate regulation service. The approach was developed for assessment of urban ES at national level in Bulgaria. Carbon storage per ecosystem is defined as an indicator that represents the regulation function of the ecosystems that controls CO_2 concentration in the atmosphere. It relies on delineation of urban ecosystems, calculation of three ecosystem condition parameters (integrated index of spatial structure, soil organic carbon and vegetation cover), and the spatial approximation of carbon content in soils and vegetation. The amount of carbon is calculated for each polygon of the GIS database using data for vegetation cover, vegetation type (trees, shrub or grass), and average amount of carbon in vegetation types by value transfer from literature and soil carbon contend by value transfer.

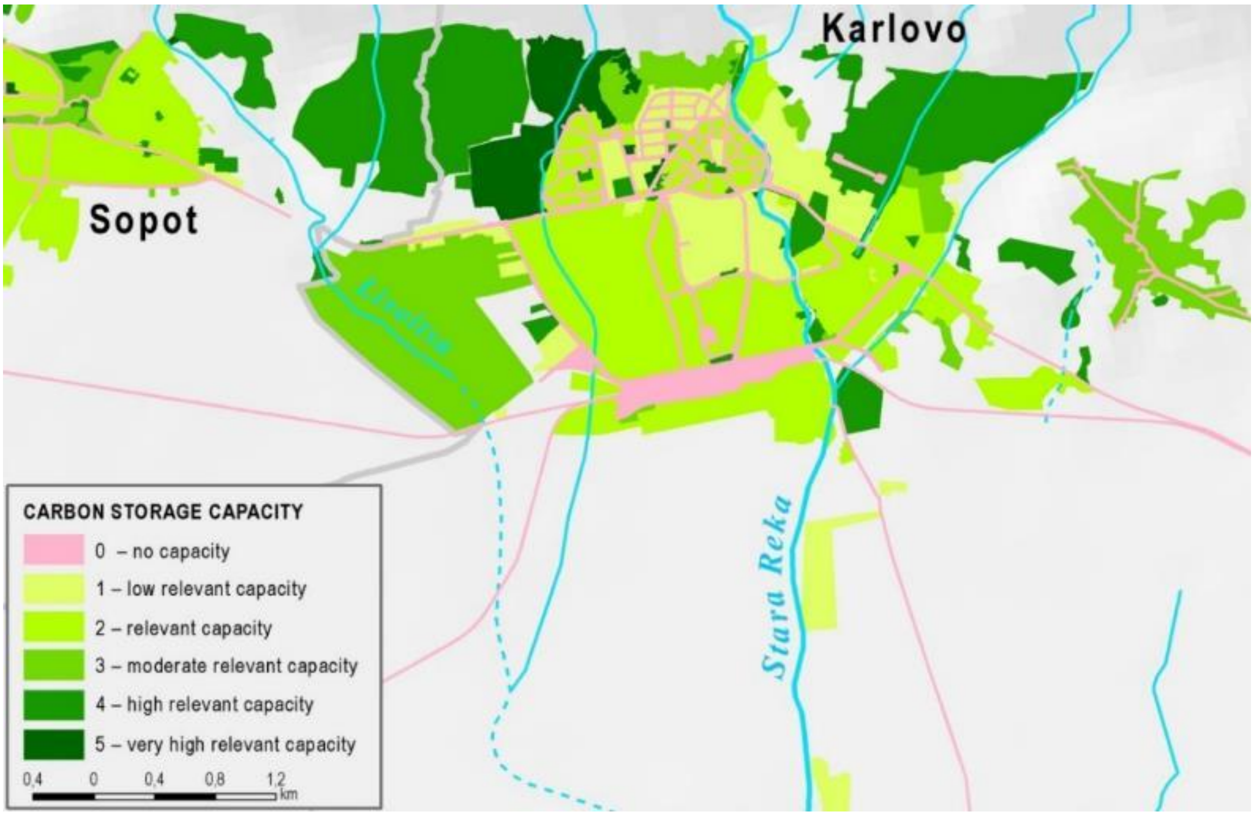


Figure 5.2. Global climate regulation supply capacity of the urban ecosystems in the city of Karlovo.

2.3.5.2 Micro and regional climate regulation
Integrated Assessment based on Indicators: *Integrated Index of Spatial Structure, Vegetation Cover and Water Bodies*
The method apply cartographic analysis, related to the spatial structure (composition and configuration) of urban ecosystems with a focus on the elements of the green infrastructure. The procedure of complex assessment is based on the sum of the following three indicators: 1) "Integrated Index of Spatial Structure" - on a scale from 1 to 5 (1 - very low potential, 2 - low potential, 3 - average potential, 4 - high potential 5 - very high potential) – which represents the potential of the indicator to influence the urban ecosystem state; 2) „Vegetation Cover" - using the same scale from 1 to 5 – which shows the potential of

the indicator to influence the urban ecosystem state and 3) "Water bodies" – with a value of 0 or 1 (0 - absence /1 – presence of water bodies in the unit/polygon of the urban ecosystem types). Visualization of areas of different potential to supply the respective ES follows GIS spatial analysis of the integrated assessment's results of each unit/polygon of the urban ecosystem types on a scale from 1 to 5 (1 - very low potential, 2 - low potential, 3 - average potential, 4 - high potential 5 - very high potential).

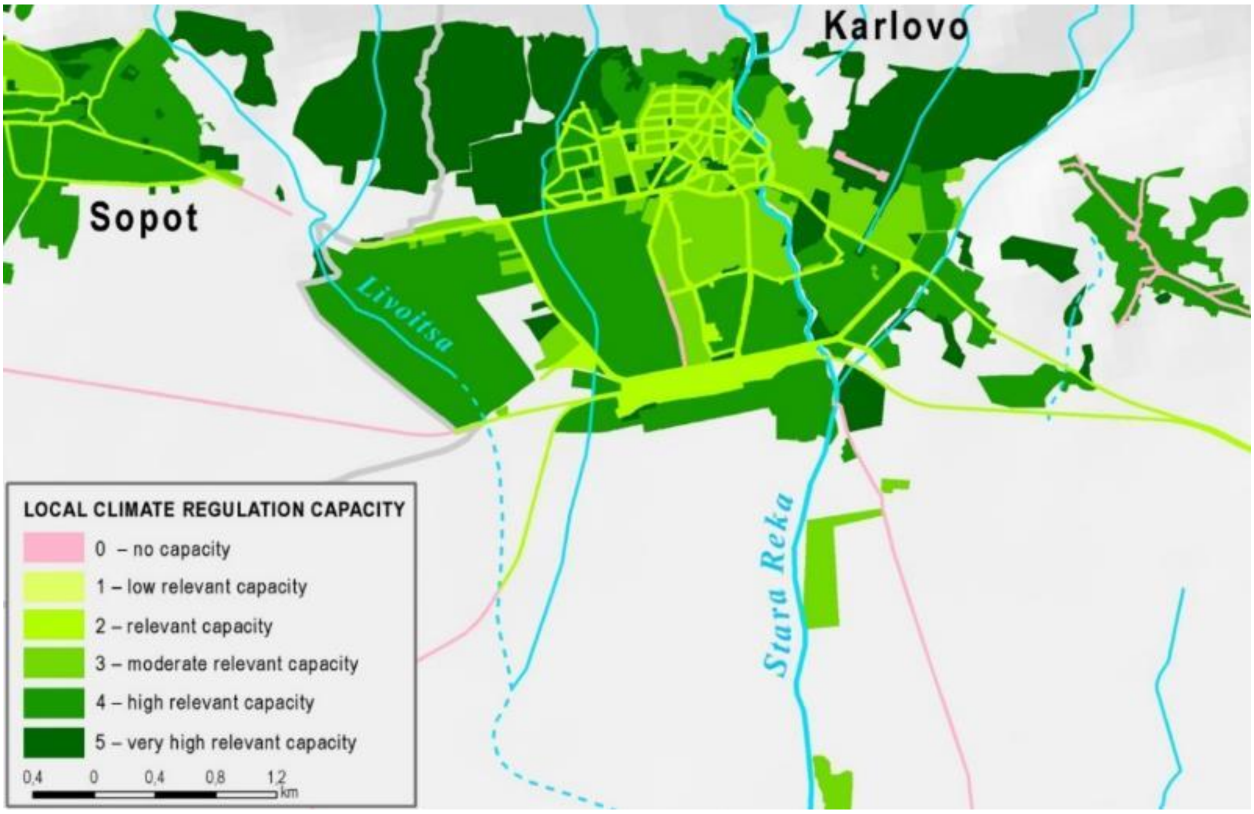


Figure 5.3. Micro and regional climate regulation supply capacity of the urban ecosystems in the city of Karlovo.

2.2.2.2 Flood protection

Indicator: *Infiltration, surface runoff and peak flow*

Flood protection ES was mapped and assessed in three watersheds in the northern part of the case study area by the process based modelling method. The approach relies on GIS based hydrological modelling performed through the extension ArcGIS AGWA2. It incorporates KINEROS (and SWAT) model, which is suitable for application in relatively small (up to 100 km^2) watersheds with predominantly surface runoff. The model simulates water balance parameters within the watershed, which are used to quantify the regulation function for the different ecosystems. The outputs of the model used as indicators for flood regulation are infiltration, surface runoff and peak flow. They represent the ability of the ecosystem (through vegetation and soil) to "absorb" part of the precipitation water thus reducing the amount of runoff during flood events. Therefore, they allow to quantify the flood prevention function of the ecosystems in the watershed which ensures flood protection ecosystem service.

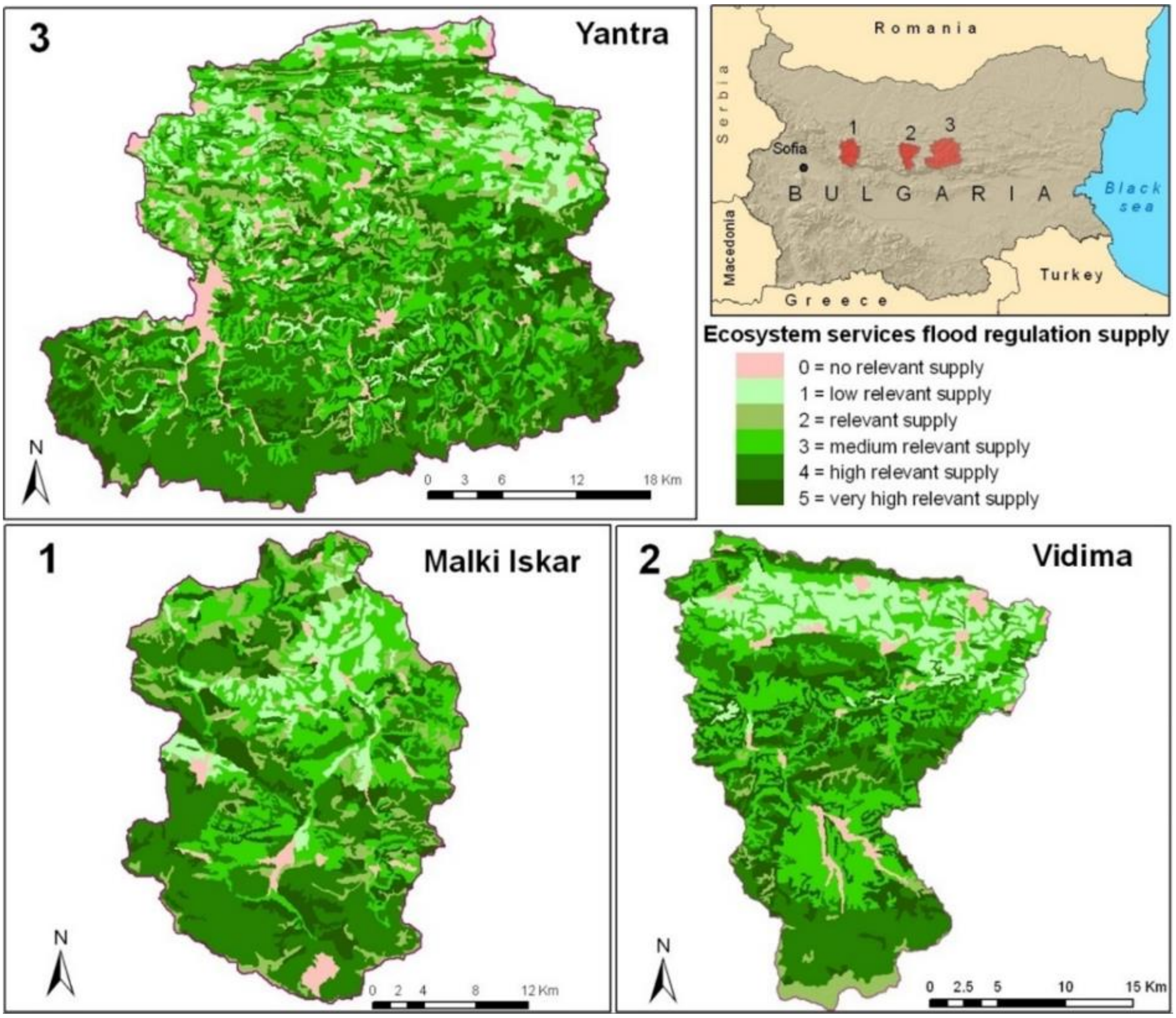


Figure 10. *Flood regulation supply capacity in three watersheds of Central Balkan area*

5.2. Socio-cultural methods for ES mapping and assessment

Social methods for mapping and assessment were applied only for cultural ES in the framework of TUNESinURB project.

5.2.1. Mapping of cultural services

3.1.2.5 Aesthetic

Indicator: *Number of pictures*

The method of photo elicitation survey was applied to aesthetic ecosystem services (AES), which refer to the visual, sensitive, and intellectual interactions with the physical environment. A representative documentation about these interactions are photos that people take and upload in the social media or other public virtual space. The application of the method includes delineation of ES subtypes in the study area; integration of the urban ecosystem subtypes map with the Google Earth pictures uploaded in the map frame; selection of all pictures in each polygon, excluding of the pictures with personal information and counting the number of all pictures related to each polygon; aggregation of the resulting information and scoring. Therefore, the number of pictures uploaded within the area of a polygon of particular ecosystem subtypes is assumed as measure of its aesthetic value. The study was implemented in four case study areas - Varna, Karlovo, Maritsa and Makresh that represent different types of urban areas in Bulgaria. The scoring of AES capacity was applied individually for each case study area. As shown in Figure 5.4, the scoring intervals for Karlovo are as follows: 1 (1-2 pictures); 2 (2-9); 3 (10-42); 4 (42-76); 5 (76-324). The assessment at national level was conducted by integration of the case studies' results and the ecosystem subtypes.

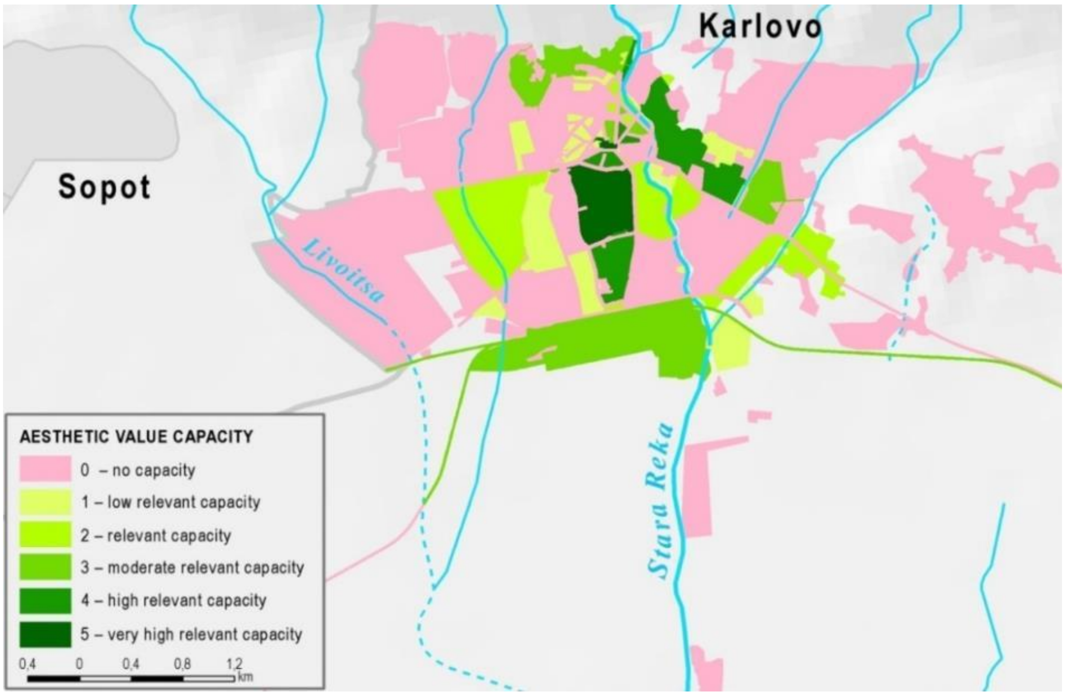


Figure 5.4. Aesthetic value of urban ecosystems in the city of Karlovo.

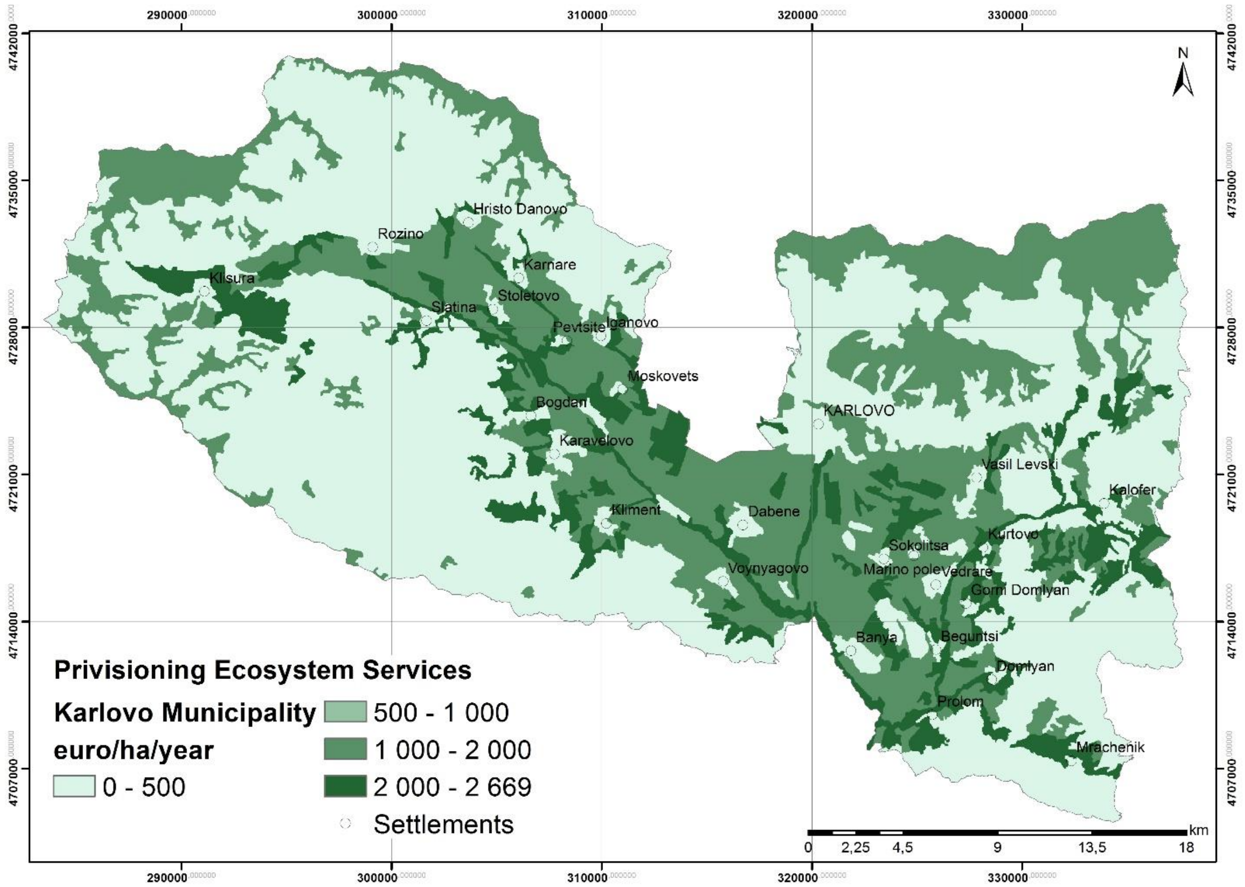
5.2.2. Economic methods for ES mapping and assessment

The selection of economic valuation methods for the ES in Karlovo municipality is described in detail in the research work of Koulov et al., (2017, in press). The investigation is a result of a preliminary analysis, which takes into account the applicability of key indicators provided by the national and regional statistics (Average yield per year, t/ha/yr; Number and capacity of accommodation sites, Site visitation, number/yr; Investments in forest plantations), the possibility and applicability of transferring data or using generalizations, and the spatial variations of representative ES (Tier 2). The study relies mostly on the method of market prices, in combination with the replacement cost method, net financial contribution (NFCu), and the transfer value method, based on data from Bulgarian mountain municipalities with similar physical and human geographic characteristics. In addition, the study methodology integrates economic and biophysical methods. The investigation interprets the CORINE Land Cover, 2012 classes as spatial units for identification of ecosystem types – classes and sub-classes (MAES, 2013) and for valuation of the ecosystem services - classes and class types (CICES 4.3). The results include: a) the Total Economic Value (TEV) of the Karlovo municipality (euro/ha/yr.) and b) the combined value of the significant ES for the local economy and welfare provided by the dominant in the particular municipality ecosystem classes - Urban, Cropland, Grassland, Woodland &Forest, and sparsely vegetated areas (LULC 2012). Geospatial analysis was used to identify ES distribution, hotspots, synergies and trade-off.

5.2.3. Mapping of provisioning Services

1.1.1.1 Cultivated crops
1.1.1.2 Reared animals and their outputs
1.1.1.3 Wild plants, algae and their outputs
1.1.2.1 Surface water for drinking purposes
1.2.1.1 Fibres and other materials from plants, algae and animals for direct use or processing
1.2.1.2 Materials from plants, algae and animals for agricultural use
1.2.1.3 Genetic materials from all biota
Indicator: *euro/ha/yr.*

The combined economic value generated by the annual supply of the above mentioned ES was attributed to the total area of their spatial sources, i.e. to their ecosystem types, respectively.



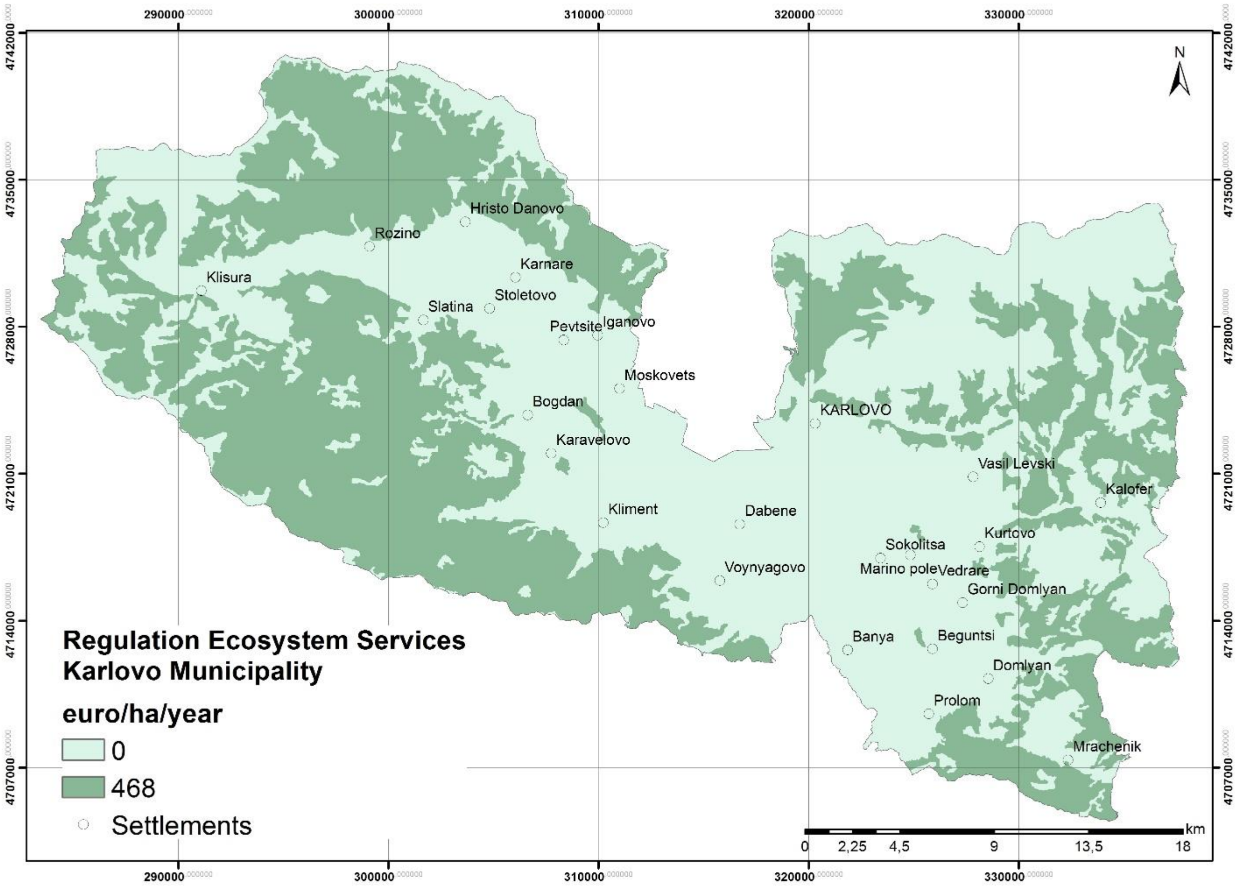
5.2.4. Mapping of regulating and maintenance services

2.2.1.1 Mass stabilization and control of erosion rates
Indicator: *Cost of restoring soil quality*

2.2.2.1 Hydrological cycle and Water flow maintenance
Indicator: *Investments in forest plantations*

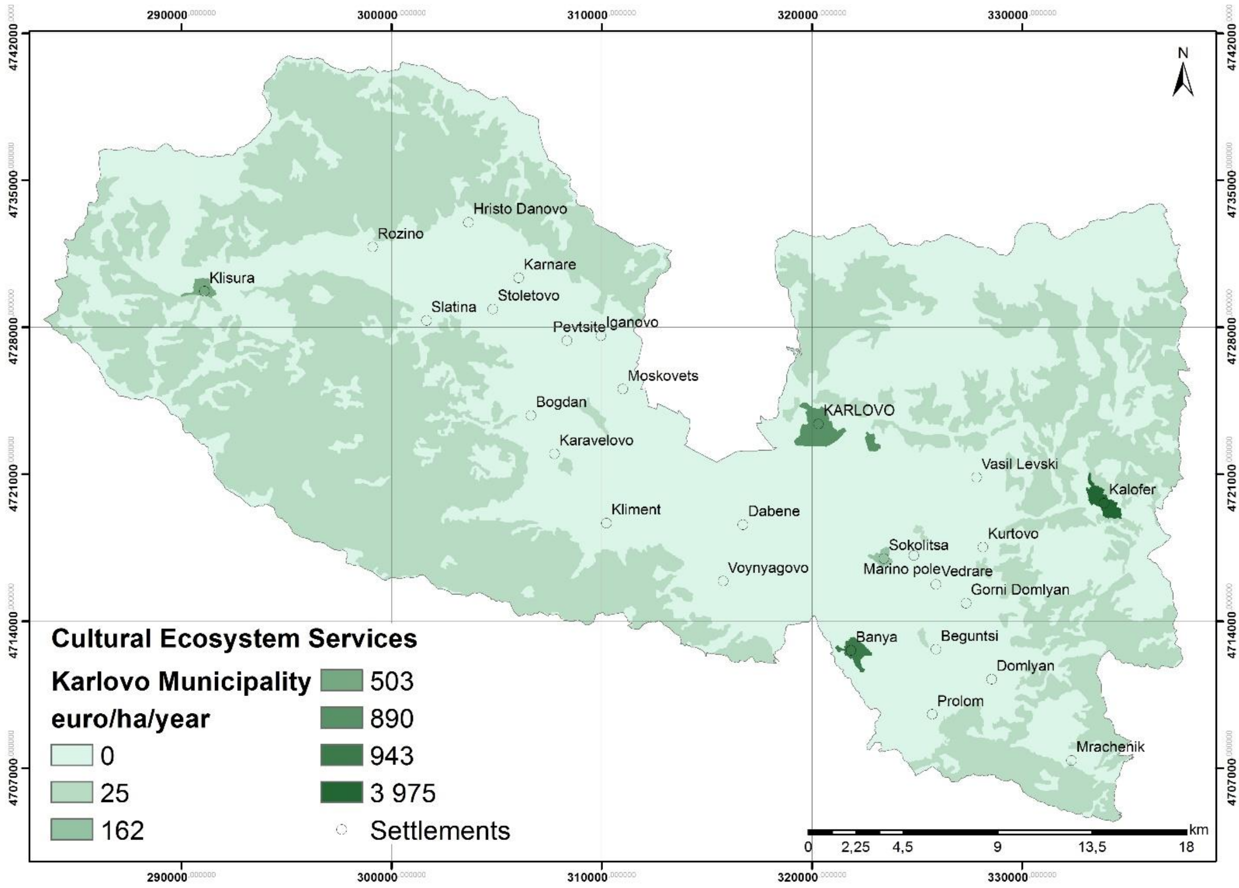
2.3.5.1 Global climate regulation by reduction of greenhouse gas concentrations
Indicator: *Carbon sequestration from forest ecosystems (CO2/yr./ha)*

The above listed indicators were used to value the supply of the respective services (Koulov et al., 2017, in press). The obtained values were allocated to the total area of Woodland and Forest ecosystems in the Central Balkan area.



5.2.5. Mapping of cultural Services

3.1.1.1 Physical use of land-/seascapes in different environmental settings***Indicator:*** *number and capacity of accommodation sites* (number/yr.)
Indicator: *site visits* (number/yr.)
The above mentioned indicators were applied to identify, evaluate and map the supply of the ES recreation and tourism relative to the total area of Wood land and Forest and Urban ecosystems (Koulov et al., 2017, in press)



5.3. Integration of ES mapping and assessment results

The integration of the results was achieved mainly in the assessment of the ecosystems' condition and of the ES. The outcomes referring to some indicators for urban ecosystem condition were successfully applied in the assessment of urban ES. For example, the integrated index of spatial structure was used as an indicator (direct use) for global climate regulation and air quality regulation while some of its elements were used in quantification of some indicators (indirect use) for the assessment of cultivated crops, surface water for drinking purposes, erosion regulation, pollination and local climate regulation.

6. Dissemination and communication

The results have been disseminated at a number of scientific conferences and PhD seminars (including field observation at the municipalities of Karlovo and Troyan), as well as workshops with stakeholders from the local authorities, local business communities, Central Balkan NP Directorate and the CBNP Public Advisory Council. A synergetic effect was achieved within the interdisciplinary teams of scientists from the Bulgarian Academy of Sciences and Sofia University St. Kliment Ohridski.

7. Implementation

The flood regulation ES as a part of nature based solution was proposed as an alternative choice to the traditional measures that include building or reinforcing existing dykes and dams. It was included in the preparation of the Karlovo municipality management plan. Ecosystem services provided by forests are already part of the legislation in forestry sector. The management plans at regional level should have maps of 9 ecosystem services provided by forests.

8. References & Annexes

References

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TUNESinURB project - http://tunesinurb.org/en/

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Annexes

Table 8.1. *ES selected for urban ecosystems assessment in project TUNESinURB*

Section	Division	Group	Class (codes CICES)
Provisioning	Nutrition	Biomass	P1. Cultivated crops (1111)
			P2. Reared animals and their outputs (1112)
			P3. Wild plants, algae and their outputs (1113, 1115)
			P4. Wild animals and their outputs (1114, 1116)
	Materials	Water	P5. Ground water for drinking (1122)
			P6. Surface water for non-drinking purposes (1221)
			P7. Ground water for non-drinking purposes (1222)
		Material	P8. Fibres and other materials (1211, 1212)
			P9. Genetic materials from all biota (1213)
	Energy	Biomass-based energy sources	P10. Plant and animal-based resources for energy (1311,1312)
			P11. Animal-based mechanical energy (1321)
Regulating and maintenance	Mediation 1	Mediation by ecos.	R1. Regulation of pollution and other impacts (2121,2122,2123)
	Mediation of flows	Mass flows	R2. Mitigation of erosion (2211,2212)
		Liquid flows	R3. Water flow maintenance and flood protection (2221,2222)
		Gaseous / air flows	R4. Regulation of air flows and atmospheric risks (2231,2232)
	Maintenance of physical, chemical, biological conditions	Lifecycle maint. etc	R5. Pollination and seed dispersal (2311)
		Pest and disease cntr	R6. Pest and disease control (2321,2322)
		Soil formation	R7. Regulation of soil formation and composition (2331,2332)
		Atmospheric and climate regulation	R8. Global climate regulation (2351)
			R9. Micro and regional climate regulation (2352)
Cultural	Physical and intellectual interactions	Physical interactions	C1. Recreation (3111,3112)
		Intellectual and representative	C2. Scientific and Educational (3121,3122)
			C3. Cultural heritage (3123)
	Spiritual, symbolic and other	Spiritual	C4. Aesthetic and spiritual (3125,3211,3212)
		Other cultural outputs	C5. Existence and bequest (3221,3222)