METHODOLOGICAL FRAMEWORK FOR ASSESSMENT AND MAPPING OF ECOSYSTEM CONDITION AND ECOSYSTEM SERVICES IN BULGARIA

PART B1

METHODOLOGY

for assessment and mapping of URBAN ecosystems condition and their services in Bulgaria

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1. Introduction

1.1. What is this methodology about?

The current methodology forms a part of the national methodological framework on mapping and assessment of ecosystem condition and ecosystem services (ES) they provide. The methodology aims at optimizing the overall process of identification, mapping and biophysical assessment of ecosystems in Bulgaria and the supply of ecosystem services at national scale. The current methodology aimed at completing the full cycle of on assessment the mapping the capacity of ecosystems to deliver ecosystem services and further reporting at national level. It contains a practical step-by-step guidance to the process of:

1. Assessing the condition of the **Urban ecosystems**
2. Assessing the **Urban ecosystems' capacity** to deliver ecosystem services (biophysical assessment).

The methodology is relevant to urban ecosystems on the entire territory of Bulgaria although its implementation will differ between NATURA 2000 zones and areas outside NATURA 2000 due to different data availability, land use and the spatial distribution of ecosystems. It forms a part of a wider national methodological framework (under development) which is consisted of detailed theoretical background behind the ecosystems approach practiced in Bulgaria, as well as the necessary steps to undertake towards fulfilling Action 5 of Target 2 Maintain and restore ecosystems and their services EU Biodiversity strategy to 2020 (Maes et al., 2013, 2014).

1.2. Who is this methodology for?

This methodology is to be used by:

- Organizations and scientists who perform ecosystems condition assessment and biophysical assessment of ecosystem services. Such organizations are expected to include the beneficiaries/partners under the programmes that have set aside funding for the national process of ecosystems mapping and assessment – for NATURA 2000, the Operational Programme Environment 2014-2020 and outside NATURA 2000 – programme BG03 Biodiversity and ecosystem services 2009-2014;
- National or local authorities who contribute data they produce to the Bulgarian biodiversity information system;
- Project promoters and partners under other projects, including for example research organizations and NGOs, who wish to perform / contribute to the national assessment results from their past or ongoing projects targeting wholly or in part a more detailed ecosystem condition assessment and ecosystem services assessment and on a regional or local scale in smaller scale pilots.
- Applicants for future projects to complement the national scale assessment and valuation of ecosystem services.
- Data users wishing to understand the contents and collection method of data, including but not limited to, organizations involved in environmental reporting, regional and local authorities, environmentally responsible companies, NGOs, and other stakeholders.

1.3. How to use this methodology?

This methodology provides a combination of information on relevant databases and their sources that may be of interest to a wider circle of stakeholders, and specific guidance to assessing ecosystem status and ecosystem services (including data collection and verification, and mapping guidance).

The wider introductory parts are more likely to be of interest to policymakers and the general public. The more targeted parts are mostly needed by professionals involved in the national mapping and assessment exercise.

As the current methodology is a living document, results from ongoing projects related to mapping and assessment the ES in urban ecosystems are desirable. Comments received are included in order to shape it as a national, widely reviewed, and adopted guidance document in this final version .

2. Typology of ecosystems in Bulgaria

2.1. Ecosystem typology of urban ecosystems in Bulgaria

We consider "Urban ecosystems" as areas where most of the human population lives and it is also a class significantly affecting other ecosystem types. Urban areas represent mainly human habitats but they usually include significant areas for synanthropic species, which are associated with urban habitats. Urban ecosystems correspond to the classes at first and second levels, defined in MAES - 2013 (Maes et al., 2013) and include urban, industrial, commercial, and transport areas, urban green areas, mines, dumping and man-made sites. At the third level the typology of urban ecosystems in Bulgaria corresponds to the National concept for spatial development for the period 2013 – 2025 (NCSD, 2012). Different types of urban ecosystems in Bulgaria are defined in Table 1.

Table 1. Typology of urban ecosystems in Bulgaria

Level 1	Level 2	Level 3
Terrestrial	**Urban**	J1. Residential and public areas of cities and towns
		J2. Sub-urban areas
		J3. Residential and public low density areas
		J4. Recreation area outside cities and towns
		J5. Urban green areas (incl. sport and leisure facilities)
		J6. Industrial sites (incl. commercial sites)
		J7. Transport networks and other constructed hard surfaced sites
		J8. Extractive industrial sites (incl. active underground mines and active opencast mineral extraction sites, and quarries)
		J9. Waste deposits
		J10. Highly artificial man-made waters and associated structures

2.2. Detailed ecosystem typology of urban ecosystems in Bulgaria

A selection of corresponding EUNIS classification on level 2 combined with NCSP on level 3, is proposed for detailed typology as level 3 for the purpose of the targeted ecosystem type (Davies et al., 2004). Total number of **10 urban sub-types** is selected. They correspond to levels "J1", "J2", "J3", "J4", "J5", "J6", "I2", and "X11", "X22", "X23", "X24", "X25" from EUNIS groups "I", "J" and "X" (EEA, 2015a; Maes et al., 2013).
Descriptions and relations to other classification systems of proposed sub-types are presented in Table 2.

Table 2. Urban ecosystems typology (Level 3)

Abbreviation	Sub-type	Description	Nomenclature(s)
J1.	Residential and public areas of cities and towns	Residential areas, and areas for public services, including objects of education, healthcare, service facilities of trade, science and scientific services, business and administrative services, social assistance and others in large and medium cities - by hierarchical system of city-centers of first, second, and third level, according to the classification of National concept for spatial development for the period 2013 – 2025. Hierarchic system of core-cities extending their influence over territorial areas of different sizes[1]: • Level One – the capital Sofia, centre of European significance for the national territory; • Level Two – big cities, centres of national significance for the territory of the regions – Plovdiv, Varna, Burgas, Ruse, Pleven, Stara Zagora; • Level Three – medium-size cities, centres of regional significance for the area of the districts – district centres and other eminent cities – Vidin, Montana, Vratsa, Lovech, Gabrovo, Veliko Tarnovo, Targovishte, Razgrad, Shumen, Silistra, Dobrich, Sliven, Yambol, Haskovo, Kardzhali, Smolyan, Pazardzhik, Pernik, Kyustendil, Blagoevgrad, Svishtof, Gorna Oryahovitsa, Kazanlak, Dimitrovgrad, Assenovgrad, Karlovo, Dupnitsa, Petrich.	EUNIS – J1 (J1.1, J1.2, J1.3, J1.5, J1.6), X24, X25
J2.	Sub-urban areas	The surrounding areas of J1 referred only for cities at Level One and Level Two - objects of suburbanization and zones of impact	EUNIS - J1 (J1.2, J1.3, J1.6; J1.7) X13, X15, X16.
J3.	Residential and public low density areas	Residential areas, and areas for public services, including objects of education, healthcare, service facilities of trade, science and scientific services, business and administrative services, social assistance and others in small towns with micro-regional importance for the territory of groups of municipalities (4 hierarchical levels according to the classification of National concept for spatial development for the period 2013 – 2025) and in very small towns and villages, centers of local importance in the territory of the municipalities and others (5 hierarchical level according to the classification of NCSD) and other villages.	EUNIS – J1 (J1.2; 1.3); X24, X25.

[1] The hierarchic ranking of the core-cities is regulated in National concept for spatial development for the period 2013 – 2025. It has been performed through assessment of their significance and role according to a number of criteria and indicators related to the population dynamics and the degree of development of their administrative, economic, transport functions etc.

Abbreviation	Sub-type	Description	Nomenclature(s)
J4.	Recreation area outside cities and towns	Park territories outside cities and towns' incl. buildings, sport and leisure facilities used for tourism and recreation.	EUNIS – J1 (J1.7); J2 (J2.1, J2.2); X11.
J5.	Urban green areas (incl. sport and leisure facilities)	Public and private open spaces in urban areas, primarily covered by native and or artificial vegetation, which are directly or indirectly available for the users. Includes all 'outdoor' spaces including streets and squares. Areas for local gardens and landscaping with prevailing open sites for sports, amusement and entertainment, playgrounds.	EUNIS – I (I2);X X11, X22, X23)
J6.	Industrial sites (incl. commercial sites)	Structures dispersed within the rural or natural environment established for the purpose of industrial, agricultural and commercial activities.	EUNIS – J1 (J1.4; J1.5; J1.6), J2 (J2.3, J2.4, J2.5, J2.6, J2.7)
J7.	Transport networks and other constructed hard surfaced sites	Includes roads, car parks, railways, paved footpaths and hard-surfaced areas of airports, water ports, train and bus stations, and associated infrastructure and landscaping.	EUNIS – J4
J8.	Extractive industrial sites (incl. active underground mines and active opencast mineral extraction sites, and quarries)	Sites in which minerals are extracted. Includes quarries, open-cast mines and active underground mines. Areas used for open-sky mining and quarrying activities and presently in operation. Disused sites that were formerly quarries or open-cast mines.	EUNIS – J3
J9.	Waste deposits	Tips, landfill sites and slurries produced as by-products, usually unwanted, of human activity. Dumps of building waste when not forming a part of construction or demolition sites, or when so large as to constitute a separate habitat. Sites used for disposal of household waste, including landfill sites that may be used for several types of waste. Includes slag heaps, mine waste, dumped quarry waste, and mineral wastes resulting from chemical processes. Dung heaps, slurry lagoons, decaying straw, dumps of unwanted produce. Sewage waste, sewage slurries. Heaps, tips and mounds formed as by-products of industrial activities.	EUNIS - J6 (J6.1, J6.2, J6.5)
J10.	Highly artificial man made waters and associated structures	Inland artificial waterbodies with wholly-constructed beds or heavily contaminated water, and their associated conduits and containers. Includes also salt works by the coast.	EUNIS – J5.1, J5.3, J5.4, J5.5

3. Data availability

3.1. Existing data sources, gaps, uncertainty of data

For mapping and assessing of urban ecosystem condition and services the most significant stage is the availability of data. In this section is presented a short overview of the data used to map and assess ecosystem condition and services at different scales – local, regional and national as well as information about data sources. In order to identify the data used for the quantification of ES, it is focused on the parameters included in the tables, which have been used as a basis for the determination of the indicators proposed. For each indicator, were identified and grouped the type of data used (e.g. land cover maps, land property maps, cadastre, statistics). The listed available spatial and quantitative database for urban territories can be usually found free of charge or after a special formal request to the stakeholders. Examples are satellite images and data from Corine Land Cover (CLC) (EEA; National Reports on the Status and Protection of the Environment in R B, 2010- 2014; National statistical institute, 2014).

Data sources in this methodology include point data (sampled observations from scientific papers), regional data (information and project reports for watersheds, small villages and towns, cities, regions, specific study areas), as well as data covering European and national extents. Modelling data could be applied for such indicators and their parameters, if models are validated for the specific component of ecosystem or for the whole ecosystem. Experts' opinion should be taken into consideration. The proposed model for green infrastructure in urban ecosystems is i-Tree (Tools for assessing and managing community forests https://www.itreetools.org/about.php) and/or other specific models describing carbon dynamics, climate, specific ES or stand structure could be applied after verification.

The most commonly used data for assessment the indicators for ecosystem condition and ecosystem services gives information about land use/land cover, components of ecosystems - national statistical data, soil data and maps, vegetation maps, national cadastre, reports and other databases. These data sources include a wide variety of data types including hydrological maps, soil characteristics, pollution data, visitor counts, but also local land cover maps and goods and products statistics. Some data on European level is available and could be applied at national scale, where gaps on country level are defined. Land cover and vegetation data, obtained using satellite imagery, are widely available and often free of charge (CLC database, EEA).

National statistics are available from the national database which has wide coverage (National Statistical Institute, 2014). This data availability is also reflected in some ecosystem services that are mapped also at regional level. For national spatial planning and development the need of qualitative and quantitative data are required especially for assessment of some regulating and supporting and/or Cultural ES at region scale. Meanwhile the cultural services such as spiritual or aesthetic enjoyment are very local with variation from individuals to cultural groups, therefore most of the data sources can't be used. In this term Provisioning, Regulating and Supporting, as well as Cultural ecosystem services of urban ecosystems sub-types are assessed and mapped in terms of habitat suitability for relevant ES based on national data supported by additional regional data. In supporting the national MAES process additional information could be found in different national and

international reports (Zhiyanski et al., 2011; Doichinova, Zhiyanski, 2012; Zhiyanski et al., 2013; Nedkov et al., 2016; Teoharov et al., 2014).

In the proposed tables, there is a list of parameters for the identified primary indicators found in our review, for which there is no data at all and additional investigations and/or case-studies are needed. The majority of these parameters are case-specific and could be produced by several research groups via smaller pilots. As mentioned before for few parameters the corresponding data sources are missing or incomplete, but the intention to generate such data is underlined and proposed in the Monitoring guide. As an example is the parameter "Health status of tree vegetation" in assessment the urban ecosystems condition, which is assessed with data obtained mainly by field observation studies. Pollination services are a specific case where no existing national data was identified. Such indicators / parameters are proposed as optional but important and additional data collection is desirable.

The available data sources at national level, which cover the information needed for indicators proposed and relevant parameters are National Plans and Strategies, Master Plans for Municipalities, National Concept for Regional Development, Urban Atlas NATURA 2000 habitat mapping, Bulgarian Geographic Atlas, Scientific publications, EU data sources, National data (MOEW, MAF, ME, MRD), National Statistics, Cadastre and other sources, listed in more details in Table 3.

For indicators and relevant parameters of urban ecosystems condition and ESs only short reference is presented - see *Annex 5 of Methodology*.

Table 3. Sources of spatial and quantitative/qualitative database

Urban ecosystem sub-type	DATABASE Sources – main stakeholders	
	Spatial	Quantitative/Qualitative
J1.Residential and public areas of cities and towns	Database EUNIS Level 2, Master Plans, Site Development plans, Cadastre www.icadastre.bg National Concept for Spatial Development 2013-2025.	Spatial Development Plans, Land Identification Parcel System, Cadastre Maps, Cadastre map of Agricultural Land, Urban Development Plans, Municipal Environment Protection Programmes, National Concept for Spatial Development 2013-2025, National Statistical Institute, Urban Atlas (EEA, MOEW), JRC, Publications, Project Reports, ME, MRD.
J2.Sub-urban areas	Database EUNIS Level 2, Master Plans, Site Development plans, Cadastre www.icadastre.bg National Concept for Spatial Development 2013-2025.	Master Plans, Spatial Development Plans, Land Identification Parcel System, Cadastre Maps, Cadastre map of Agricultural Land, Urban Development Plans, Municipal Environment Protection Programmes of Environmental protection, National Concept for Spatial Development 2013-2025, National Statistical Institute, Urban Atlas (ExEA, MOEW), JRC, Publications, Project Reports, ME, MRD.
J3.Residential and public low density areas	Database EUNIS Level 2 (VV), Master Plans, Spatial Development Plans, Cadastre maps (www.icadastre.bg) National Concept for Spatial Development 2013-2025.	Master Plans, Spatial Development Plans, Land Identification Parcel System, Cadastre Maps, Cadastre map of Agricultural Land, Urban Development Plans, Municipal Environment Protection Programmes, National Concept for Spatial Development 2013-2025, Publications, Project Reports, MOEW, ME, MRD.

Urban ecosystem sub-type	DATABASE Sources – main stakeholders	
	Spatial	Quantitative/Qualitative
J4.Recreation area outside cities and towns	Available Master Plans, Cadastre Maps, Land Identification Parcel System.	National Concept for Spatial Development 2013-2025, available Master Plans, Cadastre Maps, Land Identification Parcel System, National Statistical Institute, Projects , Reports, NCRD, MRD, MOEW, Publications.
J5.Urban green areas (incl. sport and leisure facilities)	Available Master Plans, Cadastre maps, Land Identification Parcel System, Urban Atlas (CLC), Projects for grey, blue and green infrastructure, Ongoing passportization of urban green areas.	Available Master Plans, Cadastre maps, Land Identification Parcel System, Cadastre Maps, Cadastre map of Agricultural Land, Urban Development Plans, Municipal Environment Protection Programmes, National Concept for Regional Development (NCRD), National Statistical Institute, Urban Atlas (EEA, MOEW), Dept. "Green Systems", "Urban parks and allotments", etc., Urban Parks Inventories, Projects, Publications, University of Forestry – Department of Landscape architecture, Publications.
J6.Industrial sites (incl. commercial sites)	Available Master Plans , Cadastre maps, Land Identification Parcel System, Cadastre Maps, Cadastre map of Agricultural Land	Available Master Plans, Cadastre maps, Land Identification Parcel System, Cadastre Maps, Cadastre map of Agricultural Land, EEA, MOEW
J7.Transport networks and other constructed hard surfaced sites	Road Infrastructure Agency, available Master Plans, Cadastre Maps, Land Identification Parcel System, Cadastre Maps, Cadastre map of Agricultural Land	Road Infrastructure Agency, National Railway Infrastructure Company, Bulgarian Ports Infrastructure Company, Civil Aviation Administration (MTITC), Master Plans, Cadastre maps, National Concept for Regional Development
J8.Extractive industrial sites (incl. active underground mines and active opencast mineral extraction sites, and quarries)	Available Master Plans, Cadastre maps, Land Identification Parcel System, Cadastre Maps, Cadastre map of Agricultural Land,	Available Master Plans, Cadastre maps, Land Identification Parcel System, Cadastre Maps, Cadastre map of Agricultural Land, Municipal Environment Protection Programmes, Municipal Development plans, MOEW, ME, Publications, Projects, Reports.
J9.Waste deposits	Available Master Plans, Cadastre maps, Land Identification Parcel System, Cadastre map of Agricultural Land.	MOEW, RIEW, MRD, ME, Publications, Projects, Reports.
J10.Highly artificial man made waters and associated structures	Available Master Plans, Cadastre maps, Land Identification Parcel System, Cadastre map of Agricultural Land,	MOEW, RIEW, NEK EAD "Dams and cascades" NATURA 2000; River Basins Management Plans; Flood Risk Management Plans, Projects and publications, EEA, MOEW, Basin Directorat es.

4. Mapping ecosystem types

The following section describes the procedure of mapping the ecosystem types, specifications of the final products for the maps and databases, and gives references to the Annexes to this document where database schema is provided in accordance to the specifications given hereafter.

4.1. Description of the mapping procedure

The workflow for mapping of ecosystem types comprises the following main steps:

- Generation of vector dataset with representation of polygon, polyline, or point features each of them containing information on level 3 ecosystem type;
- The source data needed to generate the vector datasets or the mapping approach should allow the specifications for the output scale, MMU and MMW to be kept as described in section 4.4.;
- Assembling the product in the geodatabase schema provided in the Annex 9 (Annex 9.00_EcosystemDatabase_Schema);
- Validation of the product accuracy, described in point 4.6. of this methodology;
- Preparation of digital maps of ecosystem types;
- Generation of metadata.

The specifications of the final product should follow the requirements provided in the following sections. As the outcome of each mapping project will be used for preparation of national dataset for ecosystem types at level 3, it is mandatory to follow each requirement described below.

4.2. Data format

Output data have to be delivered in GIS compatible vector format, in accordance with geospatial standards of OGC and INSPIRE.
The vector format should be with the following topology:

- In case all the ecosystems are presented as one geometry type - complete coverage in a single layer –;
- In case the different ecosystem types are represented with different geometry types, up to 3 layers could be delivered – one for polygon, one for polyline and one for point features.
- The vector layer has to be delivered in topologically correct geometries: see rules in http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/An_overview_of_topology_in_ArcGIS/006200000001000000/.

4.3. Geographic projection / Reference system

Vector layer should be delivered in ETRS89-LAEA. The description and definition of ETRS89 is based on the convention of ISO19111, the 'Spatial referencing by coordinates' standard. For further documentation on ETRS89, see:

http://inspire.jrc.ec.europa.eu/documents/Data_Specifications/INSPIRE_DataSpecification_RS_v3.2.pdf, and;

http://www.eionet.eu.int/gis

4.4. Geometric resolution – scale and minimum mapping units

The source data which will be used for the ecosystem type mapping vary in geometric resolution, as well as in the level of detail of the different ecosystem types. Hence, the output vector dataset containing the graphical representation of the ecosystem types should be delivered in scale between 1:10 000 and 1:25 000, depending on:

– the used source data;

– the ecosystem type on level 3.

The minimum mapping area should be between 0.1 and 0.25 ha also depending on the source data used and the mapped ecosystem type. The same apply for minimum mapping width of representing linear features: minimum 10 and up to 30m.

4.5. Data structure/schema

The structure of the database should follow the one provided in the Annex 9.00 – both on number of vectors and tables delivered the structure of each feature class and tables, and nomenclatures provided in the same Annex. The database schema in Annex 9.00 is provided in XML and Personal DataBase format – OCG and INSPIRE compatible.

The schema of the database for the ecosystem types is presented in Figure 1.

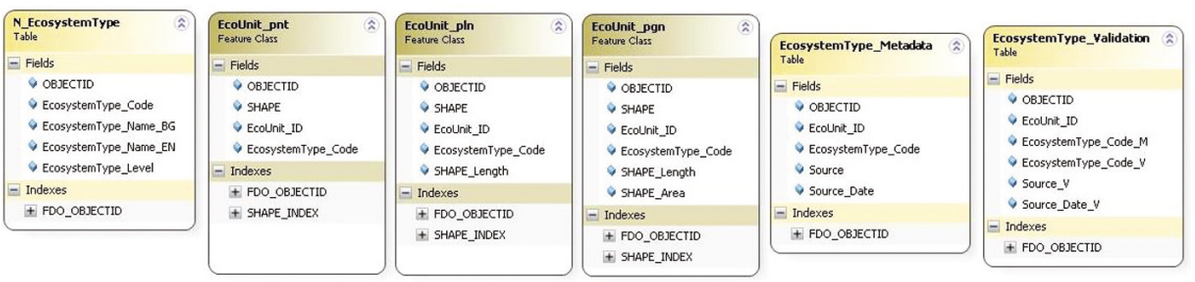


Figure 1: Ecosystem Types Database Schema

The detailed technical description of the classes and tables of the ecosystem types' database is provided in Annex 9.01_Schema_Report_ES_Database in the file 9.01_1_Schema_Report_ES_Database.htm.

The following steps were undertaken for the creation of the geodatabase:

– Feature Class **"EcoUnit"** -this is the vector feature class which contains the information on ecosystem types at level 3. The attribute fields of the feature class which have to be filled are as follows:

– EcoUnit_ID: each object should have unique ID;EcosystemType_Code: this field should contain 3 digit value of the ecosystem type at level

– The value for the ecosystem code should be taken from the nomenclature table N_EcosystemType/EcosystemType_Code provided in Annex 9.02_NOMENCLATURES_XLS.

This field is used for relating all the tables and feature classes in the database.

Since, the object geometry of the different ecosystem types could be point, polyline, or polygon, up to 3 feature classes **"EcoUnit"** could be generated and named as follows:

- **EcoUnit_pnt**: for objects with point geometry;
- **EcoUnit_pln**: for objects with polyline geometry;
- **EcoUnit_pgn**: for objects with polygon geometry.

- Table **"N_EcosystemType"**: Nomenclature table for ecosystem type levels at level 2 and 3. This table should not be changed. It has the following fields:

- EcosystemType_Code: integer codes for ecosystem types at level 2 and 3;

- EcosystemType_Name_BG: names in Bulgarian of ecosystem types at level 2 and 3;

- EcosystemType_Name_BG: names in English of ecosystem types at level 2 and 3;

- EcosystemType_Level: check field defining the level of each ecosystem type with values 2, for level 2 and 3 for level 3;

- Table **"EcosystemType_Metadata"**: Table providing information on datasources used when defining the ecosystem type for each feature from the Feature Class **"EcoUnit"**:

- EcoUnit_ID: field to relate with the feature class;

- EcosystemType_Code: integer codes for ecosystem types at level 3;

- Source: free description of the source used to map the specific ecosystem type for each feature;

- Source_Date: date of the source used to map the specific ecosystem type for each feature;

- Table **"EcosystemType_Validation"**: Table providing information on work performed to validate the thematic accuracy for the final product:

- EcoUnit_ID: field to relate with the feature class;

- EcosystemType_Code_M: integer codes for ecosystem types at level 3 of the final product;

- EcosystemType_Code_V: integer codes for ecosystem types at level 3 derived in the validation process;

- Source_V: free description of the source used to validate the ecosystem type;

- Source_Date_V: date of the source used in the validation.

4.6. Thematic accuracy and validation

The overall thematic accuracy for all ecosystem types should be >=85%.

The validation should be based on scientifically sound approach used for validation of the product thematic accuracy.

Apart from providing information in Table **"EcosystemType_Validation"**, the validation should be accompanied by Quality Control/Quality Check Reports for each ecosystem type.

4.7. Digital Maps for Ecosystem Types

Maps in scale 1:125 000 for the ecosystem types should be in PDF at size A2. In addition the maps could also be prepared in paper format in the same scale and size.

Each data frame should represent one cell from the EEA 50 km reference grid; hence up to 77 maps could be produced for all the cells of the 50 km EEA gird for Bulgaria. In case that no objects from Feature Class **"EcoUnit"** fall in certain cell, map for this cell should not be delivered. Therefore, the actual number of maps to be delivered will depend on the number of cells that contain at least one object from Feature "**Class EcoUnit**". The EEA reference grid is available at:

http://www.eea.europa.eu/data-and-maps/data/eea-reference-grids/

Color codes for visualization of the ecosystem types at level 3 should be in accordance to these used in the European Map of Ecosystem types:

http://biodiversity.europa.eu/maes/mapping-ecosystems/map-of-european-ecosystem-types

The technical details for the map, as well as color codes are accessible at:

http://projects.eionet.europa.eu/eea-ecosystem-assessments/library/draft-ecosystem-map-europe/

The ecosystem types in the European Map of Ecosystem types are defined based on EUNIS classification. Hence, not all of the level 3 types determined for Bulgaria will correspond to the European ones. In this case, similar color codes should be used, which are closer to these of EUNIS classes. When generating these color codes the guideline of EEA should be used, available here:

http://www.eionet.europa.eu/gis/docs/EEA%20Corporate%20identity%20manual%20Map%20colour%20guide.pdf

The layout of the maps of the ecosystem types should follow the guidelines of EEA:

http://www.eionet.europa.eu/gis/docs/GISguide_v4_EEA_Layout_for_map_production.pdf

4.8. Metadata

Each dataset should be accompanied by INSPIRE conformal metadata. The minimum requirement is the metadata to be generated using the INSPIRE MetadataEditor:

http://inspire-geoportal.ec.europa.eu/editor/

5. Steps for assessment of ecosystem condition

5.1. Assessment of ecosystem condition (Urban ecosystems)

Step 1: Identify the indicators of ecosystem condition for the urban ecosystem type - level 3 Indicators are a subset of the many possible attributes that could be used to quantify the condition of a particular landscape, catchments or ecosystem (Walker, 2002). According to MAES (2013) choice of indicators should be seen not only by the need to be mapped, but it is essential subsequently to be used for further assessment of ecosystems and the services they provide. In this regard the indicators have to be able to:

- provide information to policy makers and the wider public on the current condition and changes in the conditions of the environment in *Urban* ecosystems;
- assist policy makers to better understand the linkages between the causes and effects of the impacts of *Urban* ecosystems and in elaborating urban policy on the environment, and help to guide their responses to changes in environmental conditions;
- contribute to monitoring and evaluation of the effectiveness of policies in promoting sustainable management.

The obligations of the EU Biodiversity Strategy 2020, as well as international decisions at the global level (Rio+20, CBD), are generating a need to create a national monitoring system for the condition of ecosystem and ecosystem services on the basis of indicators. The outcomes of this methodology emphasized that the first step towards the development of a comprehensive national framework for urban ecosystems and ecosystem services assessment and the integration of the value of ecosystem services into national policies and decision-making processes is to identify and develop a common set of indicators to assess and monitor the condition, trends and socio-economic aspects of ecosystem services. As highlighted above, there are significant gaps in the information available on the biophysical assessment of urban ecosystem condition and services. Furthermore, there is a fundamental need to develop and/or implement new and/or improve existing indicators in order to appropriately assess nature's long-term ability to supply services. In particular, appropriate indicators for many ecosystems services, both in biophysical and socio-economic terms, are largely still missing and are under studying, especially for urban ecosystems.

There are potentially a large number of indicators that could be developed to help quantify the various components and linkages between society and urban environment. To assist in the choice of an operational set of indicators within this framework each indicator has to be examined against four general criteria:

- policy relevance - the criterion of policy relevance relates to those identified urban territories issues as being of importance to policy makers. While the list of issues is evolving and must be flexible so as to incorporate new issues or abandon old ones.
- analytical soundness - the criterion of analytical soundness concerns, in particular, the extent to which the indicator can establish links between variety of urban management/governance activities and environmental conditions, and thus refers more specifically to the attributes which provide the basis to measure the indicator. It should also be possible for the indicator to explain a link between process of urbanization and an environmental issue which is easy to interpret and applicable to a wide set of urban systems. The indicator should also be able to show trends and ranges of values over time, which might be complemented by nationally defined targets and thresholds where these exist;

- primary data contribution and measurability - the criterion of measurability, relates to the appropriate data available to measure the indicator. The indicator should be developed from established national or sub-national data, scientific data and publications, data from other data sets available in third parties preferably using an expert based and long-time series where this is available given the lengthy time period for many environmental effects to become apparent. Present work has revealed that while a considerable national and condition database exists from which to calculate indicators, problems of data gathering, data providing, definitions, quality, the regularity of data collection and methods of indicator measurement remain obstacles to progressing the work on certain indicators. In an effort to overcome some of these difficulties there has begun, a discussion on development of approaches and methods for data exchange and providing between condition authorities has begun;
- level of aggregation - the criterion of the level of aggregation seeks to determine at which level (i.e. sectoral, regional, national), the indicator can be meaningfully applied for policy purposes and not to conceal more than it reveals. This criterion highlights the issue of encapsulating the spatial and temporal diversity of the environment and the geographical scale of different environmental issues ranging from the smaller to the larger scale. In many cases national data for urban environments is often collected on the basis of administrative units, such as sub-national regions (regions, districts, municipalities). Nevertheless, methods to provide national level indicators that take into account spatial diversity have to be assessed and developed based on spatial databases available at national and European level (CORINE, GMES) and for the purposes of facilitating international comparison.

The proposed ***Condition indicators*** assess the condition of urban ecosystems - the ecosystems structure and ecosystem processes (Chapin et al., 2002, Maes et al., 2016). Among the proposed indicators, which are representative for the condition of all types of ecosystems, the defined 20 specific indicators (18 primary and 2 optional) are considered for assessing urban ecosystems condition at Step 1 (*Table 4.).* Each of the selected indicators is enough informative.

Table 4. Rationales of ecosystem condition's indicators

Ecosystem condition Indicator group	**Indicators/Rationales**
Biotic diversity	**Spatial or temporal variability of resources (EEA, 2012). Biotic diversity is caused by organisms**. **It may occur even in absence of abiotic heterogeneity**. **To determine biotic factors and urban habitat heterogeneity the following primary indicators are proposed**: *"Plant diversity",* *"Animal diversity",* *"Habitat diversity",* *"Invasive species",* **Possible (optional) indicators are:** *"Other biotic heterogeneity indicators (naturalness etc.)"* The ecosystem service projects using other indicators, must define them consistently to the current methodology

Ecosystem condition Indicator group	Indicators/Rationales
Abiotic heterogeneity	**Spatial or temporal variability of abiotic resources and factors. Abiotic heterogeneity has abiotic origin.** To determine abiotic factors and urban abiotic heterogeneity the following indicators are proposed *(*Mondeshka et al., 2006; Zhiyanski et al., 2011, 2013): *"Soil heterogeneity",* *"Hydrological heterogeneity",* *"Air heterogeneity",* *"Geomorphological heterogeneity",* *"Disturbance regime",* **Possible (optional) indicators are:** *"Other abiotic heterogeneity indicators"* The ecosystem service projects using other indicators, must define them consistently to the current methodology.
Energy budget	Ecological energy budget **describes the ways in which energy is transformed from one condition to another** within different urban ecosystems. Includes analysis of inputs, outputs, and changes in the quantities stored (Vranic et al., 2016). Ecological energy budget focuses on the use and transformations of energy in the components of urban systems. To account energy budget in urban ecosystems the following indicators are proposed: *"Energy balance (capture, storage)",* *"Metabolic efficiency",* The ecosystem service projects using other indicators, must define them consistently to the current methodology.
Matter budget	Matter budget describes **the cycle in which matter is transformed from one condition to another** within the components of urban ecosystems. To account matter budget in urban ecosystems the following indicators are proposed (Zhiyanski et al., 2011; Nedkov et al., 2016): *"Matter storage"* *"Matter balance (input, output)"* *"Element concentrations (other condition variables)"* *"Efficiency measures"* The ecosystem service projects using other indicators, must define them consistently to the current methodology.
Water budget	**The cyclical movement of water between the atmosphere and the ground surface at local scale of urban areas**, considering precipitation, evaporation, and runoff (Alexandrov, 2011; Mondeshka, 2012). The following indicators are proposed: *"Water balance (input, output)",* *"Water storage",* *"Efficiency measures"* The ecosystem service projects using other indicators, must define them consistently to the current methodology.

Step 2: Identify the parameters and dimension unit of each indicator

For the set of indicators describing urban ecosystem condition different parameters of evaluation are proposed. They are listed in Table 5 and Annex 6. In fact for some indicators there are relevant parameters in current inventories database (land cover, elements concentrations in air, carbon dioxide emissions, etc.). Considering the number of proposed parameters, the number of parameter combinations is very large, which ensures the assessment of urban ecosystem condition.

Each indicator can be assessed by determination of the range to which its parameter's rates belong. All parameters of one indicator are informative for the ecosystem condition and the scoring depends on the specific case-study and availability of data. Due to the diversity of urban ecosystems types and their specifics, the outlined common indicators are grouped in three categories: "key indicators", which are obligatory and describe the condition of all urban ecosystems; "optional indicators", which are not well supported with data at national level, but are desirable for assessment and further monitoring; "recommended indicators", which are not supported with data, but recommended for better assessment of condition of urban ecosystems could be proposed in further procedure by experts.

Each indicator can be assessed with parameters, which are complex or individual. For the parameters with no available data (and need for additional studies) relevant models could be used (if applicable) and/or additional case-studies and *in-situ* verification could be performed, if experts opinion requires such activity. These parameters are optional and/or recommended (indicated by * in Table 5) and could be included in the general assessment of selected indicator and for further monitoring as well. Spatial variability of some parameters/indicators should be considered in order to determine the scores, based on statistical analyses.

Step 3: Collecting data – national data sets – *Annex 5 of Methodology*

Comprehensive data availability at smaller scales and across different urban ecosystem types is necessary if decision-makers are to use ecosystem condition indicators to maximum effect. The availability of data for smaller regions varies greatly by location and by the kind of data required for each indicator. In some cases, data constraints at local scales will be greater than at regional scale. While the specifics and complexity of urban ecosystems define the wide variations among different urban ecosystems sub-types the common approach in assessing their condition is limited for application. For some data international sources of information can be used and applied. Because the data will be needed at multiple scales, in spatial and non-spatial formats, and include ancillary information to support normalization and disaggregation, different sources of information will need to be used.

Some of data underlined are highly relevant for establishing indicators (statistics, reports, remote-sensing, EU and national databases), but other data sources as additional measurements must also be utilized. Data collection must be ensured by two main approaches: (i) data gathering and acquisition through national statistical data sets and (ii) data acquisition *in-situ* on the field.

In order to assess the current condition of urban ecosystems expert should define the period of data collection (see Monitoring Guide). Information about some parameters should be analysed based on data collected for a minimum of 5 (five) year period. Depending on parameter type and the availability of data, shorter or longer periods are also eligible, but information collected should be enough informative.

Questionnaires and surveys are applicable for assessment the specific cultural ESs.

Step 4: How to assess indicators/parameters – fill the Table, as indicated below:

The indicators of urban ecosystem condition can be assessed through the scores of the parameters relevant to a corresponding scale, for example this shown in Table 5. The range determined in this scale is specific in describing ecosystem services conditions for each sub-type of urban ecosystems and should be determined by the experts in a specific field, approved with professional experience and expertise.

The limits of concrete indicator(s) and its/their parameter(s) for the specific urban ecosystem type(s) are referred to the basis for a hypothetical "representative urban landscape", characterized by the mean value of each parameter and defining the right diapason of scoring.

The example presented in Table 5 could be applied in performing the assessment of both condition and ecosystem services supply. The ecosystem service projects using other indicators, must define them consistently to the current methodology.

Table 5. Ecosystem conditions indicator assessment for Urban Ecosystems

Indicators group	**Indicator**	**Parameter**	**Unit**	**Measurement approach**	**Assessment scale**				
					Score 1 (very bad)	**Score 2 (bad)**	**Score 3 (mode-rate)**	**Score 4 (good)**	**Score 5 (very good)**
Biotic diversity	**plant diversity**	**Vegetation canopy cover**	**%**	**Satellite images**	**0**	**0-25**	**25-50**	**50-75**	**75-100**
		Type of vegetation cover*	%	Observa-tion, Satellite images, cadastre, Master plans	<25% of vegetation cover type resp. plant species are suitable	25-49% of vegetation cover type resp. plant sp. are of species conside-red suitable for the area	50% of vegetation cover type resp. plant sp. are of species conside-red suitable for the area	51-75% of vegetation cover type resp. plant sp. are of species conside-red suitable for the area	All vegetation cover types resp. plant sp. are of species suitable for the area

Indicators group	Indicator	Parameter	Unit	Measurement approach	Assessment scale				
					Score 1 (very bad)	Score 2 (bad)	Score 3 (mode-rate)	Score 4 (good)	Score 5 (very good)
Biotic diversity	plant diversity	Type of plant communities*	%	Observation	0	0-10	10-30	30-50	>50
		Protected species*	number	Grid data according to the Red Data Book of Bulgaria N2000	EA	EA	EA	EA	EA
	animal diversity	Protected species*	number	Grid data according to the Red Data Book of Bulgaria N2000	EA	EA	EA	EA	EA
	habitat diversity	**Soil sealing**	**%**	**Regula-tions, Satellite images**	**>80**	**80-60**	**60-40**	**40-30**	**<30**
		Area of natural habitats	**%**	**Satellite images, cadastre**	**0**	**0-5**	**5-10**	**10-20**	**>20**
		Fragmentation of GI*	%	Maps	> 50	10-50	5-10	2.5-5	< 2.5
	Invasive species	Exotic species (plant, animals)**	number	MoEW, Project reports, Green systems database, Observa-tions	EA	EA	EA	EA	EA
Abiotic heterogeneity		Invasive (plant, animals)**	number	MoEW, Green systems, reports, Observa-tions	EA	EA	EA	EA	EA
	Other biotic heterogeneity indicators (naturalness etc.)	Health status of tree vegetation **	%	ICP_ Forests Level I and II, Observa-tions	60-100	25-60	10-25	0-10	0
		Species diversity according "habitat saturation index" *		Observa-tions	<100 plant taxa and <25 animal species	100–150 plant taxa and 25–35 animal species	150–200 plant taxa and 35–45 animal species	200-250 plant taxa or >45-55 animal species	>250 plant taxa and >55 animal species

Indicators group	Indicator	Parameter	Unit	Measurement approach	Assessment scale				
					Score 1 (very bad)	Score 2 (bad)	Score 3 (mode-rate)	Score 4 (good)	Score 5 (very good)
Abiotic heterogeneity	soil heterogeneity	Soil degradation in the green infrastructure*	%	% of the soil cover	>80	50-80	20-50	10-20	<10
		Reclaimed waste deposits areas	**%**	**Maps**	**<10**	**10-30**	**30-50**	**50-80**	**>80**
	Hydrological heterogeneity	Drainage density*	km/km^2	Map	EA	EA	EA	EA	EA
		Pond area*		Map (GMP)	no	n.a.	n.a.	n.a.	yes
	air heterogeneity	**Air quality**		**ExEA, NSI**	**EA**	**EA**	**EA**	**EA**	**EA**
		Sulphur dioxide (SO_2) - annual rate for ecosystems	*µg/m^3*	*ExEA, Regional inspecto-rates, Regula-tion 12/2010, appendix 5, table 5*	> 25	20 - 25	12 -20	8 - 12	< 8
		Nitrogen oxide + dioxide ($NO+NO_2$) - annual rate for ecosystems	*µg/m^3*	*ExEA, Regional inspecto-rates, Regula-tion 12/2010, appendix 5, table 9: ecosystem health;*	> 80	30 - 80	24 - 30	19,5 - 24	< 19,5
		Annual dust emissions 10 (MAN)	*µg/m^3*	*ExEA, Regional inspecto-rates, EEA, 2014*	>75	50-75	40-50	20-40	< 20

Indicators group	Indicator	Parameter	Unit	Measurement approach	Assessment scale				
					Score 1 (very bad)	Score 2 (bad)	Score 3 (mode-rate)	Score 4 (good)	Score 5 (very good)
Abiotic heterogeneity	air heterogeneity	*Ozone - AOT40 Vegetation May to July.*	*µg/m^3.h*	*ExEA, Regional inspecto-rates*	> 27 000	18 000 - 27 000	12 000 -18 000	12 000 - 6 000	< 6 000
		Ozone - AOT40 Forests April to Aug.	*µg/m^3.h*	*ExEA, Regional inspecto-rates*	> 50 000	30 000 - 50 000	20 000 -30 000	20 000 - 10 000	< 10 000
		Climatic deficiency of potential humidity	**mm. year^{-1}**	**NIMH reports, EA**	**>400 mm >7 months /yr**	**300-400 up to 7 months /yr**	**200-300 5-6 months /yr**	**100-200 up to 4 months /yr**	**0-100 1-3 months/ yr**
	geomorphological heterogeneity	Complex indicator*		Map	EA	EA	EA	EA	EA
	Disturbance regime	Slides*	%	Reports, maps	>15	5-15	2-5	0-2	0
		Floods*	%	Reports, maps	>15	5-15	2-5	0-2	0
	Other abiotic heterogeneity indicators	**Spatial structure of urban areas**	**index**	**Complex assess-ment**	**1C, 1E, 1F, 2C, 2D, 2E, 3D, 3E, 4D, 4E, 5D, 5E, 6D, 6E, D, E**	**2B, 4A, 4F, 5F**	**2A, 4C, C**	**4B, 5C, B, F**	**5A, 5B, A**
Energy budget	energy balance (capture, storage)	**Trend of total CO_2 emissions**	**%**	NSI	**> 10**	**7-9**	**4-6**	**1-3**	**< 1**
		Direct solar-energy radiation	**kWh/m^2**	**Map**	**n.a.**	**n.a.**	**<1450**	**1450-1500**	**> 1500**
	metabolic efficiency	**Temperature sum totals (for the active growing period)**	**t°C**	**Map**	**<1600 or >4300**	**1600-2500 or 3900-4300**	**2500-2900 or 3700-3900**	**2900-3100 or 3500-3700**	**3100-3500**
		Standing biomass*	t/ha	Satellite images, direct measure-ments	< 1.5	1.5-4.0	4.15-25.0	25.1-30.0	>30.0

Indicators group	Indicator	Parameter	Unit	Measurement approach	Assessment scale				
					Score 1 (very bad)	Score 2 (bad)	Score 3 (mode-rate)	Score 4 (good)	Score 5 (very good)
Matter budget	**matter storage (input, output)**	Total OM storage (TB, FF, Soil)*	t C/ha	IPCC GPGLUL UCF (2006)	< 6.7-18.7	18.7-24.9	25-32.3	32.4-40.0	> 40.0
		OM soil*	%	Soil map, Direct	0-0.5%	0.6-1%	1,1-2.5%	2.6-5%	>5%
	element concentrations (other condition variables)	PTEs and pollutants in soil *	EA	Direct sampling, published data	EA	EA	EA	EA	EA
	efficiency measures	Sediment yield*	t/km^2/yr	Map, reports	>313	159-313	85-158	29-84	0-28
Water budget	water balance (input, output)	Urban runoff coefficient *	runoff	Spatial structure of urban areas, soil sealing, slopes, average annual precipita-tion	> 0.8 or < 0.1	0.7-0.8	0.5-0.6	0.4-0.5	0.1-0.4
	water storage	Natural ground water potential*	l/sec/km^2	Basin directora-tes - Registers of ground water resources, EA	< 0.5 or > 7.0	0.5-1.0	1.0-3.0	3.0-5.0	5.0-7.0
	efficiency measures	Risk to soil and atmospheric drought*	Level of risk	Maps and their sources, NIMH reports	severe	high	moder ate	low	No risk

Bold – key indicators, obligatory / *optional and recommended indicators; *italic – part of complex indicator air quality* / ** obligatory only in monitored plots/regions

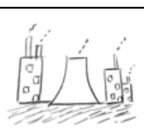
N.A. not applicable; TB – tree biomass; FF – forest floor; EA - expert assessment; Soil Degradation in the green infrastructure – presence of one or more degradation processes (in this soil erosion; soil water logging, soil contamination, soil compaction, salinization) resulting in lack of vegetation; GI – green infrastructure.

Table 6. Assessment scale of spatial structure of Urban territories

Build types	Urban land cover						
	A	B	C	D	E	F	G
2		3	2	2	1	1	2
3		3	2	2	1	1	2
4	4	3	2	2	1	1	2
5	4	3	2	2	1	1	2
6	4	3	2	2	1	1	3
7		3	2	2	1	1	
8	3	3	2	2	1	1	2
9		3	2	2	1	1	3
10		3	2	2	1	1	3
11	5	4	3	3	1	2	4

Legend:

Built types		Land cover types	
	1. Compact high rise Dense mix of tall buildings tens of stories. Few or no trees. Land cover mostly paved. Concrete, steel, stone, and glass construction materials.		A. Dense trees Heavily wooded landscape of deciduous and/or evergreen trees. Land covers mostly pervious (high trees). Zone function is natural forest, forest plantations, or urban forest park.
	2. Compact midrise Dense mix of midrise buildings 3-9 stories. Few or no trees. Land cover mostly paved. Concrete, steel, stone, and glass construction materials.		B. Scattered trees Lightly wooded landscape of deciduous and/or evergreen trees. Land cover mostly pervious (low plants and high trees). Zone function is natural forest, forest plantation, orchard, or urban forest park.
	3. Compact low-rise Dense mix of low-rise buildings from 1-3 stories. Few or no trees. Land cover mostly paved. Concrete, steel, stone, and glass construction materials.		C. Bush, scrub Open arrangement of bushes, shrubs, grass or herbaceous plants/crops and short, woody trees. Land cover mostly pervious (bare soil or sand). Zone function is natural scrubland, agriculture or urban park
	4. Open high-rise Open arrangement of tall, buildings. Abundance pervious land cover (low plants, scattered trees). Concrete, steel, stone, and glass construction materials.		D. Low plants Featureless landscape of grass or herbaceous plants/crops. Few or no trees. Zone function is grassland agriculture or urban park.

Built types		Land cover types	
	5. Open midrise Open arrangement of midrise buildings. Abundance pervious land cover (low plants, scattered trees). Concrete, steel, stone, and glass construction materials.		E. Bare rock or paved Featureless landscape of rock or paved cover. Few or no trees or plants. Zone function is natural desert (rock) or urban transportation
	6. Open low-rise Open arrangement of low-rise buildings. Abundance pervious land cover (low plants, scattered trees). Concrete, steel, stone, and glass construction materials.		F. Bare soil or sand Featureless landscape of soil or sand cover. Few or no trees or plants. Zone function is natural sand beach, dunes or agriculture.
	7. Lightweight low- rise Dense mix of single- story buildings. Few or no trees. Land cover mostly hard- packed. Lightweight construction materials (e.g., wood, thatch, corrugated metal).		G. Water Large, open water bodies suck as seas and lakes, or small bodies such as rivers, reservoirs, and lagoons. Industrial artificial water bodies.
	8. Large low-rise Open arrangement of large low-rise buildings (1–3 stories). Few or no trees. Land cover mostly paved. Steel, concrete, metal, and stone construction materials.		.
	9. Sparsely built Sparse arrangement of small or medium-sized buildings in a natural setting. Abundance of pervious land cover (low plants, scattered trees).		
	10. Heavy industry Low- rise and midrise industrial structures (towers, tanks, stacks). Few or no trees. Land cover mostly paved or hard- packed. Metal, steel, and concrete construction materials.		

Source: adapted for national purposes from Stewart I.D. and T. R. Oke. 2012. Local Cl imate Zones for Urban Temperature Studies. Bull. Amer. Meteor. Soc., 93, 1879 –1900. doi: http://dx.doi.org/10.1175/BAMS-D-11-00019.1

The above listed indicators and parameters were chosen with the aim to serve for a comprehensive assessment of the condition of each ecosystem sub-type. They must be used as described in the present methodology. At the same time, the team realizing the practical assessment may add new parameters describing particular indicator and to test them (see Guide for in-situ validation). Updating the list of indicators/parameters should be harmonized with the recent publications and reports on MAES at European and national levels. Other new indicators – which are being recently developed and under development on European and national level or based on the good practices and practical experience – proposed by the experts should be considered as useful, adequate or more appropriate for the purpose to comprehensively assess the ecosystem condition. Such indicators must be used by the same methodological manner – by determining parameters, units, measurement and assessment scale from 1 to 5, and must be consistent with the MAES research activities, guidelines and reports on the EU scale. The more convenient indicators to assess ecosystem condition are those reflecting naturalness, wilderness, status of representative species or species group and communities, high nature value areas, etc., which can rely with the grid used for mapping. More information regarding the efforts at the EU level to determine the most adequate and appropriate indicators to the ecosystem condition can be obtained via the web-pages of the institutions and research centres involved, (e.g. http://projects.eionet.europa.eu/eea-ecosystem-assessments/library), where can be found publications such as "Developing conceptual framework for ecosystem mapping - part B Ecosystem condition mapping (draft)" and other relevant documents (Burkhard, 2009; Burkhard, Müller, 2012; Burkhard, Maes, 2017; Elmqvist et al, 2013).

Such new indicators/parameters, proposed and tested in the course of the practical assessment, must be described in the final reports for task accomplishment and motivated proposals have to be made for the use of the indicators on question in future assessments. At the same time comments and estimations regarding the usefulness and applicability of the indicators listed in this methodology have to be made, on a basis of the experience acquired in their use.

The score of each parameter should be presented as integer and is considered as enough informative for specific urban ecosystem sub-type. The assessment of the urban sub-type condition is calculated as average of scores for available indicators / parameters referred to the specific urban sub-type ecosystem. The values of calculated scores of both structural and functional indicators are representative for the condition of specific urban ecosystem type. The value obtained must be rounded to the nearest first decimal place, and for the purpose of mapping to an integer. The final value should be integer. The results obtained for the parameters and indicators in assessment of urban ecosystem condition could be further used in assessment of ecosystem services. In order to assure the reliable data the measurements and parameters values' check is recommended. The periodicity of monitoring the parameters describing urban ecosystem condition could be found in the Monitoring Guide.

Step 5. Fill the matrix

After obtaining the scores of each indicator the matrix of calculation presented in Table 7 should be fulfilled. The matrix presented here is an example, which is verified with *in-situ* measurements and data collection (see Guide for in-situ verification). Detail verification process is described in the Monitoring guide and includes both in-situ and off-site assessment of indicators about urban ecosystem condition.

For further *in-situ* verification of the methodology, Samokov to wn is proposed as example of area of interest (AoI) which relates to the urban ecosystem type (J3) in Southwest Bulgaria. The approximate coordinates in Geographic coordinate system of AoI are: 42˚3347˝N, 23˚5504˝E /city center/; 42˚3392˝N, 23˚5363˝E; 42˚316934˝N, 23˚5610˝E; 42˚3491˝, 23˚5610˝.

Table 7. Ecosystem condition indicators assessment template and calculation (example for AoI)

Indicator group		Indicator	Parameter	Units	Real data measured	Score
Biotic diversity	Plant diversity	Vegetation canopy cover	total area	%	17	2
		Type of vegetation cover	species suitability	%	42	2
		Type of plant communities	participation of natural vegetation	%	72	5
	Habitat diversity	Soil sealing	sealed soil	%	58	2
Abiotic heterogenety	Soil heterogeneity	Soil degradation in the green infrastructure	Damaged area	% of soil cover	53	2
	Hydrological heterogeneity	Drainage density	Map	km/km^2	<0.5	3
	Air heterogeneity	Climatic deficiency of potential humidity	NIMH - BAS	mm and months/yr	40	4
	Disturbance regime	Slides	damaged areas to the total area	%	6	4
Matter budget	Matter storage	Total OM storage (TB, FF, Soil)	Carbon stock	t C/ha	21.5	2
		Org. C soil	C content	%	2.5	3
Water budget	Water balance	Urban runoff coefficient	coefficient		0.4	4
	Water storage	Natural ground water potential	l/sec/km^2		1.0	2
	Efficiency measures	Risk to soil and atmospheric drought	scale	Scale	No risk	5
						$\Sigma n_i = 40$
						IP = 40 / (14x5) = 0.57

*indicated condition scores: 1 – very bad; 2 – bad; 3 – moderate; 4 – good; 5 – very good

Explanation: for each indicator, according to its parameter' scoring, based on experts' assessments and further in-situ verification, the figures from 1 to 5 are assigned, according to the scale: 1 – very bad; 2 – bad; 3 – moderate; 4 – good; 5 – very good.

The scores of each indicator measured are then summed up (Σn_i).

An additional index of ecosystem performance (IP) is proposed for specific purposes in decision-making process. It is calculated as ratio of the sum of the indicators scores maximum possible indicator sum: - IP = Σn_i / Σn_i (max) and belongs to the range (0 and 1).

Where:

Σn_i – the sum of the indicator's assessments

Σn_i (max) – sum of the maximum of indicator assessment (i.e. nx5)

The IP assessment scores for the different condition of the ecosystems are as follows:

IP 0-0,2 – very bad; 0,21-0,4 – bad; 0,41-0,6 – moderate; 0,61-0,8 – good; 0,81-1,0 – very good.

In case of AoI the ecosystem condition is 0, 57 – moderate.

The IP index indicates what is the maximum of good ecosystems' condition represent in urban ecosystem type. The IP index is not obligatory, but recommended if requested for fulfilment specific tasks in strategy development by different stakeholders.

5.2. Mapping of Ecosystem condition

The following section describes the procedure of mapping the ecosystem condition, specifications of the final products for the maps and databases, and gives references to the Annexes to this document where database schema is provided in accordance to the specifications given hereafter.

5.2.1. Description of the mapping procedure

The workflow for mapping of ecosystem condition follows the steps described in section 5.1. The technical characteristics of the geodatabase are provided in section 4 and should be applied also for mapping procedures in this section.

5.2.2. Ecosystem Condition Data structure/schema

The data structure should follow the one provided in the Annex 9.00.

The schema of the database for the ecosystem states is presented in Figure 2:

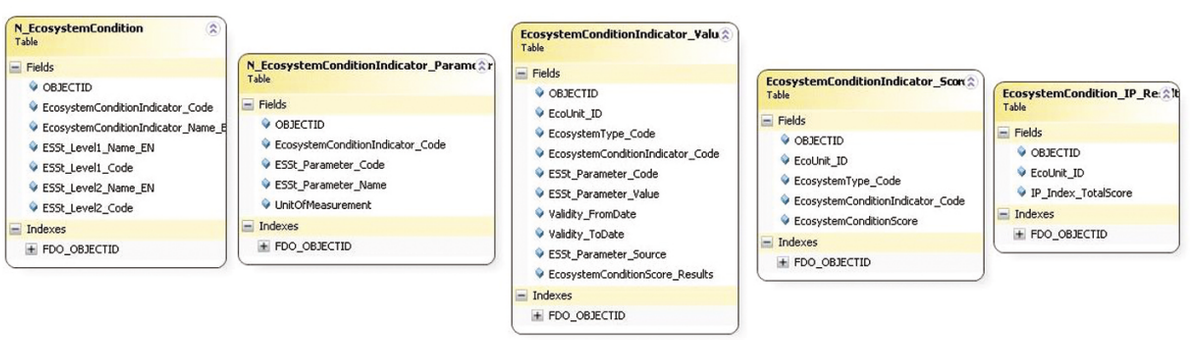


Figure 2: Ecosystem Condition Database Schema

The detailed technical description of the classes and tables of the ecosystem condition database is provided in Annex 9.01_Schema_Report_ES_Database in the file 9.01_1_Schema_Report_ES_Database.htm

The main steps of generation of the geodatabase should follow the steps described in section 5.1.:

- Table **"N_EcosystemCondition"**: Nomenclature table for ecosystem condition indicators. This table should not be changed. The nomenclatures are given in Annex 9.02_NOMENCLATURES_XLS / N_EcosystemCondition.xls. It has the following fields:

- EcosystemConditionIndicator_Code: integer codes for ecosystem condition indicators at level 3;

- EcosystemConditionIndicator_Name_EN: names in English of ecosystem condition indicators at level 3;

- ESSt_Level1_Name_EN: names in English of ecosystem condition indicators at level 1;

- ESSt_Level1_Code: integer code of ecosystem condition indicators at level 1;

- ESSt_Level2_Name_EN: names in English of ecosystem condition indicators at level 2;

- ESSt_Level2_Code: integer code of ecosystem state indicators at level 2;

- Table **"N_EcosystemConditionIndicator_Parameters"**: Nomenclature table of parameters used to determine the ecosystem condition indicator. The nomenclatures are given in Annex 9.02_NOMENCLATURES_XLS / N_EcosystemConditionIndicator_Parameter.xls. It has the following fields:

- EcosystemConditionIndicator_Code: integer codes for ecosystem state indicators at level 3;

- ESSt_Parameter_Code: integer codes for parameters used to assess the ecosystem indicators at level 3;

- ESSt_Parameter_Name: name of parameters used to assess the ecosystem indicators at level 3;

- UnitOfMeasurement: units of measurement for each parameter.

This nomenclature table should be generated using the example provided in Annex 9.02_NOMENCLATURES_XLS / N_EcosystemConditionIndicator_Parameter.xls, as well as the Table 5. *Ecosystem condition indicator assessment for XXX ecosystems*.

- Table **"EcosystemConditionIndicator_Values"**: This table is the resulting table from the assessment of the ecosystem indicators. How to perform the work on assessment of the indicators is described in Step 4 in section 5.1:

- EcoUnit_ID: field to relate with the feature class;

- EcosystemType_Code: integer codes for ecosystem types at level 3;

- EcosystemConditionIndicator_Code: integer codes for ecosystem condition indicators at level 3;

- ESSt_Parameter_Code: integer codes for parameters used to assess the ecosystem indicators at level 3;

- ESSt_Parameter_Value: value of calculated parameter used to assess the ecosystem indicators at level 3;

- Validity_FromDate: starting date for validity of the parameter;

- Validity_ToDate: end date for validity of the parameter;

- ESSt_Parameter_Source: free text to describe the source of the data used to calculate the value of the parameter;

- EcosystemConditionScore_Results: final score for each parameter calculated using the guidelines provided in Table 5. The values here should be between 1 and 5;

As this resulting table could contain enormous number of records which some GIS software could not support it is acceptable to separate it into smaller tables. In this case the records in the table should be separated based on the ecosystem types at level 3. The naming of the table should be done in the following way:

"EcosystemConditionIndicator_Values_XXX" – where XXX is the code of the ecosystem type at level 3.

- Table **"EcosystemConditionIndicator_Score"**: As for some indicator more than one parameter could be selected for measurement, additional table is required which represents the total score for each condition indicator calculated from the total score of parameters measured. Because some of the parameters could be more important than others, it is of responsibility of the expert to choose what will be the final score based on the values of the parameters calculated:

- EcoUnit_ID: field to relate with the feature class;

- EcosystemType_Code: integer codes for ecosystem types at level 3;

- EcosystemConditionIndicator_Code: integer codes for ecosystem condition indicators at level 3;

- EcosystemConditionScore: final score for each indicator calculated on the base of all parameters selected for its evaluation. The values here should be between 1 and 5;

In order the database to be more informative, one table for each condition indicator at level 3 should be prepared and named as follows: "**EcosystemConditionIndicator_Score_YYY"** where YYY is the code for condition indicators at level 3.

- Table **"EcosystemCondition_IP_Results"**: This table is the resulting table from the assessment of the ecosystem indicators and calculation of the IP for each ecosystem type at level 3. How to perform the work on assessment of the indicators is described in Step 4 in section 5.1:

- EcoUnit_ID: field to relate with the feature class;

- IP_Index_TotalScore: value for the index of ecosystem performance (IP) for each polygon representing ecosystem type at level 3. How to calculate the value is described in Step 4 in section 5.1 and an example is given in Table 7 *Ecosystem condition indicator assessment template and calculation – example*.

5.2.3. Accuracy and validation

The validation should be based on scientifically sound approach being able to assess the accuracy reached for each ecosystem condition parameter. For each validation accuracy reports should be generated and provided.

5.2.4. Digital Maps for Ecosystem Condition

Maps in scale 1:125 000 for the ecosystem condition should be delivered in PDF at size A2 presenting the results from calculation of the IP index. In addition the maps could also be prepared in paper format in the same size.

Each data frame should contain one cell from the EEA reference grid at 50km, hence up to 77 maps could be produced for all the cells from the 50km EEA gird for Bulgaria. In case that no objects from Feature Class **"EcoUnit"** fall in certain cell, map for this cell should not be delivered. Therefore, the actual number of maps to be delivered will depend on the number of cells that contain at least one object from Feature "Class **EcoUnit**". The EEA reference grid is available at:

http://www.eea.europa.eu/data-and-maps/data/eea-reference-grids/

For visualization of the IP index graduated colors should be used. Five classes should be generated as follows: 1 – very bad (values > 0 to 0.20); 2 - bad (values > 0.20 to 0.40); 3 – moderate (values > 0.40 to 0.60); 4 – good (values > 0.60 to 0.80); 5 – very good (values > 0.80 to 1).

The colour ramp should use for class 1 blue color (CMYK:50;100;5;30), class 2 violet color (CMYK:18;100;0;0), class 3 pink color (CMYK:0;70;40;0), class 4 orange color (CMYK:0;30;100;0), and for class 5 green color (CMYK:40;5;100;0).

The layout of the maps of the ecosystem types should follow the guidelines of EEA:

http://www.eionet.europa.eu/gis/docs/GISguide_v4_EEA_Layout_for_map_production.pdf

5.2.5. Metadata

Each dataset should be accompanied by INSPIRE conformal metadata. The minimum requirement is the metadata to be generated using the INSPIRE MetadataEditor:

http://inspire-geoportal.ec.europa.eu/editor/

6. Assessment of ecosystem services

6.1. Identification of indicators, parameters, data

To effectively integrate ecosystem services into planned or existing urban land use, the spatial concordance between areas that support ecosystem functions and biodiversity and those that supply ecosystem services have to be identified and more broadly evaluated. Such evaluation will require the best available data on the distribution of ecosystem condition and functions, biodiversity and ecosystem services.

Ecosystem service assessments on various temporal and spatial scales in urban ecosystems can support generation of maps. Such thematic maps can provide information on ecosystem services (supply/demand), quantify the likelihood of urban land-use and its probable impact on ecosystem functions and service supply/demand, and understand the value and flow of benefits to human populations.

Selection and definition of ecosystem services indicators of urban ecosystems is based on the classification of ecosystem services delivered by forests, agroecosystems and freshwater ecosystems as developed in the second MAES report (Maes et al., 2014). In this case as the selection of indicators as well as their assessment is much more complicated for two reasons: these ecosystems depend on the services of other ecosystems and generate huge anthropogenic impact. Moreover reference basis is not applicable in this case. The main supplier of provisioning, regulating and maintenance, as well as of cultural ecosystem services in urban territories is green infrastructure.

Data availability for some of the indicators needed for urban ecosystems significantly limits the state of knowledge for the supply of all services, but is particularly acute for regulating and cultural services. International and national database can be used, having into consideration that those indicators with institutional support have better data availability overall.

According to the Common International Classification of Ecosystem Service V4.3 they are organized in 4 hierarchical levels – section, division, group, class. The total number of ES classes is 48. Those of ES which are relevant for urban ecosystems are selected and defined in classes, which correspond to the codes in the original classification (Table 8). For each ES the indicators are identified as an example and they could be applied in assessment of ecosystem services. The most relevant and important ES from the perspective of regional land use planning in the urban regions are selected in the following 7 ES divisions listed below in Table 8 according to the relevant group code identified by letter: P – Provisioning, R – Regulating and maintenance and C – Cultural. A set of proposed indicators of ecosystem services, which could be applied in assessment and mapping of ES in urban areas is presented in Table 8. Experts could propose additional (optional) indicators of ecosystem services if their application is required for the specific case-study region, well argument and ensured with data.

According to the definitions of service themes and classes used in CICES v4.3 (Haines-Young, Potschin, 2013) “Provisioning services” include all material and biota-dependent energy outputs from ecosystems; they are tangible things that can be exchanged or traded, as well as consumed or used directly by people in manufacture. Within the provisioning service section, three major divisions of services are recognised:

- Nutrition includes all ecosystem outputs that are used directly or indirectly as foodstuffs (including potable water)

- Materials (biotic) that are used directly or employed in the manufacture of goods
- Energy (biomass) which refers to biotic renewable energy sources and mechanical energy provided by animals. Provisioning of water is either attributed to nutrition (drinking) or materials (industrial etc.). The provisioning services groups are further divided in classes and class types.

“Regulating and maintenance services” include all the ways in which ecosystems control or modify biotic or abiotic parameters that define the environment of people, i.e. all aspects of the 'ambient' environment. These are ecosystem outputs that are not consumed but affect the performance of individuals, communities and populations and their activities. Within the regulating and maintenance section, three major service divisions are recognised:

- Mediation of waste, toxics and other nuisances: the services biota or ecosystems provide to detoxify or simply dilute substances mainly as a result of human action
- Mediation of flows (air, liquid, solid masses): this covers services such as regulation and maintenance of land and snow masses, flood and storm protection
- Maintenance of physical, chemical, biological states: this recognises that ecosystems provide for sustainable living states, including soil formation, climate regulation, pest and disease control, pollination and the nursery functions that habitats have in the support of provisioning services. All the regulation and maintenance divisions are further divided into service groups, classes and class types.

“Cultural services” include all non-material ecosystem outputs that have symbolic, cultural or intellectual significance within the cultural service section; two major divisions of services are recognised:

- Physical and intellectual interactions with biota, ecosystems, and land-/seascapes
- Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes

The two cultural divisions can be broken down further into groups, classes and class types. The hierarchical classification allows these to be distinguished using criteria such as whether it involves physical or intellectual activity.

The below listed indicators for ecosystem services were chosen with the aim to assess these services as developed in CICES, the classification scheme accepted by the MAES initiative. As said above concerning the ecosystem condition indicators, after using the indicators for ecosystem services assessment listed in this methodology, the experts involved in the assessment may include other additional indicators for assessment of the services, considered by their usefulness for the purpose to comprehensively assess the ecosystem services that this ecosystem type provide. Such indicators, if any, must be used by the same methodological manner, as described in this methodology, and, after being tested, described and motivated proposals have to be made for their use in future assessment (see Monitoring Guide). Also comments and estimations regarding the usefulness and applicability of the indicators listed in this methodology have to be made, on a basis of the experience acquired in their use by the experts performing the assessment.

The relevant application of the parameters for each urban sub-type is presented in *Annex 7 of the Methodology,* where the availability of data and references are noticed.

The methodology of evaluation and scoring the ecosystems services indicators and their parameters follow the same approach described in details in chapter 6.2, following all step between 1 and 5.

Table 8. Indicators for assessing and mapping Ecosystem Services of urban ecosystems

Section	*Division*	*Group*	*Class (codes CICES)*	*Indicator* *Measuring method*	*Parameters and units*	*Data sources*
Provisioning	**Nutrition**	**Biomass**	P1. Cultivated crops (1111)	1. Environmental condition, 2 Biophysical condition	Score 1-5	Y/N
			P2. Reared animals and their outputs (1112)	1. Number of domestic animals 2. Number of milk cows, 3 Number of domestic birds	Number/ha	Y/N
			P3. Wild plants, algae and their outputs (1113, 1115)	1. Number of wild fruit plants species 2. Number of medicinal plants species, 3 Vegetation cover	Number/ha	Y/N
			P4. Wild animals and their outputs (1114, 1116)	1. Capacity for production	Score 1-5	N
	Materials	**Water**	P8. Ground water for drinking (1122)	1. Exploitation index	%	Y/N
			P12. Surface water for non-drinking purposes (1221)	1. Complex indicator (evapotranspiration, precipitation, water bodies)	Score 1-5	Y/N
			P13. Ground water for non-drinking purposes (1222)	1. Exploitation index	%	Y/N
		Material	P9. Fibres and other materials (1211, 1212)	1. Ecosystem subtype, 2. Land cover, 3. Vegetation cover	Score 1-5	N
			P11. Genetic materials from all biota (1213)	1. Spatial structure index, 2. Vegetation cover, 3. Land cover diversity	Score 1-5	Y/N
	Energy	**Biomass-based energy sources**	P14. Plant and animal-based resources for energy (1311,1312)	1. Number of large animals, 2. number of equines 3. Number of sheep and goats, 4. Number of pigs, 5. Number of birds, 6. Faeces production	1 – 5 Number 6. t/year	Y/N
			P16. Animal-based mechanical energy (1321)	1. Number of equines	Number/ha	Y/N

Section	*Division*	*Group*	*Class (codes CICES)*	*Indicator Measuring method*	*Parameters and units*	*Data sources*
Regulating and maintenance	**Mediation of waste, toxicandothernuisances**	**Mediation by ecosystems**	R3. Regulation of pollution and other impacts (2121,2122,2123)	1. Capacity for regulation	Score 1-5	N
	Mediation of flows	**Mass flows**	R6. Mitigation of erosion (2211,2212)	1. Soil sealing, 2. Sediment yield, 3. Spatial structure index	Score 1-5	Y/N
		Liquid flows	R8. Water flow maintenance and flood protection (2221,2222)	1. Complex indicator	Score 1-5	Y/N
		Gaseous / air flows	R10. Regulation of air flows and atmospheric risks (2231,2232)	1. Vegetation cover, 2. Land cover	Score 1-5	Y/N
	Maintenance of physical, chemical, biological conditions	**Lifecycle maintenance, habitat and gene pool protection**	R12. Pollination and seed dispersal (2311)	1. Number of bee families	1. number/ha	Y/N
		Pest and disease control	R14. Pest and disease control (2321,2322)	1. Complex indicator	Score 1-5	Y/N

Section	*Division*	*Group*	*Class (codes CICES)*	*Indicator Measuring method*	*Parameters and units*	*Data sources*
Regulating and maintenance	**Maintenance of physical, chemical, biological conditions**	**Soil formation and composition**	R16. Regulation of soil formation and composition (2331,2332)	1. Vegetation cover, 2 Clima te, 3 Geology, 4. Slope, 5. Spatial structure index, 6. Actual evapostraspiration, 7. OM soil, 8. Anthropogenic impact	Score 1-5	Y/N
		Atmospheric composition and climate regulation	R20. Global climate regulation by reduction of greenhouse gas concentrations (2351)	Carbon storage	1. total (t C/ha);	Y/N
			R21. Micro and regional climate regulation (2352)	1. Complex indicator	Score 1-5	Y/N
Cultural	**Physical and intellectual interactions with biota, ecosystems, and land - /seascapes [environmental settings]**	**Physical and experiential interactions**	C1. Recreation (3111,3112)	1. Resorts 2 Tourist attraction 3 Elevation 4 Relative elevation 5 Elevation deviation 6 Water bodies 7 Forest 8 number of beds 9 number of tourists	Score 1-5.	Y/N

Section	*Division*	*Group*	*Class (codes CICES)*	*Indicator* *Measuring method*	*Parameters and units*	*Data sources*
Cultural	Physical and intellectual interactions with biota, ecosystems, and land-/seascapes [environmental settings]	**Intellectual and representative interacactions**	C3. Scientific and Educational (3121)	1. Biotic diversity indicators; 2. Number of publications	1. Condition unit 2. Number	Y/N
			C5. Cultural heritage (3123)	1. Number and significance of cultural monuments etc.; 2. Number of visitors	1. n/ha; 2. number	Y/N
	Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes [environmental settings]	**Spiritual and/or emblematic**	C7. Aesthetic(3125)	1. Evaluation from questionnaires; 2. Number of arts portraying ecosystem	1. Expert score; 2. Number	Y/N
		Other cultural outputs	C10. Existence and bequest(3221,3222)	1. expert assessment (questionnaires)	1. score 1-5	N

Y – supported with data based on expert opinion
N – data available only for some regions
NB. Full description of Ecosystem services referred to specific urban ecosystems sub-types in listed in Annex 7.

6.2. Steps for assessment of ES

Step 1: Indicators for Ecosystem services assessment for urban ecosystems

A special approach to the assessment of social-ecological systems is through the analysis of ecosystems services. Ecosystem services describe the relationship between nature and human beings and refer broadly to the benefits people can obtain from urban ecosystems and thereby linking the social and the ecological systems. The benefits for ecosystems are referred to as ecosystem services, a concept which includes 'provisioning services such as food, water, timber, and fibre; regulating services that affect climate, floods, disease, wastes, and water quality; cultural services that provide for example recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling' (Millennium Ecosystem Assessment, MA 2005). The structure of cities and urban forests as part of green infrastructure differs quite considerably to different urban areas even at national level. It also implies that additional measurements are needed in order to have a more accurate estimation of the real mitigation capacity of urban green infrastructure in the regional context.

For sustainable land management, the ecosystem services concept is a suitable tool, as it allows taking account of not only the provisioning services (i.e. the obvious benefits) but also the exact relationship between land use change and shift in ecosystem functions and services in a quantitative manner. However, so far, only few regulating, maintenance, and cultural ecosystem services can be valued directly.

This indicator set is designed in such a way that they assess ecosystem services delivered by the urban ecosystems and experts should assess their relevance to the specific urban ecosystem type. Depending on the availability of the data, a rapid assessment of ecosystem services based on expert opinion at national and/or regional scale could be applied in accordance with the specifics of sub-types of urban ecosystems or due to application of scientific-based algorithm.

Step 2: Collect data – national datasets

Direct and indirect methods could be implemented in assessing ecosystem services in urban areas. Currently most of the data should be derived from existing national and sub-national data sources. Methods that can quantify the uncertainty and validity of ES maps should be further explored.

The following data sources are to be considered:

- *Municipalities*
- *National Cadastre*
- *MOEW - ExEA - CORINE project, national data bases*
- *National statistics*

- *MAFF – Executive Forestry Agency, Executive Agency for Fisheries and Aquacultures*
- *Scientific publications*
- *Projects*
- *In-situ data*
- *EU data sources*
- *Additional remote sensing data*
- *Direct surveys and interviews with experts*

Step 3: How to assess

The assessment of ecosystem services in urban areas is a further step in the whole assessment and mapping process. There are various methods for ecosystem services assessment but common standards require being quantifiable, replicable and affordable. Burkhard et al. (2012) proposed general matrix for ecosystem service demands and provisions including all main ecosystem types presented by land cover classes and selection of ecosystem services. This matrix could be applied at national and regional levels for decision making. For more accurate estimation, also for valuation economic potential, it should be considered that each service type is dependent on two factors: ecosystem area and ecosystem condition. The better condition and larger area is related with higher value of service which should be provided. It is not appropriate to compare between services as they are represented by different measurements therefore the scoring scheme proposed by Burkhard et al. (2012) gives the opportunity to transform all assessment scores into one unified system applicable for all ecosystems. This necessitates to develop a procedure for transformation of quantitative data from different sources and different units into such unified scoring system. The assessment scale consists of six from 0 to 5. A 0-score indicates that there is no relevant capacity to supply particular services and a 5-score indicates the highest relevant capacity for the supply of these services. Scores of 2, 3 and 4 represent respective intermediate capacities. In our case 0-score will be assigned for ecosystems that are not relevant for particular service therefore there is no capacity. For the other ecosystems the 1 to 5 scores will be assigned. For example, cultivated crops are relevant to J2 and J3 (see annex 7) therefore these two ecosystem types will be assessed by 1 to 5 scores, while the other ecosystems (J1, J4, J5, J6, J7, J8, J9, J10) will have 0 score corresponding to no relevant capacity. The experts should collect available data by relevant parameter and indicator, including ecosystem condition assessment for the defined class of ecosystem service. Depending on the specific case and availability of data, each ecosystem services class could be assessed by a different number of indicators and parameters respectively or complex of indictors, defined by the experts. Additional (optional) parameters and/or indicators could be proposed for the specific case-study if enough informative.

The second MAES report (2014) proposes a tiered approach for assessment of ecosystem services. It consists of three tiers starting from most simple tier 1 to most complex tier 3. The definitions of the three tiers proposed by Potschin et al. (2016) are: tier 1 of simple matrix methods based on expert judgment for land cover data; tier 2 of statistics, measured and modelled results added to Tier 1; Tier 3 of sophisticated models that could operate in varying spatial and temporal dimensions. Tier 1 is applicable for all ecosystem services relevant for urban ecosystems. The experts provide overall score for each urban ecosystem subtype at national or regional (district) level and these scores are assigned to all polygons in the respective area. Tier 2 is applicable for ecosystem services which have indicators supported by quantitative data. In this case the experts should provide overall score approach for each class of ecosystem services based on parameters data. Tier 3 is applicable for ecosystem services which could be modelled through utilization of detailed data and sophisticated approaches. This approach could be applied in selected case studies or AoI but it is unlikely to be implemented at national level.

For all relevant services experts should assign to each parameter on a scale numbers from 1 to 5, where 1 is consistent with the poorest condition of the grading criterion, and 5 is the highest level. Scores are assigned on the basis of group consensus after discussions. The dimensions of the intervals depend on the specific characteristics of the indicator and should be defined by the expert based on scientifically sound approach. The scores should be filled in the corresponding field in table 9.

Table 9. Scoring table for ecosystem service assessment (full names are given in table 8)

Class	***Indicator***	***Unit***	**Assessment scale**				
			1	**2**	**3**	**4**	**5**
P1	P1_1	rating	1	2	3	4	5
	P1_2	rating	1	2	3	4	5
P2	P2_1	number/ha	< 6	6 – 14	14 – 26	26 – 34	> 34
	P2_2	number/ha	< 0,6	0,6 – 1,4	1,4 – 2,6	2,6 – 3,4	> 3,4
	P2_3	number/ha	< 10	10 – 30	30 – 70	70 – 90	> 90
P3	P3_1	number species (n)	<11	11-21	22-32	33-44	>44
	P3_2	number species (n)	<59	59-78	79-117	118-138	>138
	P3_3	rating	1	2	3	4	5
P4	P4_1	rating	1	2	3	4	5

Class	*Indicator*	*Unit*	Assessment scale				
			1	**2**	**3**	**4**	**5**
P8	P8_1	%	0-5	5,1-25	25,1-50	50,1-75	75,1-100
P9	P9_1	rating	1	2	3	4	5
	P9_2	rating	1	2	3	4	5
	P9_3	rating	1	2	3	4	5
P11	P11_1	rating	1	2	3	4	5
	P11_2	rating	1	2	3	4	5
	P11_3	rating	1	2	3	4	5
P12	P12_1	complex index	0-1	1-2	2-3	3-4	4-5
P13	P13_1	%	0-5	5,1-25	25,1-50	50,1-75	75,1-100
P14	P14_1	number	1-1042	1042-2069	2069-3112	3112-4154	4154-13735
	P14_2	number	1-302	302-595	595-887	887-1180	1180-2796
	P14_3	number	1-6218	6218-13459	13459-19359	19359-25259	25259-73647
	P14_4	number	1-909	909-1812	1812-2716	2716-3619	3619-53903
	P14_5	number	1-113392	113392-226784	226784-340176	340176-453568	453568-1043334
	P14_6	t/year	1- 25238	25238-49435	49435-73633	73633-97830	97830-122028
P16	P16_1	number/ha	0,01-0,1	0,11-0,45	0,46-0,78	0,79-1,9	1,91-3,81
R3	R3_1	rating	1	2	3	4	5
R6	R6_1	rating	1	2	3	4	5
	R6_2	rating	1	2	3	4	5
	R6_3	rating	1	2	3	4	5
R8	R8_1	rating					
R10	R10_1	complex index	1	2	3	4	5

Class	*Indicator*	*Unit*	Assessment scale				
			1	**2**	**3**	**4**	**5**
	R10_2	rating	1	2	3	4	5
R12	R12_1	number/ha	0,12-0,74	0,75-1,21	1,22-1,76	1,77-2,49	2,49-9,59
R14	R14_1	rating	1	2	3	4	5
R16	R12_1	rating	1	2	3	4	5
	R12_2	rating	1	2	3	4	5
	R12_3	rating	1	2	3	4	5
	R12_4	rating	1	2	3	4	5
	R12_5	rating	1	2	3	4	5
	R12_6	rating	1	2	3	4	5
	R12_7	rating	1	2	3	4	5
	R12_8	rating	1	2	3	4	5
R20	R20_1	tC/ha	1,0 - 12,6	12,7-32,27	32,28-46,31	45,32-61,68	61,69-213,42
R21	R21_1	rating	1	2	3	4	5
C1	C1_1	number	no	1	1(2)	2(3)	3(3)
	C1_2	number	no	1-5	6-9	10-20	Над 21
	C1_3	meters	< 200	200-400	400-600	600-1000	>1000
	C1_4	meters	< 200	200-500	500-800	800-1200	>1200
	C1_5	meters	<300	200-300	100-200	50-100	>50
	C1_6	%	<0,9	1-2,9	3-4,9	5-6,9	>7
	C1_7	%	<10	10-30	30-50	50-70	>70
	C1_8	number / км^2	no	0,01-0,9	1,0-4,9	5,0-9,9	> 10
	C1_9	number/ км^2	no	До 0,9	1,0-19,9	20,0-99,9	> 100

Class	*Indicator*	*Unit*	Assessment scale				
			1	**2**	**3**	**4**	**5**
C3	C3_1	number	10-99	100-307	308-950	951-1675	1676-23500
C5	C5_1	number	no		1		2
	C5_2	number	no	1-3	4-9	10-19	> 20
	C5_3	number	no	1-3	4-9	10-19	> 20
	C5_4	number	no	1	2	3-4	> 5
	C5_5	number	1-5	6-10	11-20	21-30	> 30
	C5_6	number	< 99	100-149	150-199	200-299	> 300
C7	C7_1	number of pictures/ha	< 0,1	0,1 - 0,5	0,6 -1,0	1,1- 2,0	>2,0
C10	C10_1	rating	1	2	3	4	5

1 = low relevant capacity, 2 = relevant capacity, 3 = medium relevant capacity, 4 = high relevant capacity and 5 = very high relevant capacity

The assessment scale and score is based on real parameters (measurable and available statistical data) and presents expert evaluations of the parameter`s dimensions, as an average on national scale, and can be seen as research hypotheses which are to be tested in further case study applications with data from measurements, modelling or additional expert assumptions.

Each ecosystem service relevant to and provided by urban ecosystems then should be assessed at national level. After analysing information for the listed indicators, describing relevant ecosystem services for different types of urban ecosystems (from J1 to J10), the lowest and the highest values should be determined at national level. This allows assessing 100% of national coverage. Same approach could be applied at regional level (following Eurostat NUTS 2 regions for Bulgaria - http://ec.europa.eu/eurostat/documents/3859598/5916917/KS-RA-11-011-EN.PDF) for more precise studies if necessary. The assessment score of relevant class of ecosystem service is the basis for further mapping of the real capacity of urban ecosystem to supply specific ES at national level as shown in Table 10.

The ecosystem service matrix at national level consists of relevant ecosystem services (extracted from the table in annex 7) on the y-axis and each urban ecosystem sub-type (J1 to J10) on the x-axis. At the intersections, the different urban sub-type for realized ecosystem service supply should be assessed on a scale from 0 (no relevant supply) to 5 (maximum relevant supply) for a hypothetical 'normal' urban ecosystem defined by the experts at regional (national) level after completing step 3, having

Table 10. Matrix of scores given to each Class of ES presented by urban ecosystems subtypes

ES class code	Urban ecosystem subtypes									
	J1	J2	J3	J4	J5	J6	J7	J8	J9	J10
P1	1	3	3			1				
P2		1	2			1				
P3		4	4	4	4		1			
P4										2
P8	2	3	2	2	2	2	1	1	1	2
P9	3	3	3	4	4	3	1	1		2
P11	3	3	3	3	4	3	1	2	2	3
P12	2	2	2	2	2	2	2			5
P13	3	4	2	2	2	2	1	1	1	1
P14	2	2	2	2	2	2	2	2	2	2
P16		2	3			1				
R3	2	2	2	4	5	1	1			3
R6	3	3	4	4	5	3				
R8	2	2	2	2	3	2	1	2	2	3
R10	3	4	4	3	4	3	1	2	2	3
R12		1	3		3					
R14	2	3	3	3	4	2				2
R16	3	4	4	4	5	2				
R20	3	3	3	3	4	3	1	2	1	2
R21	3	4	4	4	5	3	1	1	1	4
C1	3	3	2	3	2	1				
C3	4	5	3	4	3	3	3	3	3	3
C5	4	3	1	2	1	1				
C7	4	2	1	5	4	3	1	1		
C10	2	3	3	4	5	1	1	1	1	4

1 = low relevant capacity, 2 = relevant capacity, 3 = medium relevant capacity, 4 = high relevant capacity and 5 = very high relevant capacity

into consideration the complexity of urban ecosystems and their specifics. The score (1 to 5) obtained in Table 10 should be used as as a basis to define the scores for each ecosystem service and the relevant ecosystem subtypes and the results should be filled in Table 11. All services which are defined as not relevant for particular urban ecosystem subtypes (see annex 7) will have 0 score in table 11. Furthermore, the ecosystem services marked as “not supported by data'' in annex 7 will have 0 score. This indicates that they have no relevant capacity at the time of the assessment due to the lack of data but could have higher scores in future assessments. The normalization to this relative 0-5 scale aims at making different ecosystem services (measured and assessed by various indicators and units) comparable with each other. The values obtained in the matrix are useful for detailed mapping of pilots and monitored regions (see Monitoring Guide). It should be underlined that these values are indicative only for urban ecosystems.

Table 11. Summarized data for the urban ecosystem subtypes at national level.

ES class	Urban ecosystem subtypes									
	J1	J2	J3	J4	J5	J6	J7	J8	J9	J10
1111	1	3	3	0	0	1	0	0	0	0
1112	0	1	2	0	0	1	0	0	0	0
1113	0	4	4	4	4	0	1	0	0	0
1114	0	0	0	0	0	0	0	0	0	2
1115	0	4	4	4	4	0	1	0	0	0
1116	0	0	0	0	0	0	0	0	0	2
1121*	0	0	0	0	0	0	0	0	0	0
1122	2	3	2	2	2	2	1	1	1	2
1211	3	3	3	4	4	3	1	1	0	2
1212	3	3	3	4	4	3	1	1	0	2
1213	3	3	3	3	4	3	1	2	2	3
1221	2	2	2	2	2	2	2	0	0	5
1222	3	4	2	2	2	2	1	1	1	1
1311	2	2	2	2	2	2	2	2	2	2
1312	2	2	2	2	2	2	2	2	2	2
1321	0	2	3	0	0	1	0	0	0	0
2111*	0	0	0	0	0	0	0	0	0	0
2112*	0	0	0	0	0	0	0	0	0	0
2121	2	2	2	4	5	1	1	0	0	3
2122	2	2	2	4	5	1	1	0	0	3
2123	2	2	2	4	5	1	1	0	0	3
2211	3	3	4	4	5	3	0	0	0	0
2212	3	3	4	4	5	3	0	0	0	0
2221	2	2	2	2	3	2	1	2	2	3
2222	2	2	2	2	3	2	1	2	2	3
2231	3	4	4	3	4	3	1	2	2	3
2232	3	4	4	3	4	3	1	2	2	3
2311	0	1	3	0	3	0	0	0	0	0
2312*	0	0	0	0	0	0	0	0	0	0
2321	2	3	3	3	4	2	0	0	0	2
2322	2	3	3	3	4	2	0	0	0	2
2331	3	4	4	4	5	2	0	0	0	0
2332	3	4	4	4	5	2	0	0	0	0
2341*	0	0	0	0	0	0	0	0	0	0
2351	3	3	3	3	4	3	1	2	1	2
2352	3	4	4	4	5	3	1	1	1	4
3111	3	3	2	3	2	1	0	0	0	0
3112	3	3	2	3	2	1	0	0	0	0
3121	4	5	3	4	3	3	3	3	3	3
3122*	0	0	0	0	0	0	0	0	0	0
3123	4	3	1	2	1	1	0	0	0	0
3124*	0	0	0	0	0	0	0	0	0	0
3125	4	2	1	5	4	3	1	1	0	0
3211*	0	0	0	0	0	0	0	0	0	0
3212*	0	0	0	0	0	0	0	0	0	0
3221	2	3	3	4	5	1	1	1	1	4
3222	2	3	3	4	5	1	1	1	1	4

The assessment scale: 0 = no relevant capacity of the urban subtype to provide this particular ecosystem service, 1 = low relevant capacity, 2 = relevant capacity, 3 = medium relevant capacity, 4 = high relevant capacity and 5 = very high relevant capacity.
** ES is not supported by data at national level and value 0 is additionally attributed and indicates the lack of data.*

6.3. Mapping of Ecosystem services

The following section describes the procedure of mapping the ecosystem services, specifications of the final products for the maps and databases, and gives references to the Annexes to this document where database schema is provided in accordance to the specifications given hereafter.

6.3.1. Description of the mapping procedure

The workflow for mapping of ecosystem services follows the steps described in section 6.2. The technical characteristics of the geodatabase are provided in section 4 and should be applied also for mapping procedures in this section.

6.3.2. Data structure/schema

The data structure should follow the one provided in the Annex 9.00.

The schema of the database for the ecosystem services is presented in Figure 4:

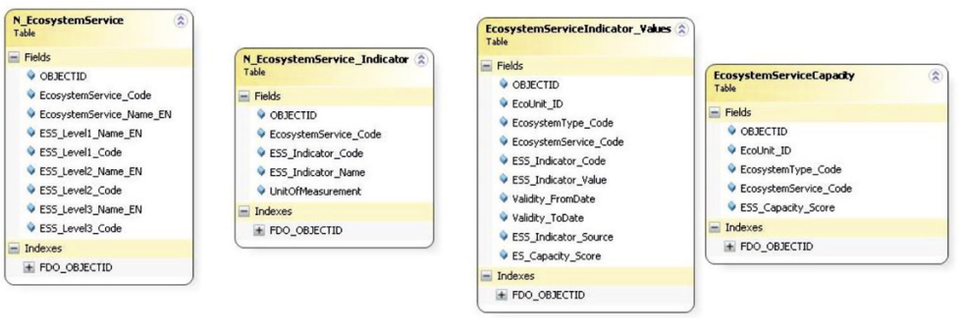


Figure 4: Ecosystem Services Database Schema

The detailed technical description of the classes and tables of the ecosystem services database is provided in Annex 9.01_Schema_Report_ES_Database in file 9.01_1_Schema_Report_ES_Database.htm

The main steps of generation of the geodatabase should follow the steps described in section 6.2.:

- Table **"N_EcosystemService"**: Nomenclature table for ecosystem services. This table should not be changed. The nomenclatures are given in Annex 9.02_NOMENCLATURES_XLS / N_EcosystemService.xls. It has the following fields:

  - EcosystemService_Code: integer codes for ecosystem services at level 4;

  - EcosystemService_Name_EN: names in English of services at level 4;

  - ESS_Level1_Name_EN: names in English of ecosystem services at level 1;

  - ESS_Level1_Code: integer code of ecosystem services at level 1;

- ESS_Level2_Name_EN: names in English of ecosystem services at level 2;

- ESS_Level2_Code: integer code of ecosystem services at level 2;

- ESS_Level3_Name_EN: names in English of ecosystem services at level 3;

- ESS_Level3_Code: integer code of ecosystem services at level 3;

- Table **"N_EcosystemService_Indicator"**: Nomenclature table of indicators used to determine the ecosystem services. The nomenclatures are given in Annex 9.02_NOMENCLATURES_XLS / N_EcosystemService_Indicator.xls. It has the following fields:

- EcosystemService_Code: integer codes for ecosystem service at level 4;

- ESS_Indicator_Code: integer codes for indicators used to assess the ecosystem services at level 4;

- ESS_Indicator_Name: name of indicators used to assess the ecosystem services at level 4;

- UnitOfMeasurement: units of measurement for each indicator.

This nomenclature table should be generated using the example provided in Annex 9.02_NOMENCLATURES_XLS / N_EcosystemService_Indicator.xls, as well as the table 7 *Additional optional indicators, which could be applied in assessing and mapping ESs in XXX ecosystems* from this methodology.

- Table **"EcosystemServiceIndicator_Values"**: This table is the resulting table from the assessment of the ecosystem services. How to perform the work on assessment of the indicators is described in Step 3 in section 6.2:

- EcoUnit_ID: field to relate with the feature class;

- EcosystemType_Code: integer codes for ecosystem types at level 3;

- EcosystemService_Code: integer codes for ecosystem service at level 4;

- ESS_Indicator_Code integer codes for indicators used to assess the ecosystem services at level 4;

- ESS_Indicator _Value: value of calculated indicator used to assess the ecosystem service at level 4;

- Validity_FromDate: starting date for validity of the indicator;

- Validity_ToDate: end date for validity of the indicator;

- ESS_Indicator_Source: free text to describe the source of the data used to calculate the value of the indicator;

- ES_Capacity_Score: calculated value for ES; how to define the score for each indicator is explained in Chapter 6.2. / Step 1;

As this resulting table could contain enormous number of records which some GIS software could not support it is acceptable to separate it into smaller tables. In this case the records in the table should be separated based on the ecosystem types at level 3. The naming of the table should be done in the following way:

"EcosystemServiceIndicator_Values_XXX" – where XXX is the code of the ecosystem type at level 3.

- Table **"EcosystemServiceCapacity"**: As for some services more than one indicator could be selected for measurement, additional table is required which represents the total score for each service calculated from the total score of indicators measured. Because some of the indicators could be more important than others, it is of responsibility of the expert to choose what will be the final score based on the values of the indicators calculated:

- EcoUnit_ID: field to relate with the feature class;

- EcosystemType_Code: integer codes for ecosystem types at level 3;

- EcosystemService_Code: integer codes for ecosystem service at level 4;

- ESS_Capacity_Score: final score for each service calculated on the bases of all indicators selected for its evaluation. The values here should be between 1 and 5 and 0 for not relevant capacity;

In order the database to be more informative, one table for each service at level 4 should be prepared and named as follows: "**EcosystemServiceCapacity_ZZZ"** where ZZZ is the code for services at level 4.

6.3.3. Accuracy and validation

The expert should provide scientifically sound approach to describe the accuracy reached for each ecosystem service indicator; hence validation approach should be applied. For each validation, accuracy reports should be generated and provided.

6.3.4. Digital Maps for Ecosystem Services

Maps in scale 1:125 000 for the ecosystem types should be delivered in PDF at size A2 presenting the results from calculation for Ecosystem Capacity. In addition the maps could also be prepared in paper format in the same size

Each data frame should contain one cell from the EEA reference grid at 50 km, hence up to 77 maps could be produced for all the cells from the 50km EEA gird for Bulgaria. In case that no polygons from Feature Class **"EcoUnit"** fall in certain cell, map for this cell should not be delivered. Therefore, the actual number of maps to be delivered will depend on the number

of cells that contain at least one polygon from Feature "**Class EcoUnit**". The EEA reference grid is available at:

http://www.eea.europa.eu/data-and-maps/data/eea-reference-grids/

At least one set of maps for the ecosystem services should be prepared. The maps representing the results for calculating the ecosystem services capacity is mandatory. Fo r visualization of the capacity graduated colors corresponding to the colors in example matrix table (table 10) should be used. Six classes should be generated as follows: 0 - no relevant capacity of the freshwater sub-type type to provide this particular ecosystem service, 1 - low relevant capacity, 2 - relevant capacity, 3 - medium relevant capacity, 4 - high relevant capacity and 5 - very high relevant capacity.

The layout of the maps of the ecosystem services should follow the guidelines of EEA:

http://www.eionet.europa.eu/gis/docs/GISguide_v4_EEA_Layout_for_map_production.pdf

6.3.5. Metadata

Each dataset should be accompanied by INSPIRE conformal metadata. The minimum requirement is the metadata to be generated using the INSPIRE MetadataEditor:
http://inspire-geoportal.ec.europa.eu/editor/

7. Annexes

Annex 1 - B1

Terms and definitions

Term	Definition
Urban ecosystems	
Area of habitats	the area covered by the defined habitat
Annual dust emissions 10	the PM-10 standard includes particles with a diameter of 10 micrometers or less.
Annual precipitation	sum of monthly precipitation (mm)
Annual distribution of river discharge	the discharge of a river is the volume of water which flows through it in a year and its dynamics.
Air temperature	mean annual temperature (MAT) of the selected specified urban territory
Air humidity	mean monthly/seasonal air humidity of the selected specified urban territory
Assessment	The analysis and review of information derived from research for the purpose of helping someone in a position of responsibility to evaluate possible actions or think about a problem. Assessment means assembling, summarizing, organizing, interpreting, and possibly reconciling pieces of existing knowledge and communicating them so that they are relevant and helpful to an intelligent but inexpert decision-maker (Parson, 1995).
Benefits	positive change in wellbeing from the fulfilment of needs and wants (TEEB, 2010).
Biodiversity	the variability among living organisms from all sources, including inter alia terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part, this includes diversity within species, between species, and of ecosystems (cf. Article 2 of the Convention on Biological Diversity, 1992).
Biophysical valuation	valuation of the physical ecosystem properties and changes that take place over a period of time related to a specific indicator and using an accepted measurement procedure.
Corg. in soil	organic carbon content in soil (incl. forest floor where exists)
Ecosystem	A dynamic complex of plant, animal, and microorganism communities and their non-living environment interacting as a functional unit (MA, 2005). For practical purposes it is important to define the spatial dimensions of concern.
Ecosystem assessment	a social process through which the findings of science concerning the causes of ecosystem change, their consequences for human well-being, and management and policy options are brought to bear on the needs of decision-makers (UK NEA, 2011).

Ecosystem condition	the physical, chemical and biological condition of an ecosystem at a particular point in time which can also be referred to as its quality. It is referred to the capacity of an ecosystem to yield services, relative to its potential capacity (MA, 2005).
Ecosystem function	subset of the interactions between biophysical structures, biodiversity and ecosystem processes that underpin the capacity of an ecosystem to provide ecosystem services (TEEB, 2010).
Ecosystem process	any change or reaction, which occurs within ecosystems, physical, chemical or biological. Ecosystem processes include decomposition, production, nutrient cycling, and fluxes of nutrients and energy (MA, 2005).
Ecosystem service	the benefits that people obtain from ecosystems (MA, 2005). The direct and indirect contributions of ecosystems to human well-being (TEEB, 2010). The concept 'ecosystem goods and services' is synonymous with ecosystem services. The service flow in MAES conceptual framework refers to the actually used service.
Exotic species (plant, animals)	'alien species' refers to a species, subspecies or lower taxon, introduced outside its natural past or present distribution; includes any part, gametes, seeds, eggs, or propagates of such species that might survive and subsequently reproduce. (some international/ regional/ national instruments use the terms 'exotic species', 'non-indigenous species' or 'non-native species' when referring to 'alien species'); Synonyms: nonindigenous = alien = exotic = non-native.
Floods	number of recorded floods per year and % damaged areas of the total area
Fragmentation	fragmented habitats are those that were once contiguous but are now separated into smaller, isolated areas.
Green Infrastructure	strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services in both terrestrial and aquatic environments. It is the structure enabling healthy ecosystems to deliver their multiple services to people and nature. On land, GI is present in both rural and urban settings, in protected and nonprotected areas (EC, 2014)
Humidification conditions	humidity criterion calculated as the difference between precipitation and potential evapotranspiration in summer – estimation of annual surface water balance (P-PET).
Index of soil heterogeneity	number of soil bodies per unit area (i.e. density) multiplied by the taxonomic contrast; provides indication about taxonomic complexity of given area (Schaetzl, R., Anderson, S. 2005. Soils Genesis and Geomorphology. Cambridge University Press. 821 pp.). In the specific case of urban ecosystems also the sealing soils are taken into consideration.
Indicator	parameter or value that reflects the conditions of the environment (or human health) component, usually with a significance that extends beyond the measurement of value itself. Indicators provide the means to assess progress toward an objective. (Objective – specific description of the state or condition that must be met in order to achieve goals and the vision.)

Invasives (plant, animals)	invasive alien species (IAS) are non-native species that are deliberately or unintentionally introduced by human action outside their natural habitats where they establish, proliferate and spread in ways that cause damage to biological diversity.
Insects and pathogens	% damaged areas of the total area by pests and diseases
Land cover	land cover is the observed (bio)physical cover on the earth's surface.
Leaf area index	LAI characterizes plant canopies. It is defined as the one-sided green leaf area per unit ground surface area (LAI = leaf area / ground area, m2 / m2) in broadleaf canopies. In conifers half of the total needle surface area per unit ground surface area.
Natural habitats	the area or natural environment within urban area (if any) in which organisms or populations normally live.
Nitrogen dioxide (NO_2)	total annual rate for ecosystems
Natural ground water discharge	the discharge of ground water is the volumetric flow rate of groundwater through an aquifer
Nutrient loss (Leaching of N,P)	natural process by which water soluble forms of nutritive elements are washed out from soil or wastes.
OM losses	reduction and loss of carbon (organic matter) from the ecosystem
Ozone - AOT40	a value of 40 ppb (AOT40) has been employed in impact assessment research in Europe and is proposed in this guidance. The ozone may affect vegetation at concentrations well below 40 ppb. Period should be defined depending of the region and type of vegetation.
Parameter	a parameter is a characteristic, feature, or measurable factor that support in defining a particular system. A parameter (or set of parameters) is an important element to consider in evaluation or comprehension of the indicator.
Passages for fauna/km of transport infrastructure -	structures that allow animals to cross human-made barriers safely(underpass tunnels, viaducts, and overpasses (mainly for large or herd-type animals); amphibian tunnels; fish ladders; tunnels and culverts (for small mammals such as otters, hedgehogs, and badgers); green roofs (for butterflies and birds).
Pond area	area covered by ponds in selected specified urban territory
Protected plant species	Habitats Directive in 1992 (Council Directive 92/43/EEC of 21 May 1992)
Reclaimed areas	making degraded or other wasteland capable for cultivation or other use (by means of drainage, chemical melioration and others)
Relief	plain (mean altitude 130-170 m a.s.l.), plain-hill (mean altitude 200-290 m a.s.l.), hill-lowlands (290-800 m a.s.l), mountainous (mean altitude 800-100 m a.s.l.), high-mountainous (mean altitude 1260 m a.s.l.) relief types based on hypsometric zoning
Rivers area	area covered by rivers in selected specified urban territory
Soil degradation	damage and/or deterioration of the soil which has adverse effect on one or more of its ecological functions. The causes could be natural and/or human induced.
Species diversity	number of animal species for specified area incl. protected animal species - Habitats Directive in 1992 (Council Directive 92/43/EEC of 21 May 1992) and Birds Directive (Directive 2009/147/EC)

Soil resistance to acidification and pollution	soil characteristic taking into consideration the pH index, the soil texture and the content of carbonates (four categories have been distinguished);
Solar-energy potential	mean annual solar energy potential integrate data about the total solar radiation, the air temperature, the air transparency and the orographic clarity of the horizon. (the values for the country vary from 1.1 up to 1.350 kWh/year)
Standing biomass	the amount of plant biomass found at a given location at a single point in time.
Sediment yield	the amount of sediment reaching or passing a determined point in a given period of time
Storage of OM	amount of carbon stored in the urban ecosystem (carbon stock, carbon storage), mainly in living biomass and soil, but to a lesser extent also in dead wood, litter and other elements of green infrastructure.
Sulfur dioxide (SO_2)	total annual rate for ecosystems
Temperature sum total	the sum of the average daily air temperature during the active growing period of the year
Trees per inhabitants	number of trees per number of inhabitants in a specified urban area
Type of plant communities	Plant Classification according to their origin – natural and artificial.
Total emissions of carbon dioxide in the air	anthropogenic emissions, less removal by sinks, of carbon dioxide (CO_2). In addition to total emissions, sectoral CO_2 emissions can be considered. The typical sectors for which CO_2 emissions/removals are estimated are energy, industrial processes, agriculture, waste, and the sector of land use, land-use change and forestry (LULUCF) (IPCC).
Type of vegetation cover	type of plant cover on the earth's surface – forest land, grassland, abandoned, pasture, allotment.
Urban protected areas	"a clearly defined geographical space, recognized, dedicated, and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values." (UN)
Vegetation cover	the observed plant cover on the earth's surface

Annex 2 - B1

List of acronyms

AoI	Area of Interest
BESS	Biodiversity & Ecosystem Service Sustainability
BFSA	Bulgarian Food Safety Agency
BSBP	Biodiversity Planning Support Programme
BQE	Biological Quality Element(s)
CBD	Convention on Biological Diversity
CICES	Common International Classification of Ecosystem Services
CLC	CORINE Land Cover
CMYK	Color model for "Cyan Magenta Yellow Black."
CORINE	Coordination of Information on the Environment
EAE	Executive Agency for the Environment
EC	European Commission
EEA	European Environment Agency
EEA FM	European Economic Area Financial Mechanism
EFA	Executive Forestry Agency
EFDAC	European Forest Data Centre
ESMERALDA	Enhancing Ecosystem Services Mapping for Policy and Decision Making – H2020 project
EnvEurope	The project “Environmental quality & pressures assessment across Europe: the LTER network as an integrated and shared system for ecosystem monitoring”
FF	Forest floor
FRAME	Directive on Floods Risk Assessment & Management 2007/60/EEC
ES	Ecosystem Services
ESC	Ecosystem Capacity
EU	European Union
EUNIS	European University Nature Information System
EQR	Ecological Quality Ratio
ExEA	Executive Environmental Agency
EEA	European Environmental Agency
GIS	Geographic Information System
GMES	Global Monitoring for Environment and Security programme
HD	Habitats Directive
INSPIRE	Infrastructure for Spatial Information in the European Community
IP	Index of Ecosystem Performance
IPP	Institute for plant Protection
IPCC	Intergovernmental Panel on Climate Change
GPGLULUCF	Good practice guidance for land use, land use change and forestry

LV	Limit value
JRC	Joint Research Centre
MA	Millennium Ecosystem Assessment
MAES	Mapping and Assessment of Ecosystems and their Services
MAF	Ministry of Agriculture and Food
ME	Ministry of Economy
MOEW	Ministry of Environment and Water
MRD	Ministry of Regional Fevelopment
MSFD	Marine Strategy Framework Directive
MTITC	Ministry of Transport, Information Technology and Communications
NEK EAD	National Electricity Company EAD
NCA	Natural Capital Accounts
NCRD	National Concept for Regional Development
NCSD	National Concept for Spatial Development
NGOs	Non-Governmental Organization(s)
NIMH	National Institute of Meteorology and Hydrology
NSI	National Statistic Institute
OM	Organic Matter
OGS	Open Geospatial Consortium
OPERA project	Operational Potential of Ecosystems Research Applications
PAF	Priority Action Framework
PES	Payment for Environmental Services
RBDs	River Basins Directorate(s)
RES	Realized Ecosystem Capacity
RIEW	Regional Inspectorate of Environment and Water
SEEA	System of Environmental Economic Accounts
SEPA	Single Euro Payments Area
TB	Total biomass
TEEB	The Economics of Ecosystems and Biodiversity
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNSC	United Nations Statistics Commission
WAVES	Wealth Accounting and the Valuation of Ecosystem Services
WFD	Water Framework Directive
WG	Working Group
WWF	World Wide Fund for Nature

Annex 3 - B1

TABLE OF ECOSYSTEM TYPES

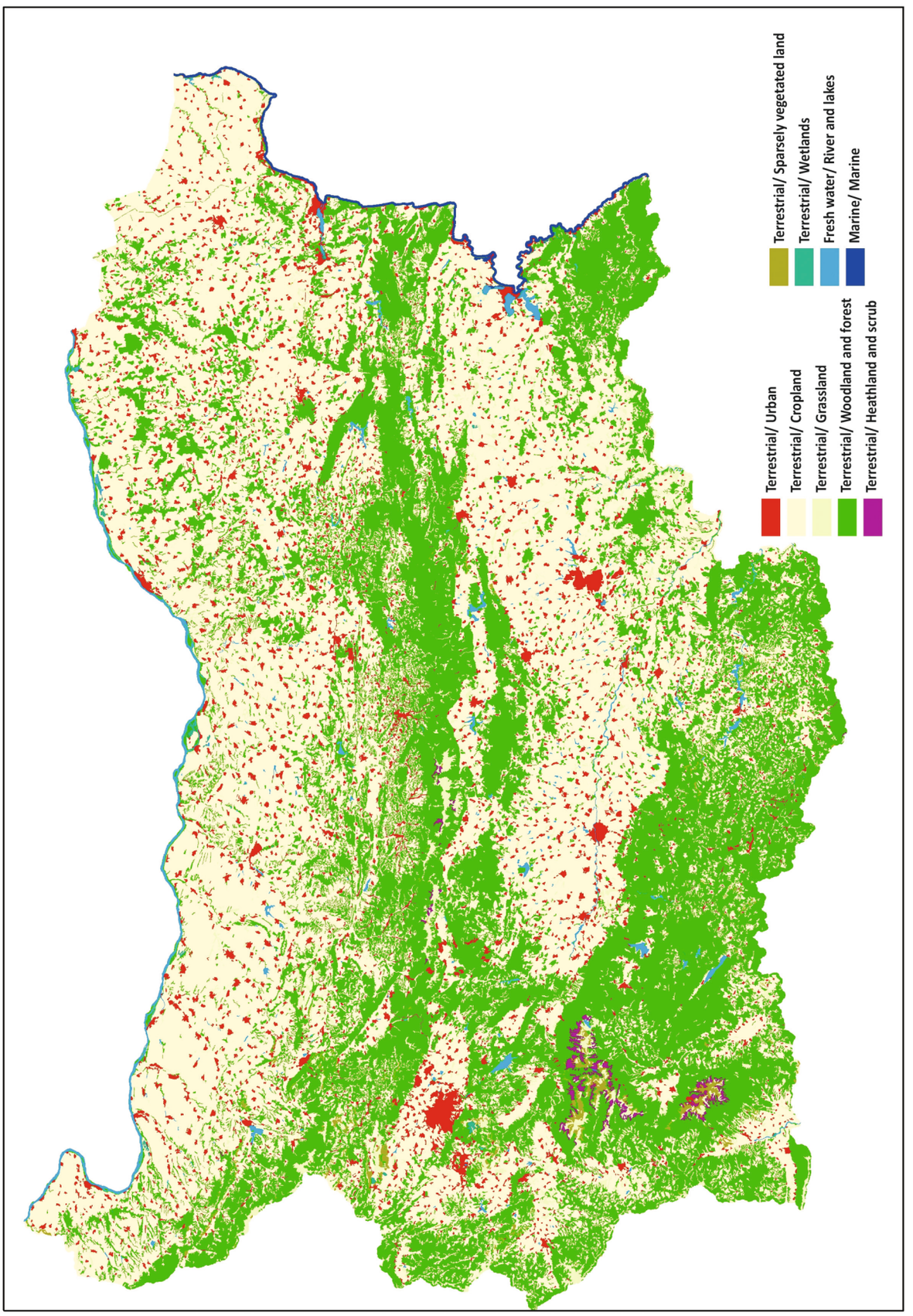
URBAN ECOSYSTEMS

Abbreviation	Sub-type	Description	Nomenclature
J1.	Residential and public areas of cities and towns	Residential areas, and areas for public services, including objects of education, healthcare, service facilities of trade, science and scientific services, business and administrative services, social assistance and others in large and medium cities - by hierarchical system of city-centers of first, second, and third level, according to the classification of National concept for spatial development for the period 2013 – 2025. Hierarchic system of core-cities extending their influence over territorial areas of different sizes[1]: Level One – the capital Sofia, centre of European significance for the national territory; Level Two – big cities, centres of national significance for the territory of the regions – Plovdiv, Varna, Burgas, Ruse, Pleven, Stara Zagora; Level Three – medium-size cities, centres of regional significance for the area of the districts – district centres and other eminent cities – Vidin, Montana, Vratsa, Lovech, Gabrovo, Veliko Tarnovo, Targovishte, Razgrad, Shumen, Silistra, Dobrich, Sliven, Yambol, Haskovo, Kardzhali, Smolyan, Pazardzhik, Pernik, Kyustendil, Blagoevgrad, Svishtof, Gorna Oryahovitsa, Kazanlak, Dimitrovgrad, Assenovgrad, Karlovo, Dupnitsa, Petrich.	EUNIS – J1 (J1.1, J1.2, J1.3, J1.5, J1.6), X24, X25
J2.	Sub-urban areas	The surrounding areas of J1 referred only for cities at Level One and Level Two - objects of suburbanization and zones of impact	EUNIS - J1 (J1.2, J1.3, J1.6; J1.7) X13, X15, X16.
J3.	Residential and public low density areas	Residential areas, and areas for public services, including objects of education, healthcare, service facilities of trade, science and scientific services, business and administrative services, social assistance and others in small towns with micro-regional importance for the territory of groups of municipalities (4 hierarchical levels according to the classification of National concept for spatial development for the period 2013 – 2025) and in very small towns and villages, centers of local importance in the territory of the municipalities and others (5 hierarchical level according to the classification of NCSD) and other villages.	EUNIS – J1 (J1.2; 1.3); X24, X25.

[1] The hierarchic ranking of the core-cities is regulated in National concept for spatial development for the period 2013 – 2025. It has been performed through assessment of their significance and role according to a number of criteria and indicators related to the population dynamics and the degree of development of their administrative, economic, transport functions etc.

Abbreviation	Sub-type	Description	Nomenclature
J4.	Recreation area outside cities and towns	Park territories outside cities and towns' incl. buildings, sport and leisure facilities used for tourism and recreation.	EUNIS – J1 (J1.7); J2 (J2.1, J2.2); X11.
J5.	Urban green areas (incl. sport and leisure facilities)	Public and private open spaces in urban areas, primarily covered by native and or artificial vegetation, which are directly or indirectly available for the users. Includes all 'outdoor' spaces including streets and squares. Areas for local gardens and landscaping with prevailing open sites for sports, amusement and entertainment, playgrounds.	EUNIS – I (I2);X X11, X22, X23)
J6.	Industrial sites (incl. commercial sites)	Structures dispersed within the rural or natural environment established for the purpose of industrial, agricultural and commercial activities.	EUNIS – J1 (J1.4; J1.5; J1.6), J2 (J2.3, J2.4, J2.5, J2.6, J2.7)
J7.	Transport networks and other constructed hard surfaced sites	Includes roads, car parks, railways, paved footpaths and hard-surfaced areas of airports, water ports, train and bus stations, and associated infrastructure and landscaping.	EUNIS – J4
J8.	Extractive industrial sites (incl. active underground mines and active opencast mineral extraction sites, and quarries)	Sites in which minerals are extracted. Includes quarries, open-cast mines and active underground mines. Areas used for open-sky mining and quarrying activities and presently in operation. Disused sites that were formerly quarries or open-cast mines.	EUNIS – J3
J9.	Waste deposits	Tips, landfill sites and slurries produced as by-products, usually unwanted, of human activity. Dumps of building waste when not forming a part of construction or demolition sites, or when so large as to constitute a separate habitat. Sites used for disposal of household waste, including landfill sites that may be used for several types of waste. Includes slag heaps, mine waste, dumped quarry waste, and mineral wastes resulting from chemical processes. Dung heaps, slurry lagoons, decaying straw, dumps of unwanted produce. Sewage waste, sewage slurries. Heaps, tips and mounds formed as by-products of industrial activities.	EUNIS - J6 (J6.1, J6.2, J6.5)
J10.	Highly artificial man made waters and associated structures	Inland artificial waterbodies with wholly-constructed beds or heavily contaminated water, and their associated conduits and containers. Includes also salt works by the coast.	EUNIS – J5.1., J5.3, J5.4, J5.5

Map of ecosystem types



Annex 5 - B1

Data Sources

Urban ecosystems sub-type	DATABASE Sources – main stakeholders	
	Spatial	Quantitative/Qualitative
J1.Residential and public areas of cities and towns	Database EUNIS Level 2, Master Plans, Site Development plans, Cadastre www.icadastre.bg National Concept for Spatial Development 2013-2025.	Spatial Development Plans, Land Identification Parcel System, Cadastre Maps, Cadastre map of Agricultural Land, Urban Development Plans, Municipal Environment Protection Programmes, National Concept for Spatial Development 2013-2025, National Statistical Institute, Urban Atlas (EEA, MOEW), JRC, Publications, Project Reports, ME, MRD.
J2.Sub-urban areas	Database EUNIS Level 2, Master Plans, Site Development plans, Cadastre www.icadastre.bg National Concept for Spatial Development 2013-2025.	Master Plans, Spatial Development Plans, Land Identification Parcel System, Cadastre Maps, Cadastre map of Agricultural Land, Urban Development Plans, Municipal Environment Protection Programmes of Environmental protection, National Concept for Spatial Development 2013-2025, National Statistical Institute, Urban Atlas (ExEA, MOEW), JRC, Publications, Project Reports, ME, MRD.
J3.Residential and public low density areas	Database EUNIS Level 2 (VV), Master Plans, Spatial Development Plans, Cadastre maps (www.icadastre.bg) National Concept for Spatial Development 2013-2025.	Master Plans, Spatial Development Plans, Land Identification Parcel System, Cadastre Maps, Cadastre map of Agricultural Land, Urban Development Plans, Municipal Environment Protection Programmes, National Concept for Spatial Development 2013-2025, Publications, Project Reports, MOEW, ME, MRD.
J4.Recreation area outside cities and towns	Available Master Plans, Cadastre Maps, Land Identification Parcel System.	National Concept for Spatial Development 2013-2025, available Master Plans, Cadastre Maps, Land Identification Parcel System, National Statistical Institute, Projects , Reports, NCRD, MRD, MOEW, Publications.
J5.Urban green areas (incl. sport and leisure facilities)	Available Master Plans, Cadastre maps, Land Identification Parcel System, Urban Atlas (CLC), Projects for grey, blue and green infrastructure, Ongoing passportization of urban green areas.	Available Master Plans, Cadastre maps, Land Identification Parcel System, Cadastre Maps, Cadastre map of Agricultural Land, Urban Development Plans, Municipal Environment Protection Programmes, National Concept for Regional Development (NCRD), National Statistical Institute, Urban Atlas (EEA, MOEW), Dept. “Green Systems”, “Urban parks and allotments”, etc., Urban Parks Inventories, Projects, Publications, University of Forestry – Department of Landscape architecture, Publications.

Urban ecosystems sub-type	DATABASE Sources – main stakeholders	
	Spatial	Quantitative/Qualitative
J6.Industrial sites (incl. commercial sites)	Available Master Plans , Cadastre maps, Land Identification Parcel System, Cadastre Maps, Cadastre map of Agricultural Land	Available Master Plans, Cadastre maps, Land Identification Parcel System, Cadastre Maps, Cadastre map of Agricultural Land, EEA, MOEW
J7.Transport networks and other constructed hard surfaced sites	Road Infrastructure Agency, available Master Plans, Cadastre Maps, Land Identification Parcel System, Cadastre Maps, Cadastre map of Agricultural Land	Road Infrastructure Agency, National Railway Infrastructure Company, Bulgarian Ports Infrastructure Company, Civil Aviation Administration (MTITC), Master Plans, Cadastre maps, National Concept for Regional Development
J8.Extractive industrial sites (incl. active underground mines and active opencast mineral extraction sites, and quarries)	Available Master Plans, Cadastre maps, Land Identification Parcel System, Cadastre Maps, Cadastre map of Agricultural Land,	Available Master Plans, Cadastre maps, Land Identification Parcel System, Cadastre Maps, Cadastre map of Agricultural Land, Municipal Environment Protection Programmes, Municipal Development plans, MOEW, ME, Publications, Projects, Reports.
J9.Waste deposits	Available Master Plans, Cadastre maps, Land Identification Parcel System, Cadastre map of Agricultural Land.	MOEW, RIEW, MRD, ME, Publications, Projects, Reports.
J10.Highly artificial man made waters and associated structures	Available Master Plans, Cadastre maps, Land Identification Parcel System, Cadastre map of Agricultural Land,	MOEW, RIEW, NEK EAD “Dams and cascades” NATURA 2000; River Basins Management Plans; Flood Risk Management Plans, Projects and publications, EEA, MOEW, Basin Directorates.

Available as a spreadsheet at:
http://www.metecosmap-sofia.org/methodological-framework/

Annex 6 - B1

Ecological condition indicators

Ecological Condition indicator			J1 Residential and public areas of cities and towns				J2 sub-urban areas			
Orientor	TYPE /Group		Indicator	Parameter (dimension unit)	Available data (Y/N)	New data needed (tick by "V")	Indicator	Parameter (dimension unit)	Available data (Y/N)	New data needed (tick by "V")
Ecosystem structure	Biotic diversity	plant diversity	Vegetation canopy cover	% of the total area	Y		Vegetation canopy cover	% of the total area	Y	
			Type of vegetation cover	% of species suitability	Y		Type of vegetation cover	% of species suitability	Y	
			Type of plant communities	% participation of natural vegetation	N	V	Type of plant communities	% participation of natural vegetation	N	V
			Protected species	number	Y/N	V	Protected species	number	Y/N	V
		animal diversity	Protected species	number	Y		Protected species	number	Y	
		habitat diversity	Soil sealing	%	Y		Soil sealing	%	Y	
			Area of natural habitats	% (area habitats/total area)	Y		Area of natural habitats	% (area habitats/total area)	Y/N	V
			Fragmentation of GI	Urban GI Fragmentation %	Y		Fragmentation of GI	Urban GI Fragmentation %	Y	
		Invasive species	exotic species (plant, animals)	Presence (number)	Y/N	V	exotic species (plant, animals)	Presence (number)	Y/N	V
			invasives (plant, animals)	Presence (number)	Y/N	V	invasives (plant, animals)	Presence (number)	Y/N	V
		Other biotic heterogeneity indicators (naturalness etc.)	health status of tree vegetation	% Discoloration and % defoliation of trees and damages visible by trees	N	V	health status of tree vegetation	% Discoloration and % defoliation of trees and damages visible by trees	Y/N	V
			Species diversity according "habitat saturation index"	EA			Species diversity according "habitat saturation index"	EA		
	Abiotic heterogeneity	Soil heterogeneity	soil degradation in the green infrastructure	%	N	V	soil degradation in the green infrastructure	%	N	V
			reclaimed waste deposits	%			reclaimed waste deposits	%	Y/N	V
		Hydrological heterogeneity	drenaige density	km/km2	Y		drenaige density	km/km2	Y	
			pond area	presence	Y		pond area	presence	Y	
		Air heterogeneity	Sulfur dioxide (SO2) - annual rate for ecosystems	mg/m3	Y		Sulfur dioxide (SO2) - annual rate for ecosystems	mg/m3	Y	
			Nitrogene dioxide (NO2) - annual rate for ecosystems	mg/m3	Y		Nitrogene dioxide (NO2) - annual rate for ecosystems	mg/m3	Y	
			Annual dust emissions 10 (MAN)	mg/m3	Y		Annual dust emissions 10 (MAN)	mg/m3	Y	
			Climatic deficiency of potential humidity	mm/yr	Y		Climatic deficiency of potential humidity	mm/yr	Y	
			Ozone - AOT40	µg/m3.h	Y		Ozone - AOT40	µg/m3.h	Y	
			Air quality (complex indicator)	complex score			Air quality (complex indicator)	complex score		

Ecological Condition indicator			J1 Residential and public areas of cities and towns				J2 sub-urban areas			
Orientor	TYPE /Group		Indicator	Parameter (dimension unit)	Available data (Y/N)	New data needed (tick by "V")	Indicator	Parameter (dimension unit)	Available data (Y/N)	New data needed (tick by "V")
Ecosystem structure	Abiotic heterogeneity	Geomorphological heterogeneity	complex indicator	slope %, aspect, other	Y		complex indicator	slope %, aspect, other	Y	
		Disturbance regime	Slides	% endangered areas of the total area	Y		Slides	% endangered areas of the total area	Y	
			Floods	% endangered areas of the total area	Y		Floods	% endangered areas of the total area	Y	
		Other abiotic heterrogeneity indicators	Spatial structure of urban areas	index			Spatial structure of urban areas	index		
Ecosystem processes	Energy budget	Energy balance (capture, storage)	trend of total CO2 emissions	(% change compared to base year* 1990 per capita)	Y		trend of total CO2 emissions	(% change compared to base year* 1990 per capita)	Y	
			direct solar-energy radiation	m2	Y		direct solar-energy radiation	m2	Y	
		Metabolic efficiency	temperature sum totals	° C temperature sum total for the active growing period	Y		temperature sum totals	° C temperature sum total for the active growing period	Y	
			Standing biomass	t/ha	N	V	Standing biomass	t/ha	N	V
	Matter budget	Matter storage	Total OM Storage (TB, FF, Soil)	t C/ha	Y/N	V	Total OM Storage (TB, FF, Soil)	t C/ha	Y/N	V
			OM soil	% C	N	V	OM soil	% C	N	V
		Element concentrations	PTEs and pollutants in soil	concentration above LV	Y		PTEs and pollutants in soil	concentration above LV	Y	
		Efficiency measures	Sediment yield	$t/km^2/year$	Y		Sediment yield	$t/km^2/year$	Y	
	Water budget	Water balance (input, output)	Urban runoff coefficient	runoff	Y		Urban runoff coefficient	runoff	Y	
		Water storage	Natural ground water potential	$l/s/km^2$	Y		Natural ground water potential	$l/s/km^2$	Y	
		Efficiency measures	risk to soil and athmospheric drought	level	Y		risk to soil and athmospheric drought	level	Y	

*indicated scores: 1-very bad; 2-bad; 3-moderate; 4-good; 5-very good (Table 5 in the Methodology)
NO INDICATION WITH Y/N:
The indicator is not relevant to the specific urban sub-type

Ecological Condition indicator			J3 Residential and public low density areas				J4 Recreation area outside cities and towns			
			Indicator	Parameter (dimension unit)	Available data (Y/N)	New data needed (tick by "V")	Indicator	Parameter (dimension unit)	Available data (Y/N)	New data needed (tick by "V")
Orientor	TYPE /Group									
Ecosystem structure	Biotic diversity	plant diversity	Vegetation canopy cover	% of the total area	Y		Vegetation canopy cover	% of the total area	Y	
			Type of vegetation cover	% of species suitability	Y		Type of vegetation cover	% of species suitability	Y	
			Type of plant communities	% participation of natural vegetation	N	V	Type of plant communities	% participation of natural vegetation	N	V
			Protected species	number	Y/N	V	Protected species	number	Y/N	V
		animal diversity	Protected species	number	N	V	Protected species	number	N	V
		habitat diversity	Soil sealing	%	Y		Soil sealing	%	Y	
			Area of natural habitats	% (area habitats/total area)	Y/N	V	Area of natural habitats	% (area habitats/total area)	Y/N	V
			Fragmentation of GI	Urban GI Fragmentation %	Y		Fragmentation of GI	Urban GI Fragmentation %	Y	
		Invasive species	exotic species (plant, animals)	Presence (number)	Y/N	V	exotic species (plant, animals)	Presence (number)	Y	
			invasives (plant, animals)	Presence (number)	Y/N	V	invasives (plant, animals)	Presence (number)	Y	
		Other biotic heterogeneity indicators (naturalness etc.)	health status of tree vegetation	% Discoloration and % defoliation of trees and damages visible by trees	Y/N	V	health status of tree vegetation	% Discoloration and % defoliation of trees and damages visible by trees	Y/N	V
			Species diversity according "habitat saturation index"	EA			Species diversity according "habitat saturation index"	EA		
	Abiotic heterogeneity	Soil heterogeneity	soil degradation in the green infrastructure	%	N	V	soil degradation in the green infrastructure	%	N	V
			reclaimed waste deposits	%			reclaimed waste deposits	%		
		Hydrological heterogeneity	drenaige density	km/km2	Y		drenaige density	km/km2	Y	
			pond area	presence	Y		pond area	presence	Y	
		Air heterogeneity	Sulfur dioxide (SO2) - annual rate for ecosystems	mg/m3	Y/N	V	Sulfur dioxide (SO2) - annual rate for ecosystems	mg/m3	Y/N	V
			Nitrogene dioxide (NO2) - annual rate for ecosystems	mg/m3	Y/N	V	Nitrogene dioxide (NO2) - annual rate for ecosystems	mg/m3	Y/N	V
			Annual dust emissions 10 (MAN)	mg/m3	Y/N	V	Annual dust emissions 10 (MAN)	mg/m3	Y/N	V
			Climatic deficiency of potential humidity	mm/yr	Y		Climatic deficiency of potential humidity	mm/yr	Y	
			Ozone - AOT40	µg/m3.h	Y/N	V	Ozone - AOT40	µg/m3.h	Y/N	V
			Air quality (complex indicator)	complex score			Air quality (complex indicator)	complex score		

Ecological Condition indicator			J3 Residential and public low density areas				J4 Recreation area outside cities and towns			
			Indicator	Parameter (dimension unit)	Available data (Y/N)	New data needed (tick by "V")	Indicator	Parameter (dimension unit)	Available data (Y/N)	New data needed (tick by "V")
Orientor	TYPE /Group									
Ecosystem structure	Abiotic heterogeneity	Geomorphological heterogeneity	complex indicator	slope %, aspect, other	Y		complex indicator	slope %, aspect, other	Y	
		Disturbance regime	Slides	% endangered areas of the total area	Y		Slides	% endangered areas of the total area	Y	
			Floods	% endangered areas of the total area	Y		Floods	% endangered areas of the total area	Y	
		Other abiotic heterrogeneity indicators	Spatial structure of urban areas	index			Spatial structure of urban areas	index		
Ecosystem processes	Energy budget	Energy balance (capture, storage)	trend of total CO2 emissions	(% change compared to base year* 1990 per capita)	Y/N	V	trend of total CO2 emissions	(% change compared to base year* 1990 per capita)	Y/N	V
			direct solar-energy radiation	m2	Y		direct solar-energy radiation	m2	Y	
		Metabolic efficiency	temperature sum totals	° C temperature sum total for the active growing period	Y		temperature sum totals	° C temperature sum total for the active growing period	Y	
			Standing biomass	t/ha	N	V	Standing biomass	t/ha	N	V
	Matter budget	Matter storage	Total OM Storage (TB, FF, Soil)	t C/ha	N	V	Total OM Storage (TB, FF, Soil)	t C/ha	N	V
			OM soil	% C	N	V	OM soil	% C	N	V
		Element concentrations	PTEs and pollutants in soil	concentration above LV	Y		PTEs and pollutants in soil	concentration above LV	Y	
		Efficiency measures	Sediment yield	t/km^2/year	Y		Sediment yield	t/km^2/year	Y	
	Water budget	Water balance (input, output)	Urban runoff coefficient	runoff	Y		Urban runoff coefficient	runoff	Y	
		Water storage	Natural ground water potential	l/s/km^2	Y		Natural ground water potential	l/s/km^2	Y	
		Efficiency measures	risk to soil and athmospheric drought	level	Y		risk to soil and athmospheric drought	level	Y	

*indicated scores: 1-very bad; 2-bad; 3-moderate; 4-good; 5-very good (Table 5 in the Methodology)
NO INDICATION WITH Y/N:
The indicator is not relevant to the specific urban sub-type

Ecological Condition indicator			J5 Urban green areas (incl. sport and leisure facilities)				J6 Industrial sites (incl.commercial sites)			
			Indicator	Parameter (dimension unit)	Available data (Y/N)	New data needed (tick by "V")	Indicator	Parameter (dimension unit)	Available data (Y/N)	New data needed (tick by "V")
Orientor	TYPE /Group									
Ecosystem structure	Biotic diversity	plant diversity	Vegetation canopy cover	% of the total area	Y		Vegetation canopy cover	% of the total area	Y	
			Type of vegetation cover	% of species suitability	Y		Type of vegetation cover	% of species suitability	Y	
			Type of plant communities	% participation of natural vegetation	Y		Type of plant communities	% participation of natural vegetation		
			Protected species	number	Y/N	V	Protected species	number		
		animal diversity	Protected species	number	Y/N	V	Protected species	number		
		habitat diversity	Soil sealing	%	Y		Soil sealing	%	Y	
			Area of natural habitats	% (area habitats/total area)	Y		Area of natural habitats	% (area habitats/total area)		
			Fragmentation of GI	Urban GI Fragmentation %	Y		Fragmentation of GI	Urban GI Fragmentation %		
		Invasive species	exotic species (plant, animals)	Presence (number)	Y		exotic species (plant, animals)	Presence (number)	Y	
			invasives (plant, animals)	Presence (number)	Y		invasives (plant, animals)	Presence (number)	Y	
		Other biotic heterogeneity indicators (naturalness etc.)	health status of tree vegetation	% Discoloration and % defoliation of trees and damages visible by trees	N		health status of tree vegetation	% Discoloration and % defoliation of trees and damages visible by trees	N	
			Species diversity according "habitat saturation index"	EA			Species diversity according "habitat saturation index"	EA		
	Abiotic heterogeneity	Soil heterogeneity	soil degradation in the green infrastructure	%	Y		soil degradation in the green infrastructure	%	Y	
			reclaimed waste deposits	%	Y		reclaimed waste deposits	%	Y/N	V
		Hydrological heterogeneity	drenaige density	km/km2	Y		drenaige density	km/km2	Y	
			pond area	presence	Y		pond area	presence	Y	
		Air heterogeneity	Sulfur dioxide (SO2) - annual rate for ecosystems	mg/m3	Y/N	V	Sulfur dioxide (SO2) - annual rate for ecosystems	mg/m3	Y/N	V
			Nitrogene dioxide (NO2) - annual rate for ecosystems	mg/m3	Y/N	V	Nitrogene dioxide (NO2) - annual rate for ecosystems	mg/m3	Y/N	V
			Annual dust emissions 10 (MAN)	mg/m3	Y/N	V	Annual dust emissions 10 (MAN)	mg/m3	Y/N	V
			Climatic deficiency of potential humidity	mm/yr	Y		Climatic deficiency of potential humidity	mm/yr	Y	
			Ozone - AOT40	µg/m3.h	Y/N	V	Ozone - AOT40	µg/m3.h	Y/N	V
			Air quality (complex indicator)	complex score			Air quality (complex indicator)	complex score		

Ecological Condition indicator			J5 Urban green areas (incl. sport and leisure facilities)				J6 Industrial sites (incl.commercial sites)			
			Indicator	Parameter (dimension unit)	Available data (Y/N)	New data needed (tick by "V")	Indicator	Parameter (dimension unit)	Available data (Y/N)	New data needed (tick by "V")
Orientor	TYPE /Group									
Ecosystem structure	Abiotic heterogeneity	Geomorphological heterogeneity	complex indicator	slope %, aspect, other	Y		complex indicator	slope %, aspect, other	Y	
		Disturbance regime	Slides	% endangered areas of the total area	Y		Slides	% endangered areas of the total area	Y	
			Floods	% endangered areas of the total area	Y		Floods	% endangered areas of the total area	Y	
		Other abiotic heterrogeneity indicators	Spatial structure of urban areas	index			Spatial structure of urban areas	index		
Ecosystem processes	Energy budget	Energy balance (capture, storage)	trend of total CO2 emissions	(% change compared to base year* 1990 per capita)	Y/N	V	trend of total CO2 emissions	(% change compared to base year* 1990 per capita)	Y/N	V
			direct solar-energy radiation	m2	Y		direct solar-energy radiation	m2	Y	
		Metabolic efficiency	temperature sum totals	° C temperature sum total for the active growing period	Y		temperature sum totals	° C temperature sum total for the active growing period	Y	
			Standing biomass	t/ha	Y/N	V	Standing biomass	t/ha	N	V
	Matter budget	Matter storage	Total OM Storage (TB, FF, Soil)	t C/ha	Y/N	V	Total OM Storage (TB, FF, Soil)	t C/ha	Y	
			OM soil	% C	Y/N	V	OM soil	% C	Y	
		Element concentrations	PTEs and pollutants in soil	concentration above LV	Y		PTEs and pollutants in soil	concentration above LV	Y	
		Efficiency measures	Sediment yield	t/km^2/year	Y		Sediment yield	t/km^2/year	Y	
	Water budget	Water balance (input, output)	Urban runoff coefficient	runoff	Y		Urban runoff coefficient	runoff	Y	
		Water storage	Natural ground water potential	l/s/km^2	Y		Natural ground water potential	l/s/km^2	Y	
		Efficiency measures	risk to soil and athmospheric drought	level	Y		risk to soil and athmospheric drought	level	Y	

*indicated scores: 1-very bad; 2-bad; 3-moderate; 4-good; 5-very good (Table 5 in the Methodology)
NO INDICATION WITH Y/N:
The indicator is not relevant to the specific urban sub-type

Ecological Condition indicator			J7 Transport networks and other constructed hard surfaced sites				J8 Extractive industrial sites (incl. active underground mines and active opencast mineral extraction sites, and quarries)			
			Indicator	Parameter (dimension unit)	Available data (Y/N)	New data needed (tick by "V")	Indicator	Parameter (dimension unit)	Available data (Y/N)	New data needed (tick by "V")
Orientor	TYPE /Group									
Ecosystem structure	Biotic diversity	plant diversity	Vegetation canopy cover	% of the total area	Y		Vegetation canopy cover	% of the total area		
			Type of vegetation cover	% of species suitability	Y		Type of vegetation cover	% of species suitability		
			Type of plant communities	% participation of natural vegetation			Type of plant communities	% participation of natural vegetation		
			Protected species	number			Protected species	number		
		animal diversity	Protected species	number			Protected species	number		
		habitat diversity	Soil sealing	%	Y		Soil sealing	%		
			Area of natural habitats	% (area habitats/total area)			Area of natural habitats	% (area habitats/total area)		
			Fragmentation of GI	Urban GI Fragmentation %			Fragmentation of GI	Urban GI Fragmentation %		
		Invasive species	exotic species (plant, animals)	Presence (number)	Y		exotic species (plant, animals)	Presence (number)		
			invasives (plant, animals)	Presence (number)	Y		invasives (plant, animals)	Presence (number)	Y	
		Other biotic heterogeneity indicators (naturalness etc.)	health status of tree vegetation	% Discoloration and % defoliation of trees and damages visible by trees	N		health status of tree vegetation	% Discoloration and % defoliation of trees and damages visible by trees		
			Species diversity according "habitat saturation index"	EA			Species diversity according "habitat saturation index"	EA		
	Abiotic heterogeneity	Soil heterogeneity	soil degradation in the green infrastructure	%	Y		soil degradation in the green infrastructure	%		
			reclaimed waste deposits	%			reclaimed waste deposits	%	Y/N	V
		Hydrological heterogeneity	drenaige density	km/km2			drenaige density	km/km2		
			pond area	presence			pond area	presence		
		Air heterogeneity	Sulfur dioxide (SO2) - annual rate for ecosystems	mg/m3	Y/N	V	Sulfur dioxide (SO2) - annual rate for ecosystems	mg/m3	Y/N	V
			Nitrogene dioxide (NO2) - annual rate for ecosystems	mg/m3	Y/N	V	Nitrogene dioxide (NO2) - annual rate for ecosystems	mg/m3	Y/N	V
			Annual dust emissions 10 (MAN)	mg/m3	Y/N	V	Annual dust emissions 10 (MAN)	mg/m3	Y/N	V
			Climatic deficiency of potential humidity	mm/yr	Y		Climatic deficiency of potential humidity	mm/yr	Y	
			Ozone - AOT40	µg/m3.h	Y/N	V	Ozone - AOT40	µg/m3.h	Y/N	V
			Air quality (complex indicator)	complex score			Air quality (complex indicator)	complex score		

Ecological Condition indicator			J7 Transport networks and other constructed hard surfaced sites				J8 Extractive industrial sites (incl. active underground mines and active opencast mineral extraction sites, and quarries)			
Orientor	TYPE /Group		Indicator	Parameter (dimension unit)	Available data (Y/N)	New data needed (tick by "V")	Indicator	Parameter (dimension unit)	Available data (Y/N)	New data needed (tick by "V")
Ecosystem structure	Abiotic heterogeneity	Geomorphological heterogeneity	complex indicator	slope %, aspect, other			complex indicator	slope %, aspect, other		
		Disturbance regime	Slides	% endangered areas of the total area	Y		Slides	% endangered areas of the total area	Y	
			Floods	% endangered areas of the total area	Y		Floods	% endangered areas of the total area	Y	
		Other abiotic heterrogeneity indicators	Spatial structure of urban areas	index			Spatial structure of urban areas	index		
Ecosystem processes	Energy budget	Energy balance (capture, storage)	trend of total CO2 emissions	(% change compared to base year* 1990 per capita)	Y/N	V	trend of total CO2 emissions	(% change compared to base year* 1990 per capita)	Y/N	V
			direct solar-energy radiation	m2	Y		direct solar-energy radiation	m2	Y	
		Metabolic efficiency	temperature sum totals	° C temperature sum total for the active growing period			temperature sum totals	° C temperature sum total for the active growing period		
			Standing biomass	t/ha	N	V	Standing biomass	t/ha		
	Matter budget	Matter storage	Total OM Storage (TB, FF, Soil)	t C/ha	Y		Total OM Storage (TB, FF, Soil)	t C/ha		
			OM soil	% C	Y		OM soil	% C		
		Element concentrations	PTEs and pollutants in soil	concentration above LV	Y		PTEs and pollutants in soil	concentration above LV	Y	
		Efficiency measures	Sediment yield	$t/km^2/year$			Sediment yield	$t/km^2/year$		
	Water budget	Water balance (input, output)	Urban runoff coefficient	runoff			Urban runoff coefficient	runoff		
		Water storage	Natural ground water potential	$l/s/km^2$			Natural ground water potential	$l/s/km^2$		
		Efficiency measures	risk to soil and athmospheric drought	level			risk to soil and athmospheric drought	level		

*indicated scores: 1-very bad; 2-bad; 3-moderate; 4-good; 5-very good (Table 5 in the Methodology)
NO INDICATION WITH Y/N:
The indicator is not relevant to the specific urban sub-type

Ecological Condition indicator			J9 Waste deposits				J10 Highly artificial man made waters and associated structures			
Orientor	TYPE /Group		Indicator	Parameter (dimension unit)	Available data (Y/N)	New data needed (tick by "V")	Indicator	Parameter (dimension unit)	Available data (Y/N)	New data needed (tick by "V")
Ecosystem structure	Biotic diversity	plant diversity	Vegetation canopy cover	% of the total area			Vegetation canopy cover	% of the total area	Y	
			Type of vegetation cover	% of species suitability			Type of vegetation cover	% of species suitability	Y	
			Type of plant communities	% participation of natural vegetation			Type of plant communities	% participation of natural vegetation		
			Protected species	number			Protected species	number	Y/N	V
		animal diversity	Protected species	number			Protected species	number	Y	
		habitat diversity	Soil sealing	%	Y		Soil sealing	%		
			Area of natural habitats	% (area habitats/total area)			Area of natural habitats	% (area habitats/total area)		
			Fragmentation of GI	Urban GI Fragmentation %			Fragmentation of GI	Urban GI Fragmentation %		
		Invasive species	exotic species (plant, animals)	Presence (number)			exotic species (plant, animals)	Presence (number)		
			invasives (plant, animals)	Presence (number)	Y		invasives (plant, animals)	Presence (number)	Y	
		Other biotic heterogeneity indicators (naturalness etc.)	health status of tree vegetation	% Discoloration and % defoliation of trees and damages visible by trees			health status of tree vegetation	% Discoloration and % defoliation of trees and damages visible by trees	N	V
			Species diversity according "habitat saturation index"	EA			Species diversity according "habitat saturation index"	EA		
	Abiotic heterogeneity	Soil heterogeneity	soil degradation in the green infrastructure	%			soil degradation in the green infrastructure	%		
			reclaimed waste deposits	%	Y/N	V	reclaimed waste deposits	%		
		Hydrological heterogeneity	drenaige density	km/km2			drenaige density	km/km2		
			pond area	presence			pond area	presence		
		Air heterogeneity	Sulfur dioxide (SO2) - annual rate for ecosystems	mg/m3	Y/N	V	Sulfur dioxide (SO2) - annual rate	mg/m3	Y/N	V
			Nitrogene dioxide (NO2) - annual rate for ecosystems	mg/m3	Y/N	V	Nitrogene dioxide (NO2)- annual rate for ecosystems	mg/m3	Y/N	V
			Annual dust emissions 10 (MAN)	mg/m3	Y/N	V	Annual dust emissions 10 (MAN)	mg/m3	Y/N	V
			Climatic deficiency of potential humidity	mm/yr	Y		Climatic deficiency of potential humidity	mm/yr	Y	
			Ozone - AOT40	µg/m3.h	Y/N	V	Ozone - AOT40	µg/m3.h	Y/N	V
			Air quality (complex indicator)	complex score			Air quality (complex indicator)	complex score		

Ecological Condition indicator			J9 Waste deposits				J10 Highly artificial man made waters and associated structures			
Orientor	TYPE /Group		Indicator	Parameter (dimension unit)	Available data (Y/N)	New data needed (tick by "V")	Indicator	Parameter (dimension unit)	Available data (Y/N)	New data needed (tick by "V")
Ecosystem structure	Abiotic heterogeneity	Geomorphological heterogeneity	complex indicator	slope %, aspect, other			complex indicator	slope %, aspect, other		
		Disturbance regime	Slides	% endangered areas of the total area			Slides	% endangered areas of the total area	Y	
			Floods	% endangered areas of the total area			Floods	% endangered areas of the total area	Y	
		other abiotic heterrogeneity indicators	Spatial structure of urban areas	index			Spatial structure of urban areas	index		
Ecosystem processes	Energy budget	Energy balance (capture, storage)	trend of total CO2 emissions	(% change compared to base year* 1990 per capita)	Y/N	V	trend of total CO2 emissions	(% change compared to base year* 1990 per	Y/N	V
			direct solar-energy radiation	m^2			direct solar-energy radiation	m^2	Y	
		Metabolic efficiency	temperature sum totals	° C temperature sum total for the active growing period			temperature sum totals	° C temperature sum total for the active growing	Y	
			Standing biomass	t/ha			Standing biomass	t/ha		
	Matter budget	Matter storage	Total OM Storage (TB, FF, Soil)	t C/ha			Total OM Storage (TB, FF, Soil)	t C/ha	Y	
			OM soil	% C			OM soil	% C		
		Element concentrations	PTEs and pollutants in soil	concentration above LV	Y		PTEs and pollutants in soil	concentratio n above LV	Y	
		Efficiency measures	Sediment yield	$t/km^2/year$	Y		Sediment yield	$t/km^2/year$	Y	
	Water budget	Water balance (input, output)	Urban runoff coefficient	runoff			Urban runoff coefficient	runoff		
		Water storage	Natural ground water potential	$l/s/km^2$			Natural ground water potential	$l/s/km^2$		
		Efficiency measures	risk to soil and athmospheric drought	level			risk to soil and athmospheric drought	level		

*indicated scores: 1-very bad; 2-bad; 3-moderate; 4-good; 5-very good (Table 5 in the Methodology)
NO INDICATION WITH Y/N:
The indicator is not relevant to the specific urban sub-type

Available as a spreadsheet at:
http://www.metecosmap-sofia.org/methodological-framework/

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Indicators services

Section	*Division*	*Group*	*Class (codes CICES)*	*Indicator Measuring method*	*Parameters and units*	*Data sources*
Provisioning	Nutrition	Biomass	P1. Cultivated crops (1111)	1. Environmental condition, 2 Biophysical condition	Score 1-5	Y/N
			P2. Reared animals and their outputs (1112)	1. Number of domestic animals 2. Number of milk cows, 3 Number of domestic birds	Number/ha	Y/N
			P3. Wild plants, algae and their outputs (1113, 1115)	1. Number of wild fruit plants species 2. Number of medicinal plants species, 3 Vegetation cover	Number/ha	Y/N
			P4. Wild animals and their outputs (1114, 1116)	1. Capacity for production	Score 1-5	N
	Materials	Water	P8. Ground water for drinking (1122)	1. Exploitation index	%	Y/N
			P12. Surface water for non-drinking purposes (1221)	1. Complex indicator (evapotranspiration, precipitation, water bodies)	Score 1-5	Y/N
			P13. Ground water for non-drinking purposes (1222)	1. Exploitation index	%	Y/N
		Material	P9. Fibres and other materials (1211, 1212)	1. Ecosystem subtype, 2. Land cover, 3. Vegetation cover	Score 1-5	N
			P11. Genetic materials from all biota (1213)	1. Spatial structure index, 2. Vegetation cover, 3. Land cover diversity	Score 1-5	Y/N
	Energy	Biomass-based energy sources	P14. Plant and animal-based resources for energy (1311,1312)	1. Number of large animals, 2. number of equines 3. Number of sheep and goats, 4. Number of pigs, 5. Number of birds, 6. Faeces production	1 – 5 Number 6. t/year	Y/N
			P16. Animal-based mechanical energy (1321)	1. Number of equines	Number/ha	Y/N

Section	*Division*	*Group*	*Class (codes CICES)*	*Indicator Measuring method*	*Parameters and units*	*Data sources*
Regulating and maintenance	Mediation of waste, toxicandother nuisances	Mediation by ecosystems	R3. Regulation of pollution and other impacts (2121,2122,2123)	1. Capacity for regulation	Score 1-5	N
	Mediation of flows	Mass flows	R6. Mitigation of erosion (2211,2212)	1. Soil sealing, 2. Sediment yield, 3. Spatial structure index	Score 1-5	Y/N
		Liquid flows	R8. Water flow maintenance and flood protection (2221,2222)	1. Complex indicator	Score 1-5	Y/N
		Gaseous / air flows	R10. Regulation of air flows and atmospheric risks (2231,2232)	1. Vegetation cover, 2. Land cover	Score 1-5	Y/N
	Maintenance of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	R12. Pollination and seed dispersal (2311)	1. Number of bee families	1. number/ha	Y/N
		Pest and disease control	R14. Pest and disease control (2321,2322)	1. Complex indicator	Score 1-5	Y/N
		Soil formation and composition	R16. Regulation of soil formation and composition (2331,2332)	1. Vegetation cover, 2 Climate, 3 Geology, 4. Slope, 5. Spatial structure index, 6. Actual evapostraspiration, 7. OM soil, 8. Anthropogenic impact	Score 1-5	Y/N
		Atmospheric composition and climate regulation	R20. Global climate regulation by reduction of greenhouse gas concentrations (2351)	Carbon storage	1. total (t C/ha);	Y/N
			R21. Micro and regional climate regulation (2352)	1. Complex indicator	Score 1-5	Y/N

Section	Division	Group	Class (codes CICES)	Indicator Measuring method	Parameters and units	Data sources
Cultural	Physical and intellectual interactions with biota, ecosystems, and land-/seascapes [environmental settings]	Physical and experiential interactions	C1. Recreation (3111,3112)	1. Resorts 2 Tourist attraction 3 Elevation 4 Relative elevation 5 Elevation deviation 6 Water bodies 7 Forest 8 number of beds 9 number of tourists	Score 1-5.	Y/N
		Intellectual and representative interactions	C3. Scientific and Educational (3121)	1. Biotic diversity indicators; 2. Number of publications	1. Condition unit 2. Number	Y/N
			C5. Cultural heritage (3123)	1. Number and significance of cultural monuments etc.; 2. Number of visitors	1. n/ha; 2. number	Y/N
	Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes [environmental settings]	Spiritual and/or emblematic	C7. Aesthetic(3125)	1. Evaluation from questionnaires; 2. Number of arts portraying ecosystem	1. Expert score; 2. Number	Y/N
			C10. Existence and bequest(3221,3222)	1. expert assessment	1. score 1-5	N

* Data soures: Ministry of agriculture and local agriculture offices, Agrostatistics ОПООС, green system, Basin directorates, Water utility companies, National statistics institute, Regional development plans, NIMH, AGCC ect.

Section	*Division*	*Group*	*Class (codes CICES)*	Sub-type urban ecosystem									
				J1	J2	J3	J4	J5	J6	J7	J8	J9	J10
Provisioning	Nutrition	Biomass	P1. Cultivated crops (1111)	X	X	X			X				
			P2. Reared animals and their outputs (1112)		X	X			X				
			P3. Wild plants, algae and their outputs (1113, 1115)		X	X	X	X		X			
			P4. Wild animals and their outputs (1114, 1116)										X
	Materials	Water	P8. Ground water for drinking (1122)	X	X	X	X	X	X				
			P12. Surface water for non-drinking purposes (1221)	X	X	X	X	X	X	X			X
			P13. Ground water for non-drinking purposes (1222)	X	X	X	X	X	X				
		Material	P9. Fibres and other materials (1211, 1212)	X	X	X	X	X	X	X	X	X	X
			P11. Genetic materials from all biota (1213)	X	X	X	X	X	X	X	X	X	X
	Energy	Biomass-based energy sources	P14. Plant and animal-based resources for energy (1311,1312)	X	X	X	X	X	X	X	X	X	X
			P16. Animal-based mechanical energy (1321)		X	X		X					

Section	Division	Group	Class (codes CICES)	Sub-type urban ecosystem									
				J1	J2	J3	J4	J5	J6	J7	J8	J9	J10
Regulating and maintenance	Mediation of waste, toxicandother nuisances	Mediation by ecosystems	P1. Cultivated crops (1111)	X	X	X	X	X	X	X			X
			R3. Regulation of pollution and other impacts (2121,2122,2123)										
	Mediation of flows	Mass flows	R6. Mitigation of erosion (2211,2212)	X	X	X	X	X	X				
		Liquid flows	R8. Water flow maintenance and flood protection (2221,2222)	X	X	X	X	X	X	X	X	X	X
		Gaseous / air flows	R10. Regulation of air flows and atmospheric risks (2231,2232)	X	X	X	X	X	X	X	X	X	X
	Maintenance of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	R12. Pollination and seed dispersal (2311)		X	X			X				
		Pest and disease control	R14. Pest and disease control (2321,2322)	X	X	X	X	X	X				X
		Soil formation and composition	R16. Regulation of soil formation and composition (2331,2332)	X	X	X	X	X	X				
		Atmospheric composition and climate regulation	R20. Global climate regulation by reduction of greenhouse gas concentrations (2351)	X	X	X	X	X	X	X	X	X	X
			R21. Micro and regional climate regulation (2352)	X	X	X	X	X	X	X	X	X	X

Section	*Division*	*Group*	*Class (codes CICES)*	Sub-type urban ecosystem									
				J1	**J2**	**J3**	**J4**	**J5**	**J6**	**J7**	**J8**	**J9**	**J10**
Cultural	**Physical and intellectual interactions with biota, ecosystems, and land-/seascapes [environmental settings]**	**Physical and experiential interactions**	P1. Cultivated crops (1111)	X	X	X	X	X	X				
			C1. Recreation (3111,3112)										
		Intellectual and representative interactions	C3. Scientific and Educational (3121)	X	X	X	X	X	X	X	X	X	X
			C5. Cultural heritage (3123)	X	X	X	X	X	X				
	Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes [environmental settings]	**Spiritual and/or emblematic**	C7. Aesthetic(3125)	X	X	X	X	X	X	X	X		
			C10. Existence and bequest(3221,3222)	X	X	X	X	X	X	X	X	X	X

* Data soures: Ministry of agriculture and local agriculture offices, Agrostatistics ОПООС, green system, Basin directorates, Water utility companies, National statistics institute, Regional development plans, NIMH, AGCC ect.

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Database templates and nomenclature tables

The databases and related tables and vector layers described in the methodological part of the document, as well as the nomenclature tables for ecosystem types and indicators for condition and ecosystem services are provided in a digital format to this Methodology.

The structure and content of the data under Appendix 9 is as follows:

1. Directory: 9.00_EcosystemDatabase_Schema

Contains a template of the database to this methodology in several different formats:
- Ecosystem_DB_v07.diagram: database structure for review in ArcGIS Diagrammer - free software for creating, editing and analyzing geodatabase schemas
- Ecosystem_DB_v07.mdb: database structure in MDB format;
- Ecosystem_DB_v07. XML: database structure in XML format;
- Ecosystem_DB_v07. jpg: preview of the database schema in JPG format.

2. Directory: 9.01_Schema_Report_ES_Database

It contains a descriptive geodatabase document including the specifications of all the tables and vector layers, as well as a description of all the attribute fields in them:
- 9.01_0_Schema_Report_ES_Database.htm: document describing the structure of the database.

3. Directory: 9.02_NOMENCLATURES_XLS

Contains nomenclature tables for ecosystem types and for the indicators for condition and ecosystem services:
- N_EcosystemType.xls: table in MS Excel format containing all ecosystem types at different hierarchical levels;
- N_EcosystemCondition.xls: MS Excel table containing nomenclatures for ecosystem condition indicators up to level 3;
- N_EcosystemConditionIndicator_Parameter.xls: MS Excel table containing information on how to create a table for ecosystem condition parameters for each specific ecosystem type;
- N_EcosystemService.xls: MS Excel table containing ecosystem services nomenclatures up to level 4
- N_EcosystemService_Indicator.xls: an MS Excel table containing information on how to create a table for ecosystem service indicators for each specific ecosystem type;
- Instruction_Nomenclature_Tables_ES_Condition_Services.docx: document in MS Word format containing a description of the sequence and specifics for filling in all the nomenclature tables of the Methodology as well as the tables in the database for each specific ecosystem type.

4. Directory: 9.03_Data_Maps

Contains the EEA (European Environment Agency) reference grid for Bulgaria at 50 km grid.

The data and documents in Annex 9 are available on:

http://www.metecosmap-sofia.org/methodological-framework/