PART B5

METHODOLOGY

for assessment and mapping of HEATHLAND AND SHRUB ecosystems condition and their services in Bulgaria

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

**METHODOLOGY FOR ASSESSMENT AND MAPPING
OF HEATHLAND AND SHRUB 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 services which aims at streamlining the national ecosystems, their biophysical assessment and mapping. The methodology is not aimed at completing the full cycle of ecosystem service valuation and reporting. It delivers a practical step-by-step guidance to the process of:

1. Assessing the condition of the **Heathland and shrub** ecosystems;
2. Assessing the **Heathland and shrub** ecosystems' potential to deliver ecosystem services (biophysical valuation).

The methodology is relevant to *Heathland and shrub* 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 will form a part of a wider national methodological framework (under development) which details the 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 the EU Biodiversity strategy to 2020.

1.2. Who is this methodology for?

This methodology is to be used by:

- Organizations and scientists who perform ecosystems condition assessment and biophysical valuation of ecosystem services. Such organizations are expected to include the beneficiaries/partners under the programs that have set aside funding for the national process of ecosystems mapping and assessment – for NATURA 2000, the Operational Program Environment 2014-2020 and outside NATURA 2000 – Program BG03 Biodiversity and ecosystem services 2009-2014;
- National or local authorities who wish to 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 biophysical valuation and ecosystem services assessment and on a regional or local scale in smaller scale pilots;
  - plan future projects to complement the national scale assessment and valuation;
- 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?

The methodological framework provides a combination of information on relevant information sources that may be of interest to a wider circle of stakeholders, while the current methodology is dedicated to specific guidance to assessing ecosystem condition 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 use defined in the current methodology will be mostly needed by professionals involved in the national mapping and assessment exercise.

As the current methodology is a living document, comments are welcome in order to shape it as a national, widely reviewed and adopted guidance document.

2. Typology of ecosystems in Bulgaria

2.1. General typology of Heathland and shrub ecosystems

The ecosystems represent an integration of social and ecological systems, and can be considered from different disciplinary standpoints (social, economic, ecological). *Heathland and shrub* type ecosystems are consisted of shrub and dwarf shrub communities of primary and secondary origin, occurring in Bulgaria from lowlands to the alpine belt. Some of these vegetation types could be part of farm holdings (pastures, hedges, ridges, field margins, buffer strips, uncultivated lands, etc.). *Heathland and shrub* ecosystems include some lands used for production of natural resources for animal consumption as food, for production of fiber or for livestock services referring to animals raised. Such ecosystems include dynamic associations of different species building typical or complex shrub communities, livestock, other fauna, soils, water, and the atmosphere.

The proposed typology of *"Heathland and shrub"* corresponds with the ecosystem classification of MAES (2013), combined with the habitat classification types of European Nature Information System (EUNIS). It is also related to some of the CORINE Land Cover (CLC) classes. The MAES ecosystem typology differentiates two levels, whereas the Level 2 of the MAES proposal follows closely the EUNIS Level 1. The EUNIS level 2 will be the base for the mapping and assessment approach.

Table 1. Typology of Heathland and shrub ecosystems in Bulgaria

Level 1	Level 2	Level 3
Terrestrial	Heathland and shrub	F2. Arctic, alpine and subalpine scrub
		F3. Temperate and Mediterranean-montane scrub
		F9. Riverine and fen scrubs

2.2. Detailed typology of Heathland and shrub ecosystems

A selection of EUNIS classification on level 2 is proposed for detailed typology as level 3 for target ecosystem type. Total number of three Heathland and shrub types suitable for Bulgaria is selected. They correspond to levels "F2", "F3", and "F9" from EUNIS group "F". The proposed ecosystem types are modified to a certain degree so that they can reflect more precisely the peculiarities of the Bulgarian natural habitats.

Descriptions and relations to other classification systems of proposed subtypes of Heathland and shrub ecosystems are presented in Table 2.

Table 2. Descriptions of Heathland and shrub ecosystem subtypes (Level 3)

Subtype	Description	Nomenclature(s)
Arctic, alpine and subalpine scrub	Scrub occurring above the climatic tree limit. It may occur close to but below the climatic tree limit, where trees are suppressed either by late-lying snow or by wind or repeated browsing. These are shrub and dwarf shrub communities mostly of primary origin and dominated by *Juniperus sibirica, Pinus mugo, Vaccinium uliginosum, V. vitis-idaea, V. myrtillus, Arctostaphylos uva-ursi, Bruckenthalia spiculifolia, Dryas octopetala, Salix lapponum,* etc.	EUNIS – F2; Bondev (1991) – 3, 4, 6, 7
Temperate and Mediterranean-montane scrub	Shrub communities of nemoral affinities. They include deciduous and evergreen scrubs or brushes of the nemoral zone, and deciduous scrubs of the sub-Mediterranean zone. These are shrub communities mostly dominated by *Juniperus communis, J. oxycedrus, Paliurus spina-christi, Jasminum friticans, Cotinus coggygria, Crataegus monogyna, Corylus avellana, Carpinus orientalis, Amygdalus nana, Astragalus angustifolius,* etc.	EUNIS – F3; Bondev (1991) – 71, 72, 118, 119, 120, 121, 122, 123, 124, 125, 126
Riverine and fen scrubs	Riversides, lakesides, fens and marshy floodplains dominated by woody vegetation less than 5 m high. These are shrub communities of secondary origin mostly dominated by *Tamarix ramosissima, T. tetrandra, Salix fragilis, S. purpurea,* etc.	EUNIS – F9

3. Data availability

3.1. Existing data sources, gaps, uncertainty of data

For mapping and assessing of *Heathland and shrub* ecosystem conditions and services the most significant stage is the availability of data. In this section we give a short overview of the data used to map and assess *Heathland and shrub* ecosystem condition and services in the smaller scale. We then put this in the context of data available at the national level. For each parameter, we identified and grouped the type of data used (e.g. land cover maps, land property maps, cadaster, statistics).

Available spatial and quantitative database for *Heathland and shrub* territories can be found free of charge or after special request to the stakeholders.

Data sources in this guidance include point data (sampled observations from scientific papers), regional data (information and project reports), and data covering European and national extents. Modeling data could be applied for some parameters and indicators, if models are validated for the specific ecosystems.

The most commonly used data to derive ecosystems' condition and services indicators were land use/cover maps, national statistics, soil data and vegetation maps. 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 European data available could be applied at national scale, where there are gaps defined. Land cover and vegetation data, obtained using satellite imagery, are widely available and often free of charge.

National statistics are available from the national database which has wide coverage. This data availability is also reflected in some ecosystem services that are mapped at regional level. Local data are needed to quantify supporting or cultural ESs. Cultural services such as spiritual or aesthetic enjoyment are very local (i.e. reflect the uniqueness of particular landscape, rare species, traditional activities or historical heritage) with variation from individuals to cultural groups; therefore many data sources can be used. Supporting services, could be mapped in terms of habitat suitability, using sub-national species distribution data and conservation indices.

In the tables proposed there is a list of parameters for primarily and optional indicators. Primary indicators are mandatory, while optional are those for which there are no data and additional investigations and/or case-studies are needed. The majority of these optional indicators is case-specific and could be produced by several research groups. Specific case is the pollination services, where no existing national data was identified although expert potential there exists. Therefore pollination is proposed as optional but important additional indicator.

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, NATURA 2000 habitat mapping, Scientific publications, EU data sources, National data (MOEW, MAF, ME, MRD), National Statistics and other sources - see Annex 5.

Table 3. Sources of spatial and quantitative/qualitative database

Ecosystem subtype	DATABASE Sources – main stakeholders	
	Spatial	**Quantitative/Qualitative**
Arctic, alpine and subalpine scrubs	Maps of Restored Property, MOEW - CORINE project, national data bases; NATURA 2000 mapping and database; Additional remote sensing data	MOEW - CORINE project, national data bases; NATURA 2000 mapping and database; Scientific publications
Temperate and Mediterranean-montane scrub	Maps of Restored Property, MOEW - CORINE project, national data bases; NATURA 2000 mapping and database; Additional remote sensing data	MOEW - CORINE project, national data bases; NATURA 2000 mapping and database; Scientific publications

Ecosystem subtype	DATABASE Sources – main stakeholders	
	Spatial	Quantitative/Qualitative
Riverine and fen scrubs	Maps of Restored Property, MOEW - CORINE project, national data bases; NATURA 2000 mapping and database; Additional remote sensing data	MOEW - CORINE project, national data bases; NATURA 2000 mapping and database; Scientific publications

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 shema 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:

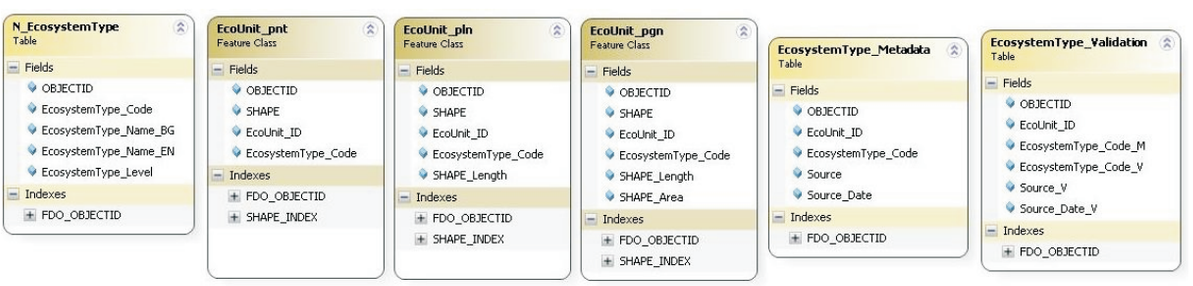
- the used source data;
- the ecosystem type on level 3.

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 30 m.

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.



Fifure 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. Assessment of Heathland and shrub ecosystems condition

5.1. Assessment of Ecosystem condition

Step 1: Identify the indicators of ecosystem condition for the given 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, catchment or ecosystem (Walker 1998). 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 state and changes in the conditions of the environment in *Heathland and shrub* ecosystems;
- assist policy makers to better understand the linkages between the causes and effects of the impact of target ecosystem and agricultural 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.

There are potentially a large number of indicators that could be developed to help quantify the various components of 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 environmental characteristics as being of importance to policy makers. While the list of indicators is evolving, it must be flexible so as to incorporate new indicators or abandon old ones where is needed;
- analytical soundness - the criterion of analytical soundness concerns, in particular, the extent to which the indicator can establish environmental characteristics, 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 an environmental characteristics which is easy to interpret and applicable to a wide set of *Heathland and shrub* ecosystems. 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 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;
- 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 characteristics ranging from the single region to the global scale. In many cases national data are often collected on the basis of political and/or administrative units, such as sub-national regions (regions, districts, municipalities). There is no unique way to address the aggregation issue for each indicator and it is most effectively tackled pragmatically, on an issue-by-issue and indicator-by-indicator basis. 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 state of *Heathland and shrub* ecosystems, their structure and functional processes. Among the proposed indicators, which are representative for conditions of all sub-types, the defined 19 specific indicators (6 primary and 13 optional) are considered for assessing *Heathland and shrub* ecosystem conditions at Step 1 (Table 4.). Each of the selected indicators is enough informative.

Table 4. Rationales of ecosystem condition indicators

Ecosystem condition Indicator group	Indicators/Rationales
Biotic diversity	Spatial or temporal variability of biotic resources. Biotic diversity is caused by organisms. It may occur even in absence of abiotic heterogeneity. Positive relationships between plant species habitat diversity and animal species diversity are well documented on different scales (Davidowitz & Rosenzweig, 1998), but empirical and theoretical studies have showed contradictory results (Tews et al., 2004). Effects of biotic diversity may vary considerably depending on what is perceived as a habitat by the species group studied. Structural attributes of the vegetation that constitute habitat diversity for one group may be perceived as habitat fragmentation by another taxonomic group (e.g. Okland, 1996). **To determine biotic factors and *Heathland and shrub* habitat diversity the following primary indicators are proposed:** *"Cove of shrub layer"* *"Plant diversity",* *"!nimal diversity",* *"!lien invasive species" ,* *"Red list species"* Plant and animal diversity indicators are of primary importance, positively correlated to the biotic diversity. Alien invasive species although contributing to the overall diversity are negatively correlated to the ecosystem condition. **Possible (optional) indicators are:** *"Other biotic diversity indicators (for example, naturalness, habitat diversity etc.)".* The ecosystem service projects using other indicators, must define them consistently to the current methodology.
Abiotic heterogeneity	Spatial or temporal variability of abiotic resources and factors. **To determine abiotic factors and heterogeneity in *Heathland and shrub* ecosystem, the following primary indicators are proposed:** *"Soil heterogeneity",* *"Disturbance regime",* **Possible (optional) indicators are:** *"Hydrological heterogeneity",* *"Geomorphological heterogeneity",* *"Other abiotic heterogeneity indicators"* The ecosystem service projects using other indicators, must define them consistently to the current methodology.

Ecosystem condition Indicator group	Indicators/Rationales
Energy budget	Energy is the essential functional characteristic of ecosystems and of the biosphere as a whole. At the most fundamental level, what ecosystems do is to capture and transform energy. **To account energy budget in *Heathland and shrub* ecosystems possible (optional) indicators are:** "*Energy balance (capture, storage)*", "*Metabolic efficiency*", "*Other energy budget indicators*" 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 state to another within the components of *Heathland and shrub* ecosystems. **To account matter budget in *Heathland and shrub* ecosystems the proposed primary indicator is :** *"Matter storage"* **Other possible (optional) indicators are:** *"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 *Heathland and shrub* areas, considering precipitation, evaporation and runoff. **The following indicators are possible (optional):** *"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 of each indicator

For the set of indicators describing *Heathland and shrub* ecosystems condition different parameters of evaluation are proposed. They are listed in *Annex 6*. In fact, for some indicators there are relevant parameters in current inventories database (biodiversity – plant and/or animal, land cover, etc.). Considering the number of proposed parameters, the number of parameter combinations is very large, which ensures the assessment quality of the ecosystems 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 depend on the specific case-study and availability of data. 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 desirable to be included in the general assessment of selected indicator.

Step 3: Collecting data – national data sets

Given the broad spectrum of scientific disciplines that cover the concept of ecosystem condition and services, a full assessment of the impact of drivers and pressures requires an interdisciplinary data combining approach. Such integrated assessment needs to be translated into suitable indicators for *Heathland and shrub* ecosystem condition and services and subsequently to the benefits obtained from these services. Clearly, such development requires, strong scientific cooperation and considerable IT efforts (for instance see Schröter et al. 2005; Metzger et al. 2008). The availability of ecosystem conditions 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. 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.

The proposed methods are designed to minimize measurement problems and maximize the ability to make a plausible (if not definitive) case for demonstrating activity impacts within resource constraints for carrying out monitoring and evaluation activities.

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 ongoing throughout the growing season.

There is clearly potential for developing the links between measuring indicators addressing this issue and available state national data sources. For some of the developed indicators, preliminary work on data gathering and measurement could be applied.

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.

In order to assess the current conditions of *Heathland and shrub* ecosystems, information about the parameters should be collected for a minimum of 3 (three) years. Depending on parameter type of reporting and/or availability of data, shorter or longer periods are also eligible, but information collected should be enough informative.

The following data sources are to be primarily considered:

- *MOEW - ExEA - CORINE project, national data bases*
- *MoAF - National annual Agro statistical reports, Agro statistical surveys - BANSIK, FADN, LUCAS*
- *Scientific publications*
- *In-situ data*
- *EU data sources*
- *Additional remote sensing data*

Step 4: How to assess

Table 5. Ecosystem condition indicators assessment/scoring for Heathland and shrub ecosystems

Ecological condition indicators		Indicator	Parameter	Unit	Measurement approach	Assessment scale				
Type	Indicator Group					Score 1 (very bad)	Score 2 (bad)	Score 3 (moderate)	Score 4 (good)	Score 5 (very good)
Ecosytem structure	Biotic diversity	Shrub layer cover	% cover of shrubs	Percent	Estimation	⩽30%	31-40%	41-50%	51-70%	>70%
		Plant diversity	Plant species richness	Number of species per sample plot	Calculation	⩽5	6-10	11-20	21-30	⩾30
		Animal diversity	Wild animal species richness	Number of species per sample plot	Calculation	<20	21-50	51-100	101-150	>150
		Invasive species	Alien invasive species presence	Number per unit area OR percent cover	Number per grid unit of national data	⩾10	7-9	4-6	1-3	0
					Cover per sample plot	>15%	10-15%	4-10%	1-3%	0
		Red list species (plant/animal)	Red list species (plant/animal)	Number of species per grid unit	Grid data according to the Red Data Book of Bulgaria	0	1-4	5-11	12-22	⩾23
		Other biotic diversity indicators								
	Abiotic heterogeneity	Soil heterogeneity	Soil quality	Soil type	Assessment by soil map	Anthro-sols	Histosols	Gleysols	Areno-sols	All other types
			Soil organic matter	C (g/kg)	Estimation/ Assessment by available data	<5	5-10	10-15	15-25	>25
				N (g/kg)		<0,98	0,98-1,33	1,33-1,95	1,95-2,86	>2,86
			Soil erosion risk	Score	Estimation/Assessment by available data	Very high	High	Medium	Low	Very low
		Disturbance regime	Fire	Number of recorded fires	Number per grid unit per 5 years	⩾4	3	2	1	0
		Other abiotic heterogeneity indicators	Concentration of pollutants in soil from surrounding areas	Number of dump sites	Number per grid unit	⩾4	3	2	1	0
Ecosystem processes	Matter budget	Matter storage	Biomass	t/ha (absolutely dry) (for dwarf shrub ecosystems)	Estimation/ Assessment by available data	⩽1	1,1-1,5	1,5-2	2,1-3	>3
				t/ha (absolutely dry) (for other shrub ecosystems)		⩽5	5,1-10	10,1-15	15,1-20	>20

Periodic measurements and comparison of parameter values need to be carried out, in order to verify authenticity of the data obtained within the assesment of ecosystem condition. Periodicity of the measurement approaches, will be described in the Monitoring guide.

The above listed indicators were chosen with aim to serve for a comprehensive assessment of the condition of this ecosystem type. They must be used as described in the present methodology. At the same time, the team realizing the practical assessment may add and test in assessment, after using the above listed, 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 - that the experts involved will consider 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 consist 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 mapping scale. 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 centers involved, for example 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.

Such new indicators, 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.

To clarify the assessment process an example is given below. The data included is real and has been extracted from scientific literature and map sources. The proposed example relates to *Arctic, alpine and subalpine scrub* ecosystem type in the region of Botev peak, central part of Balkan Range. These are arctic, alpine and subalpine scrub communities in the surroundings of Botev peak, Central Balkan Range, developed in the altitudinal range of 2000-2300 m asl.. The region is a NATURA 2000 site. Dominant species are *Juniperus sibirica* and *Vaccinium* spp. The place is characterized by relatively high human impact – tourist pressure. Pasturing of cows is also available.

Table 6. Ecosystem condition indicator assessment template and calculation - example

Indicator type	Indicator group	Indicator	Parameter	Units	Real data measured	Score
Ecosytem structure	Biotic diversity	Shrub layer cover	% cover of shrubs	Percent	95%	5
		Plant diversity	Plant species richness	Number of species per sample plot	17	3
		Animal diversity	Wild animal species richness	Number of species per sample plot	163	5
		Invasive species	Alien invasive species presence	Number per unit area	0	5
		Red list species (plant/animal)	Red list species (plant/animal)	Number of species per grid unit	25	5
	Abiotic heterogeneity	Soil heterogeneity	Soil quality	Soil type	Umbrosols	5
			Soil organic matter	Percent	15	4
			Soil erosion risk	Score	<0.5	5
		Disturbance regime	Fire	Number of recorded fires	0	5
		Other abiotic heterogeneity indicators	Concentration of pollutants in soil from surrounding areas	Number of dump sites	0	5
Ecosystem processes	Matter budget	Matter storage	Biomass	Biomass (absolutely dry) in t/ha	No data found	

$$\sum n_i = 51; \sum n_i(max) = 55; n = 11$$

$$IP = 51/55 = 0.927$$

Explanation: for every indicator, according to their parameter measurement an expert assessment in scores from 1 to 5 is assigned, according to the scale in Table 5.

The assessment score for every parameter measured are then summed up ($\sum n_i$).

An index of ecosystem performance (IP) is then calculated, as the ratio of the sum of the parameter assessment scores to the maximum possible parameter sum: - $\sum n_i / \sum n_{i(max)}$

Where:

$\sum n_i$ – sum of parameter assessments

$\sum n_{i(max)}$ – sum of the maximum of parameter assessments (i.e. n *5)

IP – a real number with values between 0 and 1

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 shema 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:

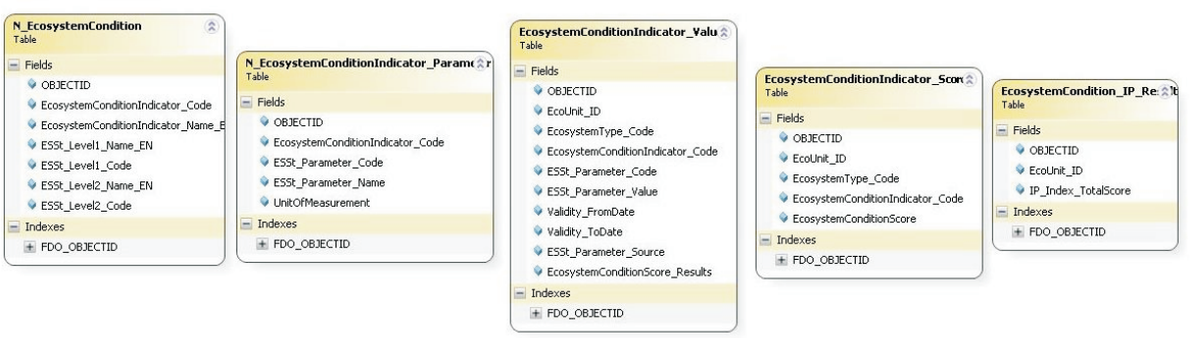


Figure 2: Ecosystem Condition Database Schema

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 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 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

Provisioning services

Heathland and shrub ecosystems may provide food, feed, fibres, and maintain habitats providing resources for the overall ecosystem functioning. The two main divisions of provisioning services (nutrition and materials) can be mapped either through access to detailed parcel data or using regional statistics. The units of measure can be surfaces, weight and energy. Once the indicator is selected (area, yield or caloric content), it should be maintained throughout the division in order to avoid double counting. Livestock is considered as an ecosystem service as it feeds on products of the ecosystems. For this same reason, data on livestock should not be used if *Heathland and shrub* ecosystems are already accounted for in the provisioning services.

Regulating/Maintenance Services

Heathland and shrub ecosystems have a great impact on regulating/maintenance services. The perspective from which the mapping must be done is of how much these ecosystems support regulation of ecological processes such as bio-remediation, filtration, mass stabilisation, flood protection, soil formation, and atmospheric composition. There is a difficulty in mapping this type of services like protection of soil erosion, pollution by nitrates, etc. Drivers, pressures and impacts can be associated to the ecosystem services frame in a post-analysis context to explain links and trends. Some indicators are readily available, for example information on soil weathering processes is available in the LUCAS topsoil survey organic carbon content and percentage of soil cover are available in the AEI framework. National/regional surveys are also needed to report on the pollination ecosystem service, which relies on data on pollinators' distribution. As a proxy, the areal coverage of farmland features supporting pollination can be used. Pollination is needed for the production of seeds both in wild plants and crops.

Cultural services

Provision of cultural ecosystem services may be considered within the *Heathland and shrub* ecosystems. Cultural manifestations of the link between human society and *Heathland and shrub* ecosystems are numerous and very different throughout the EU, therefore the MAES table, especially for intellectual and spiritual ecosystem services, cannot be exhaustive. Moreover, due to this variety, and also to some methodological and practical difficulties in mapping this type of services EU wide (often surveys are needed), only a few indicators are readily available in monitoring frameworks. The mapping of these services is based on indicators describing the experiential use of *Heathland and shrub* ecosystems. These refer to visitors/tourism in such areas; number of rural enterprises offering tourism-related services; density of walking, riding, biking trails; number of flower-watchers or bird-

watchers. Among these, visitors' data are the most appropriate variable to directly map the actual service. Most of this information can be available at national/regional level. Certified products (Protected Designation of Origin, Protected Geographical Identification) that require specific (often traditional) landscape management can be used, since on the one hand these products directly represent cultural heritage linked to *Heathland and shrub* ecosystems, and on the other hand, their marketing may support some agricultural landscape maintenance. Data on visitors can be used in this context. The number of photos of *Heathland and shrub* ecosystems uploaded on websites is becoming an option for estimation spiritual and emblematic services. *Heathland and shrub* ecosystems included in conservation or protection programmes on the basis of their importance for the maintenance of biodiversity and other cultural values (e.g. NATURA 2000, Biosphere reserves, IUCN category V areas, World Heritage Unesco sites, landscape conservation areas) can be taken as representative of 'existence' services in the CICES typology. The synthesis of the different layers is the product of a spatial overlay and not of the sum of areas.

The indicators and parameters for assessing the ecosystem services of *Heathland and shrub* ecosystems are listed in Table 7.

Table 7. Indicators for assessing and mapping of Ecosystem Services in Heathland and shrub ecosystems

Section	Division	Group	Class	CICES codes	Indicator	Parameters and units	Data sources	% error
Provisioning	Nutrition	Biomass	Reared animals and their outputs	1112	Reared animals	Livestock units/ha	Statistics; Ecosystem condition assessment	
			Wild plants, algae and their outputs	1113	Primary biomass production of wild plants and fungi for food	t/ha	Statistics; Ecosystem condition assessment	
			Wild animals and their outputs	1114	Heads of wild animals for hunting	Number of species/ha	Statistics; Ecosystem condition assessment	
	Materials	Biomass	Fibres and other materials from plants, algae and animals for direct use or processing	1211	Biomass production of plants, fungi and animals for materials	1. t/ha 2. t/livestock unit	Statistics; Ecosystem condition assessment	
Regulation & Maintenance	Mediation of flows	Mass flows	Mass stabilisation and control of erosion rates	2211	Erosion prevention	Scale	Available map	
			Buffering and attenuation of mass flows	2212	Mass flows prevention	Scale	Available map	
	Maintenance of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	Pollination and seed dispersal	2311	Pollination potential	Scale	Expert knowledge	
			Maintaining nursery populations and habitats	2312	Biodiversity maintaining	Total species biodiversity	Ecosystem condition assessment	

Section	Division	Group	Class	CICES codes	Indicator	Parameters and units	Data sources	% error
	Maintenance of physical, chemical, biological conditions	Soil formation and composition	Weathering processes	2331	Soil degradation	Loss of net primary production (kg/ha/yr)	Map from EEA	
			Decomposition and fixing processes	2332	Organic matter decomposition	Soil organic matter content g/kg	1. EU; 2. Ecosystem condition assessment; 3. Statistics	
Cultural	Physical and intellectual interactions with biota, ecosystems, and land-/seascapes [environmental settings]	Physical and experiential interactions	Experiential use of plants, animals and land-/seascapes in different environmental settings	3111	Wilderness experiences	1. Number of visitors (e. g. tourists, birdwatch, plantwatch, etc.) per year; 2. Number of activities (e.g. farm tourism, walking and biking traits, etc.) per year	National data	
			Physical use of land-/seascapes in different environmental settings	3112				
		Intellectual and representative interactions	Scientific	3121	Scientific interest	Amount of scientific studies: 1. Number of published papers; 2. Number of projects	1. WWW; 2.Libraries	
			Educational	3122	Education potential	Number of educational activities (festivals, visiting centers, green school, etc.) per year	National data	
			Heritage, cultural	3123	Cultural interaction	Number of monuments or products from traditional management of landscapes	National data	
			Entertainment	3124	Entretaiment events potential (Festivals and other cultural events)	Number of events per year	National data	
			Aesthetic	3125	Aestetic experience	Number of photos uploaded in Google Earth	WWW	
	Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes [environmental settings]	Spiritual and/or emblematic	Symbolic	3211	Symbolic species	Number of species	National data	
			Sacred and/or religious	3212	Sacred and religious tourism	Number of monasteries, churches, places	National data	
		Other cultural outputs	Existence	3221	Conservation significance	Overlaping with protected areas (e.g. NATURA2000, Biosphere reserves,etc.)	National data, MOEW	

In Annex 7 is included a full list of Ecosystem Services according to different ecosystem subtypes.

The above listed indicators for ecosystem services were chosen with aim to assess these services as developed in CICES and 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 propose other new indicators for assessment of the services, considered by them useful or more adequate 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, must be described and motivated proposals have to be made for their use in future assessment. 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.

6.2. Assessment of Ecosystem services

The assessment of ecosystem services is a further step in the valuation process. There are various methods for ecosystem services assessment but common standards require to be quantifiable, replicable and affordable. Burkhard et al. (2012) propose general matrix for ecosystem service demands and provisions including all main ecosystem types. This matrix could be applied at national or regional level for decision making. For more accurate estimation, also for valuation economic potential, it should be considered that each service type may depend on two factors: ecosystem area and condition. The better condition and larger the area the higher value of service should be provided. On some cases the provided ecosystem service doesn't depend strictly on condition of the ecosystem. Some ecosystems in relatively bad condition provide high value service. It is not appropriate to compare between services as they are represented by different measurements. The applicants should collect precise data by each parameter and further on it will be subject of valuation.

Step 1: Indicators for Ecosystem services assessment for *Heathland and shrub* ecosystems

Provisioning services are one of the most easy to understand. Food provision is fundamental service ensuring existence of human society. It includes plants, their fruits, reared and wild animals. Fibers, medicinal plants and other material from plant and animal species could be mapped using different parameters, but for the current purpose only one should be applied depending on the available data.

Heathland and shrub ecosystems take part in regulating and maintenance process as control of erosion, buffering mass flow, pollination potential, maintaining existence of particular species and habitats. Assessment of this group of services is to be based on maps or models on national or European scale. Currently only scarce national or regional data is available. Further projects for additional measures and field data collection should be implemented.

Cultural services can be assessed in many different ways. They mostly are of non-material benefit for the society, but play important role. This is why selected parameters are more numerous as compared to other services.

The indicators and their parameters that should be used to assess ecosystem services for *Heathland and shrub* ecosystems are listed in Table 7 above.

Step 2: Collect data – national datasets.

Egohetal et al. (2012) underlines that the primary data leads to more accurate representation of spatial distribution. However, 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.

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

The following data sources are to be primarily considered:

- *MOEW - ExEA - CORINE project, national data bases*
- *MoAF - National annual Agro statistical reports, Agro statistical surveys - BANSIK, FADN, LUCAS*
- *Scientific publications*
- *In-situ data*
- *EU data sources*
- *Additional remote sensing data*

An example of data collecting is provided in Table 8.

The proposed example relates to the *Arctic, alpine and subalpine scrub* type in the region of Botev peak, central part of Balkan Range. This is the same case study used for assessing of ecosystem condition shown above.

Table 8. Data table for Heathland and shrub ecosystems services - example

Ecosystem services		**Parameter/Units**	**Actual data for the current ecosystem polygon**	**Source**
Provisioning	Reared animals and their outputs	Livestock units/ha	0,85 units/ha	Data from NP Directorate
	Wild plants, algae and their outputs	t/hat/ha	0,032 t/ha fruits of *Vaccinium myrtillus* 0,065 t/ha fruits of *Vaccinim vitis-idea*	Management plan for NP Central Balkan
	Wild animals and their outputs	Number of species/ha	0	The territory is a part of National park and hunting is forbidden.
	Fibers and other materials from plants, algae and animals for direct use or processing	1. t/ha 2. t/livestock unit	0,4 t/ha shoots of *Thymus* sp. div.	Management plan for NP Central Balkan

Ecosystem services		Parameter/Units	Actual data for the current ecosystem polygon	Source
Regulation & Maintenance	Mass stabilization and control of erosion rates	Scale		Available maps
	Buffering and attenuation of mass flows	Scale	Not relevant	
	Pollination potential	Scale	No data	Expert knowledge
	Maintaining nursery populations and habitats	Total species biodiversity	180	Ecosystem condition assessment
Cultural	Experiential use of plants, animals and land-/seascapes in different environmental settings	Number of visitors (e. g. tourists, birdwatch, plantwatch, etc.) per year	Average 40 000 visitors/per year	Tourist service of the town of Kalofer
	Scientific	Amount of scientific studies: 1. Number of published papers; 2. Number of projects	4 scientific studies	1. WWW; 2.Libraries
	Educational	Number of educational activities (festivals, visiting centers, green school, etc.) per year	0	National data
	Entertainment	Number of events per year	0	National data
	Aesthetic	Number of photos uploaded in Google Earth	56	Google Earth
	Symbolic	Symbolic species [number]	0	1. National data; 2. Expert knowledge
	Sacred and/or religious interactions	Number of monasteries, churches, places	0	National data
	Conservation significance	Overlaping with protected areas (e.g. NATURA2000, Biosphere reserves,etc.)	100%	National data, MOEW

Step 3: How to assess

The applicants should collect precise data by each parameter and further on it will be subject of valuation/scoring. Filling the data matrix will allow setting up the dimensions of each indicator's parameter. Applicant should analyze the dimensions obtained and to elaborate appropriate scoring system. The score values range from 1 to 5 where score 1 equals to the lowest rate of particular service provision and 5 equals to the highest rate respectively. The score value 0 is given when some Ecosystem service is not relevant. The output table should look like in the following example of dummy variables:

The following assessment scores are not final. They will be actualized and corrected after ecosystem mapping in NATURA 2000 network.

Table 9. Scoring table for ecosystem services assessment.

Ecosystem services	Class	Indicator	Parameter/Units	Assessment score					
				Score 0 (not relevant)	Score 1 (low relevant capacity)	Score 2 (relevant capacity)	Score 3 (medium relevant capacity)	Score 4 (high relevant capacity)	Score 5 (very high relevant capacity)
Provisioning	Reared animals and their outputs	Reared animals	Livestock units (ruminants)/ha	0	<0.01	0.01-0.04	0.05-0.07	0.08-0.14	>0.14
	Wild plants, algae and their outputs	Primary biomass production of wild plants and fungi for food	kg/ha (wild fruits from bushes)	0	<0.001	0.001-0.004	0.004-0.050	0.051-0.20	>0.20
	Wild animals and their outputs	Heads of wild animals for hunting	Number of species/ha	0	<0.05	0.06-0.07	0.08-0.09	0.10-0.20	>0.20
	Fibres and other materials from plants, algae and animals for direct use or processing	Biomass production of plants, fungi and animals for materials	kg/ha	0	<0.01	0.01-0.07	0.08-0.15	0.16-6.0	>6.0
Regulation & Maintenance	Mass stabilisation and control of erosion rates	Erosion prevention	Scale (% of non-eroded area)	0	<1	1.0-55.0	56.0-85.0	86.0-95.0	>95.0
	Buffering and attenuation of mass flows	Mass flows prevention	Scale (Vegetation cover %)	0	10-30	31-40	41-50	51-70	>70
	Pollination and seed dispersal	Pollination potential	Scale (number of bee hives per UTM grid)	0	<200	200-400	401-800	801-1300	>1300
	Maintaining nursery populations and habitats	Biodiversity maintaining	Total species biodiversity	0	<25	25-60	61-120	121-180	>180
	Weathering processes	Soil degradation	Loss of net primary production (kg/ha/yr)	0	>16	11-16	5-10	1-4	0
	Decomposition and fixing processes	Organic matter decomposition	Soil organic matter content g/kg	0	<5	5.0-10.0	11.0-15.0	16.0-25.0	>25.0

Ecosystem services	Class	Indicator	Parameter/Units	Assessment score					
				Score 0 (not relevant)	Score 1 (low relevant capacity)	Score 2 (relevant capacity)	Score 3 (medium relevant capacity)	Score 4 (high relevant capacity)	Score 5 (very high relevant capacity)
Cultural	Experiential use of plants, animals and land-/seascapes in different environmental settings	Wilderness experiences	1. Number of visitors (e. g. tourists, birdwatch, plantwatch, etc.) per year; 2. Number of activities (e.g. farm tourism, walking and biking traits, etc.) per year	0	0	0	0	0	0
	Physical use of land-/seascapes in different environmental settings			0	1	2	3	4	>4
	Scientific	Scientific interest	Amount of scientific studies: 1. Number of published papers; 2. Number of projects	0	1	2	3	4	>4
	Educational	Education potential	Number of educational activities (festivals, visiting centers, green school, etc.) per year	0	1	2	3	4	>4
	Heritage, cultural	Cultural interaction	Number of monuments or products from traditional management of landscapes	0	1	2	3	4	>4
	Entertainment	Entretaiment events potential (Festivals and other cultural events)	Number of events per year	0	1	2	3	4	>4
	Aesthetic	Aestetic experience	Number of photos uploaded in Google Earth	0	1	2-3	4-5	6-10	>10
	Symbolic	Symbolic species	Number of species (number of villages named on shrubs)	0	1	2	3	4	>4
	Sacred and/or religious	Sacred and religious tourism	Number of monasteries, churches, places (in radius of 1 km)	0	1	2	3	4	>4
	Existence	Conservation significance	Number of sites in protected areas (e.g. NATURA2000, Biosphere reserves,etc.) per UTM grid	0	1	2	3	4	>4

The assessment of ecosystem services is based on real parameters (measurable and available) and presents the Real (expert assessed) **ESs Capacity**.

The example in Table 10 is based on expert evaluations/scoring of the parameter`s dimensions and can be seen as research hypotheses which are to be tested in further case study applications with data from measurements, modeling or additional expert assumptions.

Table 10. Assessment of ecosystem services - example

Type of ecosystem services	Division of ESs	Class of ESs	Real (expert assessed) ESs Capacity
Provisioning	Nutrition	P1. Reared animals and their outputs	2
		P2. Wild plants, algae and their outputs	2
		P3. Wild animals and their outputs	1
	Materials	P.4 Fibres and other materials from plants, algae and animals for direct use or processing	3
Regulation & Maintenance	Mediation of flows	R1. Mass stabilisation and control of erosion rates	5
		R2. Buffering and attenuation of mass flows	4
	Maintenance of physical, chemical, biological conditions	R3. Pollination and seed dispersal	1
		R4. Maintaining nursery populations and habitats	3
		R5. Weathering processes	4
		R6. Decomposition and fixing processes	3
Cultural	Physical and intellectual interactions with biota, ecosystems, and land-/seascapes [environmental settings]	C1. Experiential use of plants, animals and land-/seascapes in different environmental settings	3
		C2. Physical use of land-/seascapes in different environmental settings	2
		C3. Scientific	5
		C4. Educational	2
		C5. Heritage, cultural	2
		C6. Entertainment	5
		C7. Aesthetic	5
	Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes [environmental settings]	C8. Symbolic	2
		C9. Sacred and/or religious	0
		C10. Existence	1

Step 4: Fulfill the matrix

The ecosystem services matrix at national level consists of relevant ecosystem services (currently 4 provisioning, 6 regulating and 10 cultural services; according to Table 7). On the x-axis are ecosystem services and on the y-axis are ecosystem types on level 3. At the intersections, the score of the current spatial units' ecosystem subtype services were assessed on a scale from 0 to 5. The scores are expert evaluations and is based on a combination of expert judgement/experience with statistical data. 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 following table presents an example matrix of one generalized *Arctic, alpine and subalpine scrub* ecosystem for Bulgaria.

Table 11. Matrix of scores given to each Class of ESs presented by ES/ES subtype – Example of scoring a representative ES (example values are given in the second row).

		Heathland and shrub ecosystem subtypes		
		F2	**F3**	**F9**
ESs class codes CICES	1111			
	1112	2	3	1
	1113			
	1114			
	1115			
	1116			
	1121			
	1122			
	1211			
	1212			
	1213			
	1221			
	1222			
	1311			
	1312			
	1321			
	2111			
	2112			
	2121			
	2122			
	2123			

		Heathland and shrub ecosystem subtypes		
		F2	**F3**	**F9**
	2211			
	2212			
	2221			
	2222			
	2231			
	2232			
	2311*			
	2312			
	2321			
	2322			
	2331*			
	2332*			
	2341			
	2342			
	2351			
	2352			
	3111			
	3112			
	3121			
	3122			
	3123			
	3124			
	3125			
	3211			
	3212			
	3221			
	3222			

The assessment scale reaches: 0 = no relevant capacity 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. * ESs is not supported by data at national level. Marked in red is not relevant for Heathland and shrub ecosystems.

When comparing different Ecosystem Services between different ecosystem subtypes, the full list of ESs included in Annex 7 should be considered.

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 shema 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 3:

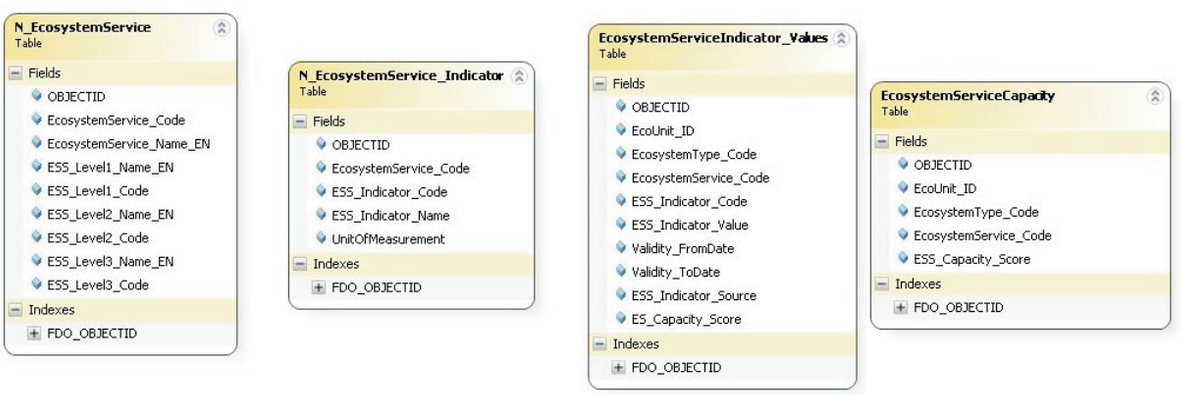


Figure 3: Ecosystem Services Database Schema

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_NOMENCLA-

TURES_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 50 km 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. For 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-B5

Terms and definitions

Term	Definition
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, summarising, organising, 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.
Drivers of change	Any natural or human-induced factor that directly or indirectly causes a change in an ecosystem. A direct driver of change unequivocally influences ecosystem processes and can therefore be identified and measured to differing degrees of accuracy; an indirect driver of change operates by altering the level or rate of change of one or more direct drivers (MA, 2005).
Economic valuation	The process of expressing a value for a particular good or service in a certain context (e.g., of decision-making) in monetary terms (TEEB, 2010).
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 reffered to the capacity of an ecosystem to yield services, relative to its potential capacity (MA, 2005).

Term	Definition
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.
Fragmentation	Fragmented habitats are those that were once contiguous but are now separated into smaller, isolated area s.
Habitat	Terrestrial or aquatic areas distinguished by geographic, abiotic and biotic features, whether entirely natural or seminatural.
Heathland	Open, low-growing woody vegetation
Indicator	Observed value representative of a phenomenon to study. In general, indicators quantify information by aggregating different and multiple data. The resulting information is therefore synthesised.
Invasives (plant, animals)	Invasive alien species 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.
Restoration	Refers to the process of actively managing the recovery of an ecosystem that has been degraded, damaged or destroyed as a means of sustaining ecosystem resilience and conserving biodiversity (CBD, 2012).
Scrub	A plant community characterized by vegetation dominated by shrubs, often also including grasses, herbs, and geophytes. It may either occur naturally or be the result of human activity
Species diversity	Number of species for specified area
Vegetation cover	the observed plant cover on the earth's surface

Annex 2-B5

List of acronyms

AEI	Agri-environmental Indicator
CICES	Common International Classification of Ecosystem Services
CORINE	Coordinate Information on the Environment
EEA	European Environmental Agency
ES	Ecosystem Services
EU	European Union
EUNIS	European Union Nature Information Sysytem
FADN	Farm Accountancy Data Network
HD	Habitats Directive
IP	Index of performance
IUCN	International Union for Conservation of Nature
MAES	Mapping and Assessment of Ecosystems and their Services
MAF	Ministry of Agriculture and Food
MF	Ministry of Finances
MOEW	Ministry of Environment and Waters
MRD	Ministry of Regional Development
NGO	Non-governmental organization

Annex 3-B5

Table of ecosystem types / Heathlands and shrubs

Table of ecosystem types

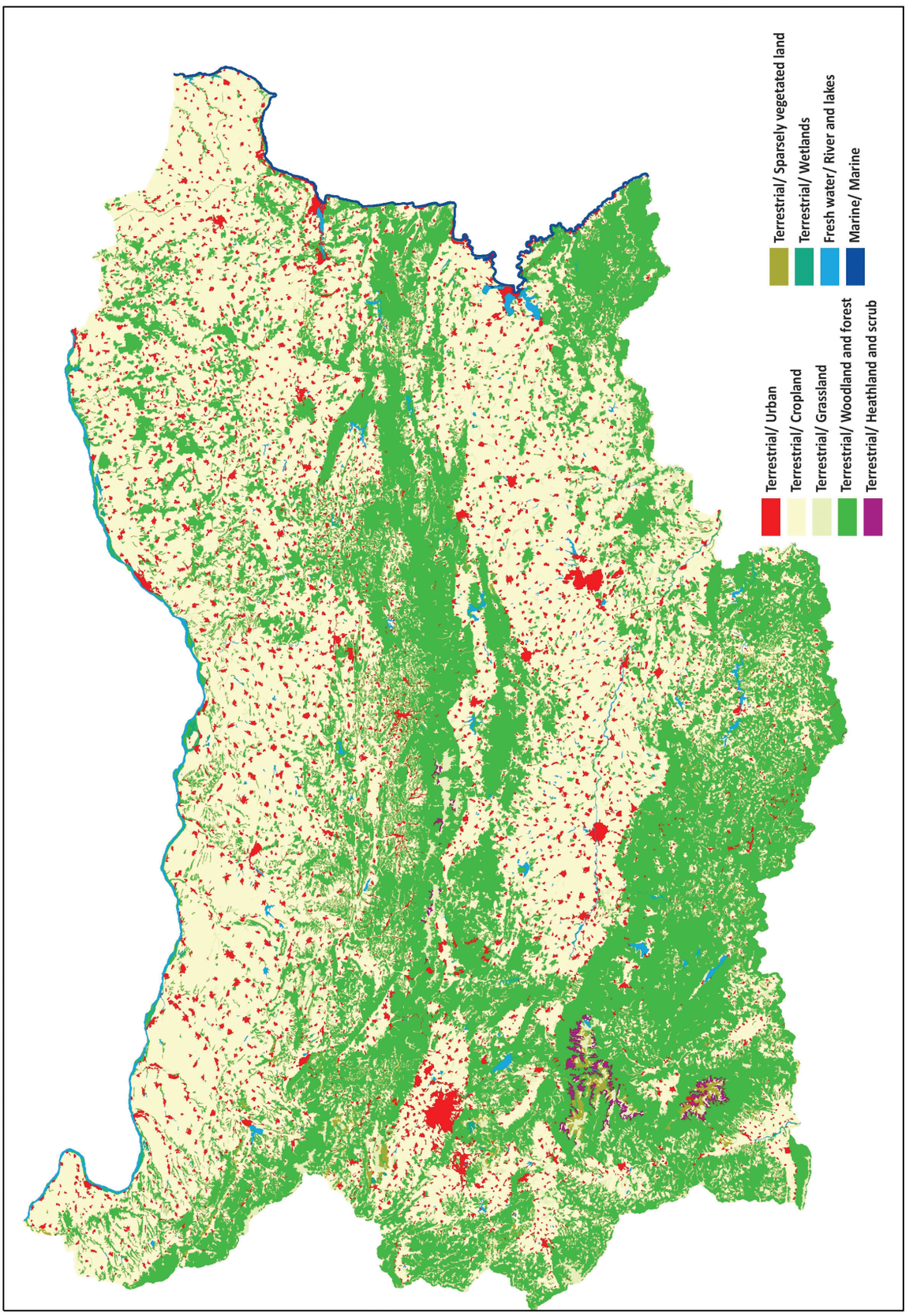
Level 1 / Ниво 1 (Major ecosystem category / Категория основна екосистема)	**Level 2 / Ниво 2** (Sub-classes/под-типове)	**Methodology part/ Част от Методологията**
Terrestrial	Urban	B1
	Cropland	B2
	Grassland	B3
	Woodland and forest	B4
	Heathlands and shrubs	**B5**
	Sparsely vegetated land	B6
	Wetlands	B7
Rivers and lakes	Rivers and lakes	B8
Marine	Marine	B9

Heathlands and shrubs

Level 3_Name	**Level 3_Description**
Arctic, alpine and subalpine scrub	Scrub occurring above the climatic tree limit. It may occur close to but below the climatic tree limit, where trees are suppressed either by late-lying snow or by wind or repeated browsing. These are shrub and dwarf shrub communities mostly of primary origin and dominated by *Juniperus sibirica, Pinus mugo, Vaccinium uliginosum, V. vitis-idaea, V. myrtillus, Arctostaphylos uva-ursi, Bruckenthalia spiculifolia, Dryas octopetala, Salix lapponum* etc.
Temperate and mediterranean-montane scrub	Shrub communities of nemoral affinities. They include deciduous and evergreen scrubs or brushes of the nemoral zone, and deciduous scrubs of the sub-mediterranean zone. These are shrub communities mostly dominated by *Juniperus communis, J. oxycedrus, Paliurus spina-christi, Jasminum friticans, Cotinus coggygria, Crataegus monogyna, Corylus avellana, Carpinus orientalis, Amygdalus nana, Astragalus angustifolius* etc.
Riverine and fen srubs	Riversides, lakesides, fens and marshy floodplains dominated by woody vegetation less than 5 m high. These are shrub communities of secondary origin mostly dominated by *Tamarix ramosissima, T. tetrandra, Salix fragilis, S. purpurea* etc.

Annex 4-B5

Map of ecosystem types



Annex 5-B5

Data Sources

Ecological state/condition indicators				
Type	***Indicator group***	***Indicator***	***Parameter***	***Data Sources***
Ecosytem structure	Biotic diversity	Vegetation cover	Vegetation cover	Phytosociological releves from Phytosociological Data Bases, scientific publications, Project reports etc.; Personal inpublished data; Field collected data.
		Plant diversity	Plant species richness	Phytosociological releves from Phytosociological Data Bases, scientific publications, Project reports etc.; Personal inpublished data; Field collected data.
		Animal diversity	Animal species richness	Literature data from Data Bases, scientific publications, Project reports etc.; Personal inpublished data; Field collected data.
		Red list species	Number of red list species (plant/animal)	Information according Red Data Book in Bulgaria (2015); Literature data from Data Bases, scientific publications, Project reports etc.; Personal inpublished data; Field collected data.
		Alien and invasive species presence	number of alien and invasive species	Information according Invasive alien plant species in Bulgaria (2012), ESENIAS Poject; ; Literature data from Data Bases, scientific publications, Project reports etc.; Personal inpublished data; Field collected data.
		Other biotic diversity indicators (for example, naturalness, habitat diversity, etc.)		
	Abiotic heterogeneity	soil heterogeneity	Soil quality	Soil type maps of Bulgaria
			Soil organic matter	Soil monitoring data from Executive environment agency; Literature data from Data Bases, scientific publications, Project reports etc.; Personal inpublished data
		Hydrological heterogeneity	Hydrological heterogeneity	
		Geomorphological heterogeneity	Geomorphological heterogeneity	
		Disturbance regime	Soil erosion risk	Wind and water soil erosion risk maps from Executive environment agency;
			Pollution	
			Fire	
		Other abiotic heterogeneity indicators		
Ecosystem processes	Energy budget	Energy balance (capture, storage)	Energy balance (capture, storage)	
		Metabolic efficiency	Metabolic efficiency	
		Other energy budget indicators	Other energy budget indicators	
	Matter budget	Matter storage	Biomass	Literature data from Data Bases, scientific publications, Project reports etc.; Field collected data.
		Matter balance (input, output)	Matter balance (input, output)	
		Element concentrations (other state variables)	Element concentrations (other state variables)	

Ecological state/condition indicators				
Type	***Indicator group***	***Indicator***	***Parameter***	***Data Sources***
Ecosystem processes		Efficiency measures	Efficiency measures	
	Water budget	Water balance (input, output)	Water balance (input, output)	
		Water storage	Water storage	
		Efficiency measures	Efficiency measures	

Ecosytem services indicators						
				Indicator	Parameters and units	Data sources
Section	**Division**	**Group**	**Class (code)**			
Provisioning	Nutrition	Biomass	Cultivated crops (1111)			
			Reared animals and their outputs (1112)	Rared animals	livestock units/ha	Statistics; Ecosystem state assessment
			Wild plants, algae and their outputs (1113)	Primary biomass production of wild plants and fungi for food	t/ha	Statistics; Ecosystem state assessment
			Wild animals and their outputs (1114)	Heads of animals reared for hunting	number/ha	Statistics; Ecosystem state assessment
			Plants and algae from in-situ aquaculture (1115)			
			Animals from in-situ aquaculture (1116)			
		Water	Surface water for drinking (1121)			
			Ground water for drinking (1122)			
	Materials	Biomass	Fibres and other materials from plants, algae and animals for direct use or processing (1211)	Biomass production of plants, fungi and animals for materials	T/ha	Statistics; Ecosystem state assessment
			Materials from plants, algae and animals for agricultural use (1212)			
			Genetic materials from all biota (1213)			
		Water	Surface water for non-drinking purposes (1221)			
			Ground water for non-drinking purposes (1222)			
	Energy	Biomass-based energy sources	Plant-based resources for energy (1311)			
			Animal-based resources (1312)			
		Mechanical energy	Animal-based energy (1321)			
Regulation & Maintenance	Mediation of waste, toxics and other nuisances	Mediation by biota	Bio-remediation by micro-organisms, algae, plants, and animals (2111)			
			Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals (2112)			
		Mediation by ecosystems	Filtration/sequestration/storage/accumulation by ecosystems (2121)			
			Dilution by atmosphere, freshwater and marine ecosystems ecosystems (2122)			
			Mediation of smell/noise/visual impacts (2123)			
	Mediation of flows	Mass flows	Mass stabilisation and control of erosion rates (2211)	Erosion prevention	Scale	available map
			Buffering and attenuation of mass flows (2212)			
		Liquid flows	Hydrological cycle and water flow maintenance (2221)			
			Flood protection (2222)	Flood prevention	Scale	available map
		Gaseous / air flows	Storm protection (2231)			
			Ventilation and transpiration (2232)			

Ecosytem services indicators						
				Indicator	Parameters and units	Data sources
Section	**Division**	**Group**	**Class (code)**			
Regulation & Maintenan	Maintenance of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	Pollination and seed dispersal (2311)	pollination potential	scale	Joint Research Center - IES
			Maintaining nursery populations and habitats (2312)	Biodiversity maintaining	Cumulative species number	national data/MOEW
		Pest and desease control	Pest control (2321)			
			Disease control (2322)			
		Soil formation and composition	Weathering processes (2331)			
			Decomposition and fixing processes (2332)	soil organic matter content	g/kg	EU; Ecosystem condition assessment; Statistics
		Water conditions	Chemical condition of freshwaters (2341)			
			Chemical condition of salt waters (2342)			
		Atmospheric composition and climate regulation	Global climate regulation by reduction of greenhouse gas concentrations (2351)			
			Micro and regional climate regulation (2352)			
Cultural	Physical and intellectual interactions with biota, ecosystems, and land-/seascapes [environmental settings]	Physical and experiential interactions	Experiential use of plants, animals and land-/seascapes in different environmental settings (3111)	Wilderness expierience	Number of visitors (e. g. tourists, birdwatch, plantwatch, etc.) per year; Number of activities (e.g. farm tourism, walking and biking traits, etc.)	national data
			Physical use of land-/seascapes in different environmental settings (3112)	Wilderness expierience	Number of visitors (e. g. tourists, birdwatch, plantwatch, etc.) per year; Number of activities (e.g. farm tourism, walking and biking traits, etc.)	national data
		Intellectual and representative interactions	Scientific (3121)	Scientific interest	Amount of scientific studies: number of published papers; number of projects	WEB, libraries
			Educational (3122)	Education potential	Number of educational activities (festivals, visiting centers, green school, etc.)per year	national data
			Heritage, cultural (3123)	Cultural interaction	Number of monuments or products from traditional management of landscapes	national data
			Entertainment (3124)	Entretaiment events potential (Festivals and other cultural events)	Number of events per year	national data
			Aesthetic (2125)	Aestetic experience	Number of photos uploaded in Google Earth	WEB
	Spiritual, symbolic and other interactions with biota, ecosystems, and land/seascapes [environment al settings]	Spiritual and/or emblematic	Symbolic (3211)	Symbolic species	Number of species	national data
			Sacred and/or religious (3212)	Sacred and religious tourism	Number of monasteries, churches, places	national data
		Other cultural outputs	Existence (3221)	Conservation significance	Number of sites in protected areas (e.g. Natura2000, Biosphere reserves,etc.)	national data, MOEW
			Bequest (3222)			

Annex 6-B5

Ecological condition indicators - Heathland and shrub

Ecological condition indicandum			F2 - Arctic, alpine and subalpine scrub					
Orientor type	***Indicandum group***		***Parameter***	***Dimentions (units)***	***Available data (Y/N)***	***New data needed (tick by "V")***	***Periodicity of measurring (years etc.)***	***Significance***
Ecosytem structure	**Biotic diversity**	Cover of shrub layer	% cover of shrubs	Percent	Y		5 years	primary
		Plant diversity	Plant species richness	Number of species per sample plot	Y		5 years	primary
		Animal diversity	Animal species richness	number of species	Y		5 years	primary
		Red list species	Number of red list species (plant/animal)	number of species	Y		5 years	primary
		Alien and invasive species presence	Number of species per grid unit	number of species	Y		5 years	primary
		Other biotic diversity indicators (for example, naturalness, habitat diversity, etc.)						optional
	Abiotic heterogeneity	Soil heterogeneity	Soil quality	soil type	Y		once only	primary
			Soil organic matter	Percent	Y		5 years	primary
		Hydrological heterogeneity	Hydrological heterogeneity					optional
		Geomorphological heterogeneity	Geomorphological heterogeneity					optional
		Disturbance regime	Soil erosion risk	score	Y		5 years	primary
			Pollution	Number of dump sites		V	5 years	primary
			Fire	Number of recorded fires		V	5 years	primary
		Other abiotic heterogeneity indicators						optional

Ecological condition indicandum			F2 - Arctic, alpine and subalpine scrub					
Orientor type	*Indicandum group*		*Parameter*	*Dimentions (units)*	*Available data (Y/N)*	*New data needed (tick by "V")*	*Periodicity of measurring (years etc.)*	*Significance*
Ecosystem processes	Energy budget	Energy balance (capture, storage)	Energy balance (capture, storage)					optional
		Metabolic efficiency	Metabolic efficiency					optional
		Other energy budget indicators	Other energy budget indicators					optional
	Matter budget	Matter storage	Biomass	t/ha		V	5 years	primary
		Matter balance (input, output)	Matter balance (input, output)					optional
		Element concentrations (other matter budget variables)	Element concentrations (other matter budjet variables)					optional
		Efficiency measures	Efficiency measures					optional
	Water budget	Water balance (input, output)	Water balance (input, output)					optional
		Water storage	Water storage					optional
		Efficiency measures	Efficiency measures					optional

Ecological condition indicandum			F3 - Temperate and mediterranean-montane scrub					
Orientor type	***Indicandum group***		***Parameter***	***Dimentions (units)***	***Available data (Y/N)***	***New data needed (tick by "V")***	***Periodicity of measurring (years etc.)***	***Significance***
Ecosytem structure	**Biotic diversity**	Cover of shrub layer	% cover of shrubs	Percent	Y		5 years	primary
		Plant diversity	Plant species richness	Number of species per sample plot	Y		5 years	primary
		Animal diversity	Animal species richness	number of species	Y		5 years	primary
		Red list species	Number of red list species (plant/animal)	number of species	Y		5 years	primary
		Alien and invasive species presence	number of alien and invasive species	number of species	Y		5 years	primary
		Other biotic diversity indicators (for example, naturalness, habitat diversity, etc.)						optional
	Abiotic heterogeneity	Soil heterogeneity	Soil quality	soil type	Y		once only	primary
			Soil organic matter	Percent	Y		5 years	primary
		Hydrological heterogeneity	Hydrological heterogeneity					optional
		Geomorphological heterogeneity	Geomorphological heterogeneity					optional
		Disturbance regime	Soil erosion risk	score	Y		5 years	primary
			Pollution	Number of dump sites		V	5 years	primary
			Fire	Number of recorded fires		V	5 years	primary
		Other abiotic heterogeneity indicators						optional

Ecological condition indicandum			F3 - Temperate and mediterranean-montane scrub					
Orientor type	***Indicandum group***		***Parameter***	***Dimentions (units)***	***Available data (Y/N)***	***New data needed (tick by "V")***	***Periodicity of measurring (years etc.)***	***Significance***
Ecosystem processes	**Energy budget**	Energy balance (capture, storage)	Energy balance (capture, storage)					optional
		Metabolic efficiency	Metabolic efficiency					optional
		Other energy budget indicators	Other energy budget indicators					optional
	Matter budget	Matter storage	Biomass	t/ha		V	5 years	primary
		Matter balance (input, output)	Matter balance (input, output)					optional
		Element concentrations (other matter budget variables)	Element concentrations (other matter budjet variables)					optional
		Efficiency measures	Efficiency measures					optional
	Water budget	Water balance (input, output)	Water balance (input, output)					optional
		Water storage	Water storage					optional
		Efficiency measures	Efficiency measures					optional

Ecological condition indicandum			F9 - Riverine and fen srubs					
Orientor type	***Indicandum group***		***Parameter***	***Dimentions (units)***	***Available data (Y/N)***	***New data needed (tick by "V")***	***Periodicity of measurring (years etc.)***	***Significance***
Ecosytem structure	**Biotic diversity**	Cover of shrub layer	% cover of shrubs	Percent	Y		5 years	primary
		Plant diversity	Plant species richness	Number of species per sample plot	Y		5 years	primary
		Animal diversity	Animal species richness	number of species	Y		5 years	primary
		Red list species	Number of red list species (plant/animal)	number of species	Y		5 years	primary
		Alien and invasive species presence	number of alien and invasive species	number of species	Y		5 years	primary
		Other biotic diversity indicators (for example, naturalness, habitat diversity, etc.)						optional
	Abiotic heterogeneity	Soil heterogeneity	Soil quality	soil type	Y		once only	primary
			Soil organic matter	Percent	Y		5 years	primary
		Hydrological heterogeneity	Hydrological heterogeneity					optional
		Geomorphological heterogeneity	Geomorphological heterogeneity					optional
		Disturbance regime	Soil erosion risk	score	Y		5 years	primary
			Pollution	Number of dump sites		V	5 years	primary
			Fire	Number of recorded fires		V	5 years	primary
		Other abiotic heterogeneity indicators						optional

Ecological condition indicandum			F9 - Riverine and fen srubs					
Orientor type	***Indicandum group***		***Parameter***	***Dimentions (units)***	***Available data (Y/N)***	***New data needed (tick by "V")***	***Periodicity of measurring (years etc.)***	***Significance***
Ecosystem processes	**Energy budget**	Energy balance (capture, storage)	Energy balance (capture, storage)					optional
		Metabolic efficiency	Metabolic efficiency					optional
		Other energy budget indicators	Other energy budget indicators					optional
	Matter budget	Matter storage	Biomass	t/ha		V	5 years	primary
		Matter balance (input, output)	Matter balance (input, output)					optional
		Element concentrations (other matter budget variables)	Element concentrations (other matter budjet variables)					optional
		Efficiency measures	Efficiency measures					optional
	Water budget	Water balance (input, output)	Water balance (input, output)					optional
		Water storage	Water storage					optional
		Efficiency measures	Efficiency measures					optional

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

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Table of Indicators ES Services

Methodology for Assessment and Mapping of Heathland and Shrub Ecosystems Condition and Their Services In Bulgaria

Section	Division	Group	Class	CICES Codes	Indicator	Parameter (Dimentions/Units)	Data sources	Heathland and shrub F2	Heathland and shrub F3	Heathland and shrub F9
1. Provisioning	1. Nutrition	1. Biomass	1. Cultivated crops	1111						
			2. Reared animals and their outputs	1112	1. Reared animals	1. Livestock units/ha	1. Statistics; 2. Ecosystem condition assessment.	X	X	X
			3. Wild plants, algae and their outputs	1113	1. Primary biomass production of wild plants and fungi for food	1. t/ha	1. Statistics; 2. Ecosystem condition assessment.	X	X	X
			4. Wild animals and their outputs	1114	1. Heads of wild animals for hunting	1. Number of species/ha	1. Statistics; 2. Ecosystem condition assessment.	X	X	X
			5. Plants and algae from in-situ aquaculture	1115						
			6. Animals from in-situ aquaculture	1116						
		2. Water	1. Surface water for drinking	1121						
			2. Ground water for drinking	1122						
	2. Materials	1. Biomass	1. Fibres and other materials from plants, algae and animals for direct use or processing	1211	1. Biomass production of plants, fungi and animals for materials	1. t/ha 2. t/livestock unit	1. Statistics; 2. Ecosystem condition assessment.	X	X	X
			2. Materials from plants, algae and animals for agricultural use	1212						
			3. Genetic materials from all biota	1213						
		2. Water	1. Surface water for non-drinking purposes	1221						
			2. Ground water for non-drinking purposes	1222						
	3. Energy	1. Biomass-based energy sources	1. Plant-based resources	1311						
			2. Animal-based resources	1312						
		2. Mechanical energy	1. Animal-based energy	1321						

Section	Division	Group	Class	CICES Codes	Indicator	Parameter (Dimentions/Units)	Data sources	Heathland and shrub		
								F2	F3	F9
2. Regulation & Maintenance	1. Mediation of waste, toxics and other nuisances	1. Mediation by biota	1. Bio-remediation by micro-organisms, algae, plants, and animals	2111						
			2. Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals	2112						
		2. Mediation by ecosystems	1. Filtration/sequestration/storage/accumulation by ecosystems	2121						
			2. Dilution by atmosphere, freshwater and marine ecosystems	2122						
			3. Mediation of smell/noise/visual impacts	2123						
	2. Mediation of flows	1. Mass flows	1. Mass stabilisation and control of erosion rates	2211	1. Erosion prevention	1. Scale	1. Available maps	X	X	X
			2. Buffering and attenuation of mass flows	2212	1. Mass flows prevention	1. Scale	1. Available maps	X	X	X
		2. Liquid flows	1. Hydrological cycle and water flow maintenance	2221						
			2. Flood protection	2222						
		3. Gaseous / air flows	1. Storm protection	2231						
			2. Ventilation and transpiration	2232						
	3. Maintenance of physical, chemical, biological conditions	1. Lifecycle maintenance, habitat and gene pool protection	1. Pollination and seed dispersal	2311	1. Pollination potential	1. Scale	Expert knowledge	X	X	X
			2. Maintaining nursery populations and habitats	2312	1. Biodiversity maintaining	1. Total species biodiversity	1. Ecosystem condition assessment	X	X	X
		2. Pest and disease control	1. Pest control	2321						
			2. Disease control	2322						
		3. Soil formation and composition	1. Weathering processes	2331	1. Soil formation			X	X	X
			2. Decomposition and fixing processes	2332	1. Organic matter decomposition	1. Soil organic matter content g/kg	1. EU; 2. Ecosystem condition assessment; 3. Statistics	X	X	X
		4. Water conditions	1. Chemical condition of freshwaters	2341						
			2. Chemical condition of salt waters	2342						
		5. Atmospheric composition and climate regulation	1. Global climate regulation by reduction of greenhouse gas concentrations	2351						
			2. Micro and regional climate regulation	2352						

Section	Division	Group	Class	CICES Codes	Indicator	Parameter (Dimentions/Units)	Data sources	Heathland and shrub		
								F2	F3	F9
3. Cultural	1. Physical and intellectual interactions with biota, ecosystems, and land-/seascapes [environmental settings]	1. Physical and experiential interactions	1. Experiential use of plants, animals and land-/seascapes in different environmental settings	3111	1. Wilderness experiences	1. Number of visitors (e. g. tourists, birdwatch, plantwatch, etc.) per year; 2. Number of activities (e.g. farm tourism, walking and biking traits, etc.) per year	1. National data	X	X	X
			2. Physical use of land-/seascapes in different environmental settings	3112				X	X	X
		2. Intellectual and representative interactions	1. Scientific	3121	1. Scientific interest	Amount of scientific studies: 1. Number of published papers; 2. Number of projects	1. WWW; 2.Libraries	X	X	X
			2. Educational	3122	1. Education potential	1. Number of educational activities (festivals, visiting centers, green school, etc.) per year	1. National data	X	X	X
			3. Heritage, cultural	3123	1. Cultural interaction	1. Number of monuments or products from traditional management of landscapes	1. National data	X	X	X
			4. Entertainment	3124	1. Entretaiment events potential (Festivals and other cultural events)	1. Number of events per year	1. National data	X	X	X
			5. Aesthetic	3125	1. Aestetic experience	1. Number of photos uploaded in Google Earth	1. Google Earth	X	X	X
	2. Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes [environmental settings]	1. Spiritual and/or emblematic	1. Symbolic	3211	1. Symbolic species	1. Number of species	1. National data; 2. Expert knowledge	X	X	X
			2. Sacred and/or religious	3212	1. Sacred and religious tourism	1. Number of monasteries, churches, places	1. National data	X	X	X
		2. Other cultural outputs	1 Existence	3221	1. Conservation significance	1. Overlaping with protected areas (e.g. NATURA2000, Biosphere reserves,etc.)	1. National data, MOEW	X	X	X
			2. Bequest	3222						

not supported by data

not relevant for Heathland and shrub ecosystems

Annex 8-B5

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Annex 9-B5

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/