PART B6

METHODOLOGY

for assessment and mapping of SPARSELY VEGETATED LAND 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 SPARSELY VEGETATED LAND ECOSYSTEMS CONDITION AND THEIR SERVICES IN BULGARIA**

PART B6

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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 **Sparsely vegetated land ecosystems**
2. Assessing **Sparsely vegetated land ecosystems' potential to deliver ecosystem services** (biophysical valuation).

The methodology is relevant to Sparsely vegetated land 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 of 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 programmes that have set aside funding for the national process of ecosystems mapping and assessment – for NATURA 2000, the Operational Programme Environment 2014-2020 and outside NATURA 2000 – programme BG03 Biodiversity and ecosystem services 2009-2014
- National or local authorities who 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 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 Sparsely vegetated land ecosystems

Sparsely vegetated lands are areas that include unvegetated or sparsely vegetated habitats (naturally unvegetated areas). Often these ecosystems have extreme natural conditions that might support particular species. They include bare rocks, screes, dunes, beaches and sand plains.

The proposed typology of sparsely vegetated land ecosystems corresponds with the ecosystem classification of MAES (2013) combined with the European Nature Information System (EUNIS) habitat classification types. It is also related to some of CORINE Land Cover (CLC) classes. The MAES ecosystem typology on Level 2 follows closely the EUNIS Level 1. The third level of the MAES typology corresponds therefore to the EUNIS level 2. The EUNIS level 2 will be the base for the mapping and assessment approach.

Table 1. Typology of Sparsely vegetated land ecosystems in Bulgaria

Level 1	Level 2	Level 3
Terrestrial	Sparsely vegetated land	B1. Coastal dunes and sandy shores
		B2. Coastal shingle
		B3. Costal Rock cliffs, ledges and shores, including the supralittoral
		H2. Screes
		H3. Inland cliffs, rock pavements and outrcrops

2.2. Detailed typology of Sparsely vegetated land ecosystems

A selection of units of EUNIS classification on level 2 is proposed for detailed typology as level 3 for target ecosystem type. Rock and stony areas, such as screes and cliffs (including the costal ones) are selected. They correspond to levels “H2” and “H3” from EUNIS group “H” and “B3” from EUNIS group “B” respectively. Additionally as sparsely vegetated land should be assumed also sandy dune, sandy shores and shingle beaches (EUNIS - B1, B2). Total number of 5 sparsely vegetated land types is selected. 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 Sparsely vegetated lands are presented in Table 2.

Table 2. Sparsely vegetated land ecosystem typology (Level 3)

	Subtype	Description	Nomenclature(s)
1.	Coastal dunes and sandy shores	Sand-covered shorelines of the Black Sea, fashioned by the action of wind or waves. This group includes all types of dune system (embryonic, white, grey dunes etc.) and also sandy beaches used for recreation. Vegetation cover vary from sparsely distributed individuals of *Eryngium maritimum*, *Cakile maritima*, *Salsola ruthenica* etc. close to water-line, throw open and semi-open psammophyte communities to the closed communities rich of mosses and lichens in inner parts	EUNIS –B1; Bondev (1991)-147; HD 92/42/EEC – 2110, 2120, 2130, 2190;
2.	Coastal shingle	Beaches covered by pebbles, or sometimes boulders, usually formed by wave action. On some places with accumulations of drift material, sandy gravels and gravels rich in nitrogenous organic matter occur. They are very open with low formations of annuals and perennials.	EUNIS – B2; HD 92/42/EEC – 1210;
3.	Costal rock cliffs, ledges and shores, including the supralittoral	Herbaceous aerohaline communities of the sea-cliffs of the maritime facade of the Stranja, Cape Kaliakra and other areas of Bulgarian Pontic coast, with *Limonium gmelinii*, *Goniolimon collinum*, *Crithmum maritimum*, *Elymus pycnanthus, Cichorium intybus, Atriplex hastata, Kochia prostrata, Convolvulus lineatus*, etc. and the local endemic, as *Silene caliacrae*.	EUNIS – B3 (especially B3.332 Pontic sea-cliff communities); HD92/42/EEC – 1240
4.	Screes	Accumulations of boulders, stones, rock fragments, pebbles, gravels or finer material, of non-aeolian depositional origin, unvegetated, occupied by lichens or mosses, or colonized by sparse herbs or shrubs. Included screes and scree slopes produced by slope processes, moraines and drumlins originating from glacial deposition. They are represented predominantly in high mountain and mountain belt. A very few patches form in lowland areas.	EUNIS – H2; HD 92/42/EEC – 8110, 8120

	Subtype	Description	Nomenclature(s)
5.	Inland cliffs, rock pavements and outrcrops	Unvegetated, sparsely vegetated, and bryophyte- or lichen-vegetated cliffs, rock faces and rock pavements in inland areas.	EUNIS-H3; HD 92/42/EEC –8210, 8220, 8230

3. Data availability

3.1. Existing data sources, gaps, uncertainty of data.

For mapping and assessing of sparsely vegetated land 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 ecosystem condition and services in the smaller scale, concerning sparsely vegetated land ecosystems. We then put this in the context of data available at the national level. In order to identify the data used for the quantification of ES, we focused on the parameters included in the tables, used as a basis for the primary and optional indicators proposed. For each parameter, we identified and grouped the type of data used (e.g. land cover maps, land property maps, cadastre, statistics). Available spatial and quantitative database for sparsely vegetated land 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 for specific study areas), 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. These parameters could create indicators for the ecosystem condition.

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 ES. 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 is case-specific and could be produced by several research groups.

As mentioned earlier, for a few indicators and their parameters and the corresponding data types

used (such as tourist information data) the data is missing, but the intention to generate such data is underlined. 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
Coastal dunes and sandy shores	Maps of Restored Property, MOEW - CORINE project, national data bases; NATURA 2000 mapping and database; Maps produced in accordance with Act for the Black Sea Coast Additional remote sensing data	MOEW - CORINE project, national data bases; NATURA 2000 mapping and database; Scientific publications
Coastal shingle	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
Costal rock cliffs, ledges and shores, including the supralittoral	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
Screes	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
Inland cliffs, rock pavements and outrcrops	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:

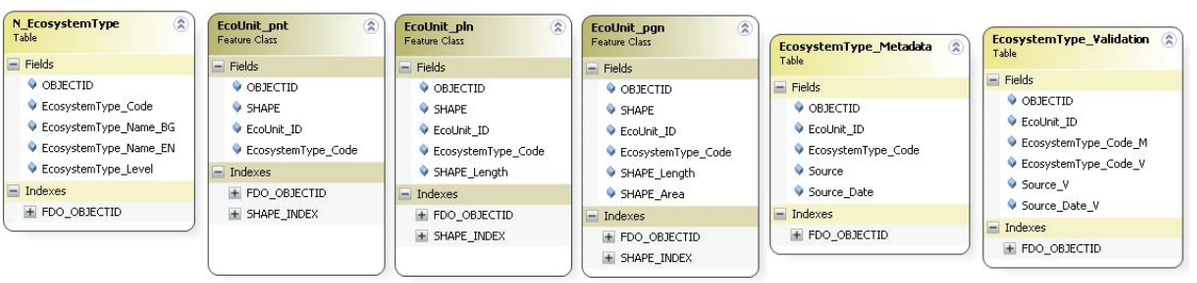
- the used source data;
- the ecosystem type on level 3.

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 inFigure 1.



Fifure 2: 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 Sparsely vegetated land 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 sparsely vegetated lands;
- 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 sparsely vegetated 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 is 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 sparsely vegetated land ecosystems their structure and functional processes. Among the proposed indicators, which are representative for conditions of all sub-types, the defined 17 specific indicators (5 primary and 12 optional) are considered for assessing sparsely vegetated land ecosystems conditions at Step 1 (*Table 4.*). Each of the selected indicators is enough informative.

Table 4. Rationales of ecosystem conditions 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 heterogeneity 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

Ecosystem condition indicator group	Indicators/Rationales
Biotic diversity	species group studied. Structural attributes of the vegetation that constitute habitat heterogeneity for one group may be perceived as habitat fragmentation by another taxonomic group (e.g. Okland, 1996). To determine biotic factors and sparsely vegetated land habitat diversity the following **primary indicators** are proposed: *"Plant diversity",* *"Animal diversity",* *"Invasive species"* *"Vegetation cover",* *"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 condition assessment 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 sparsely vegetated land abiotic heterogeneity the following **primary indicator** is proposed: *"Disturbance regime"* **Possible (optional) indicators are:** *"Geomorphological heterogeneity"* *"Other abiotic heterogeneity indicators"* The ecosystem condition assessment projects using other indicators, must define them consistently to the current methodology.
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 sparsely vegetated land ecosystems **possible (optional) indicators are:** "*Energy balance (capture, storage)*", "*Metabolic efficiency*", "*Other energy budget indicators*"

Ecosystem condition indicator group	Indicators/Rationales
	The ecosystem condition assessment projects using these optional or 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 sparsely vegetated land ecosystems. To account matter budget in sparsely vegetated land ecosystems the following **primary indicator** is proposed: *"Matter storage"* Other **possible (optional) indicators are:** *"Matter balance (input, output)"* *"Element concentrations (other condition variables)"* *"Efficiency measures"* The ecosystem condition assessment projects using these optional or 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 sparsely vegetated areas, considering precipitation, evaporation, and runoff. The following **possible (optional) indicators** are proposed: *"Water balance (input, output)",* *"Water storage",* *"Efficiency measures"* The ecosystem condition assessment projects using these optional or other indicators, must define them consistently to the current methodology.

Step 2: Identify the parameters of each indicator

For the set of indicators describing sparsely vegetated land ecosystem conditions 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, landcover, 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 sparsely vegetated land 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 sparsely vegetated 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. Periodic measurements and comparison of parameter values need to be carried out, in order to verify authenticity of the data obtained within the assessment of ecosystem condition. Periodicity of the measurement approaches, will be described in the Monitoring guide.

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 parameters

For each indicator's parameters for each ecosystem subtype (level 3) of sparsely vegetated lands should be considered range scores accordingly ecosystem's specifics. These scores classes ranged from 1-very bad to 5 very good. The range of each class depends of expert's best knowledge or real data available or data collected during in situ validation of ecosystem condition mapping procedure. When some parameters (for example presence of alien/invasive species) could be measured by dif-

ferent approaches for target ecosystem's polygons only one real data should be choose. For sparsely vegetated lands the cover of angiosperms (mosses and lichens) should be calculated in parameter "vegetation cover".

An example of score classes for mandatory indicators and their parameters for sparsely vegetated ecosystem are indicated in Table 5.

Table 5. Ecosystem conditions indicators assessment for Sparsely vegetated land ecosystems

Ecological condition indicators		Indicator	Parameter	Unit	Measurement approach	Assessment scale and score				
Type	Indicator Group					Score 1 (very bad)	Score 2 (bad)	Score 3 (mode rate)	Score 4 (good)	Score 5 (very good)
Ecosystem structure	Biotic diversity	Vegetation cover	Vegetation cover	Percent per the sample plot area	Estimation	<1%	2-5%	6-10%	11-50%	>50%
		Plant diversity	Plant species richness	number of species per sample plot area	Calculation	0	1	2-4	5-7	>7
		Animal diversity	Animal species richness	number of species per sample plot area	Calculation	<20	21-50	51-100	101-150	>150
		Red list species	Red list species (plant/animal)	number of species per grid unit OR in ecosystem polygon	Grid data according to the Red Data Book of Bulgaria	0	1-4	5-11	12-22	>23
		Alien and invasive species presence	Number of Alien and invasive species	Number of species per unit area OR Percent cover of alien/invasive species per polygon	Number per grid unit of national data OR Cover per sample plot	>10 >15%	7-9 10-15%	4-6 4-10%	1-3 1-3%	0 0%
	Abiotic heterogeneity	Disturbance regime	Pollution	number of dump sites per grid unit	number per grid unit	>3	3	2	1	0
Ecosystem processes	Matter budget	Matter storage	Biomass	t/ha (air dry)	Estimation/ Assessment by available data	<0,01	0,02-0,03	0,04-0,05	0,1-0,2	>0,2

Periodic measurements and comparison of parameter values need to be carried out, in order to verify authenticity of the data obtained within the assessment 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 or field observations. The proposed example relates to the Coastal dunes and sandy shores ecosystem. The chosen concrete ecosystem polygon of this sub-type is located between Hadzhijska River and hotel Burgas in Sunny beach resort. It covers costal sand dune complex included embryonic, "white" and "grey"' dunes.

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

Indicator type	Indicator group	Indicator	Parameter	Units	Real data measured	Score	Source
Ecosystem structure	Biotic diversity	Vegetation cover	Vegetation cover	%	0 to 65% per plot in different types of dunes (embryonic, white and grey dunes) average 30-35% for the whole polygon	4	Meshinev et al. 1994; Tzonev et al. 2005, database for Natura 2000 sites in Bulgaria; field observations

Indicator type	Indicator group	Indicator	Parameter	Units	Real data measured	Score	Source
Ecosystem structure	Biotic diversity	Plant diversity	Plant species richness	Number of species	1 to 13 per plot in different types of dunes (embryonic, white and grey dunes)	5	Meshinev et al. 1994; Tzonev et al. 2005, database for Natura 2000 sites in Bulgaria; field observations
		Animal diversity	Animal species richness	Number of species	No data	-	No data found
		Red list species	Red list species (plant/animal)	number of species per grid unit	12-22	4	Map in Red book of Bulgaria
		Alien and invasive species presence	Number of Alien and invasive species	Number per unit area	3	4	field observations
	Abiotic heterogeneity	Disturbance regime	Pollution	number of dump sites	0	5	Field observation data
Ecosystem processes	Matter budget	Matter storage	Biomass	Estimation/ Assessment by available data	No data	-	No available data

$$\Sigma ni = 27;\ \Sigma n_i(max) = 30\ ;\ n = 6$$

$$IP = (27/30) = 0.9$$

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 (Σn_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:

$\Sigma n_i / \Sigma n_i(max)$

Where:

Σn_i – sum of parameter assessment

$\Sigma n_i(max)$ – sum of the maximum of parameter assessment (i.e. nx5)

IP – is a real number with values between 0 and 1

The IP assessment scores for the different conditions of the target ecosystem's polygon are as follows:

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

In our case the ecosystem condition is 0,9 – very good

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:

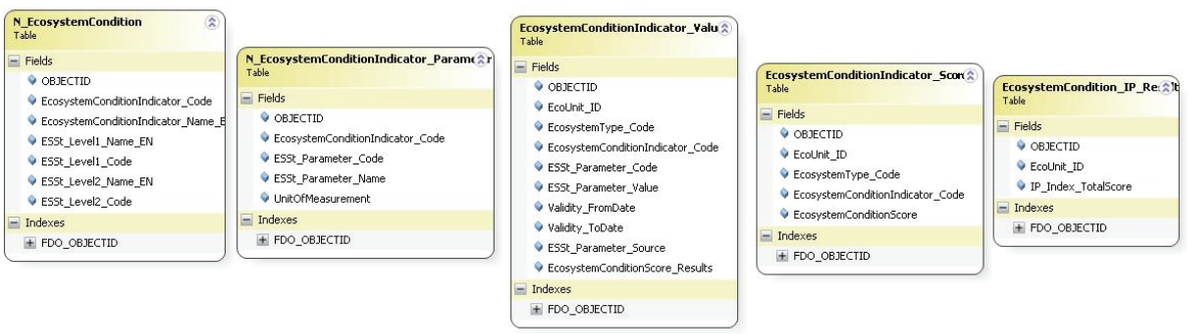


Figure 2: Ecosystem Condition Database Schema

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

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

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

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

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

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

5.2.5. Metadata

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

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

6. Assessment of ecosystem services

6.1. Identification of indicators, parameters, data

Selection and definition of ecosystem services indicators of sparsely vegetated land ecosystems is based on the classification of ecosystem services delivered by forests, agroecosystems (and grasslands) ecosystems as developed in the second MAES report (2014) on the base of CICES ver. 4.3. Classification.

Data availability for some of the indicators needed for sparsely vegetated ecosystems are limited. International and national database can be used, having into consideration that those indicators with institutional support have better data availability overall.

The most relevant and important ESs from the perspective of regional land use planning in the sparsely vegetated lands are selected in the following ESs divisions listed below in Table 7 according to the relevant group code: P – Provisioning, R – Regulating and maintenance and C – Cultural. A set of proposed indicators of ecosystem services, which could be applied in assessment and mapping of ESs in sparsely vegetated areas is presented in Table 7. Experts could propose additional (optional) indicators of ecosystem services if their application is required for the specific case-study region, well argument and ensured with data.

Provisioning services

For sparsely vegetated land to provide food, feed, fibres, etc is not a primary role. Probably, providing the wild animals and their outputs is the main ecosystem service in this group. Providing of materials (e.g. medicinal plants, lichens) is optional to be considered.

Regulating/Maintenance Services

Sparsely vegetated land ecosystems have a relatively low 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.

Cultural services

Cultural manifestations of the link between human society and sparsely vegetated lands are numerous and very different throughout the EU, especially for intellectual and spiritual ecosystem services. Moreover, due to this variety, and also due to some methodological and practical difficulties in the EU wide mapping of this type of services (often surveys are needed), only a few indicators are readily available in monitoring frameworks. The mapping of physical interaction services is based on indicators describing the experiential use people make of sparsely vegetated lands. 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 birdwatchers. 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. The number of photos of this ecosystems uploaded on websites is becoming an option for estimation spiritual and emblematic services. Sparsely vegetated land ecosystems included in conservation or protection programmes on the basis of their importance for the maintenance of biodiversity and other cultural values (e.g. NATURA2000, 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.

Table 7. Indicators for assessing and mapping of Ecosystem Services in Sparsely vegetated land ecosystems

Section	Division	Group	Class *(codes CICES)*	Indicator	Parameters and units	Data sources	*% error*
Provisioning	Nutrition	Biomass	P1. Wild animals and their outputs (1114)	Heads of wild animals for hunting	Number of species	Statistics; Ecosystem condition assessment	
Regulation and Maintenance	Maintenance of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	R1. Pollination and seed dispersal (2311)	Pollination potential	scale	1. Joint Research Center - IES; 2. Expert knlowledge	
			R2. Maintaining nursery populations and habitats (2312)	Biodiversity maintaining	total of species biodiversity	Ecosystem condition assessment	
Cultural	Physical and intellectual interactions with biota, ecosystems, and land-/seascapes [environmental settings]	Physical and experiential interactions	C1. Experiential use of plants, animals and land-/seascapes in different environmental settings and Physical use of land-/seascapes in different environmental settings (3111, 3112)	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.)	national data	
		Intellectual and representative interactions	C2. Scientific (3121)	Scientific interest	Amount of scientific studies 1. number of published papers; 2. number of projects	WEB, libraries	
			C3. Educational (3122)	Education potential	1. number of educational activities (festivals, visiting centers, green school, etc.) per year	national data	
			C4. Heritage, cultural (3123)	Cultural interaction	1. number of monuments or products from traditional management of landscapes	national data	

Section	Division	Group	Class *(codes CICES)*	Indicator	Parameters and units	Data sources	*% error*
			C5. Entertainment (3124)	Entertainment events potential (Festivals and other cultural events)	1. number of events per year	national data	
			C6. Aesthetic (3125)	Aestetic experience	number of photos uploaded in Google Earth	WEB	
	Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes [environmental settings	Spiritual and/or emblematic	C7. Symbolic (3211)	Symbolic species	number of species	national data	
			C8. Sacred and/or religious (3212)	Sacred and religious tourism	1. number of monasteries, churches, places	nationaal data	
		Other cultural outputs	C9. 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.

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 is dependent 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.

Step 1: Indicators for Ecosystem services assessment for sparsely vegetated lands

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.

Sparsely vegetated lands take a low part in regulating and maintenance process. 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 Sparsely vegetated land 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. The experts should collect available data by relevant parameter or indicator, including ecosystem condition assessment for the defined class of ecosystem service. Depending on the specific case and availability of data, each ecosystem services class could be assessed by a different number of indicators and parameters respectively or complex of indictors, defined by the experts. Additional (optional) parameters and/or indicators could be proposed for the specific case-study if enough informative.

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.

The following data sources are to be 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 Coastal dunes and sandy shores ecosystem located between Hadzhijska river and hotel Burgas in Sunny beach resort. This is the same case study used for assessing of ecosystem condition above.

Table 8. Data table for Sparsely vegetated land ecosystem services - example

Ecosystem services Section	Ecosystem services Class	Indicator/Parameter/ Units	Actual data for the current ecosystem polygon	Source
Provisioning	P1. Wild animals and their outputs (1114)	Heads of wild animals for hunting[number/ha]	Not relevant for the polygon	-
Regulation & Maintenance	R1. Pollination and seed dispersal (2311)I	Pollination potential [scale]	No data found	-
	R2. Maintaining nursery populations and habitats (2312)	Biodiversity maintaining	80 species	ES condition data
	C1. Experiential use of plants, animals and land-/seascapes	Wilderness experiences 1. Number of visitors (e. g. tourists, birdwatch, plantwatch, etc.) per year; 2. Number of activities	> 1000 tourists per year	Data from hotels

Ecosystem services Section	Ecosystem services Class	Indicator/Parameter/ Units	Actual data for the current ecosystem polygon	Source
Cultural	C1. Experiential use of plants, animals and land-/seascapes	(e.g. farm tourism, walking and biking traits, etc.) [Number per year]		
	C2. Scientific (3121)	Scientific interest Amount of scientific studies [number of published papers, number of projects]	4 published scientific papers and 2 mapping projects	Scientific literature
	C3. Educational (3122)	Education potential Number of educational activities (festivals, visiting centers, green school, etc.) [number of activities per year]	3 green school	Data from hotels
	C4. Heritage, cultural (3123)	Cultural interaction number of monuments or products from traditional management of landscapes [number]	0	
	C5. Entertainment (3124)	Entertainment events potential (Festivals and other cultural events) [number of activities per year]	2	Data from hotels and tour operators
	C6. Aesthetic (3125)	Aestetic experience aesthetic landscapes [number of photos uploaded in Google Earth]	51	Web data
	C7. Symbolic (3211)	symbolic species [number]	0	
	C8. Sacred and/or religious (3221)	Sacred and religious tourism Number of monasteries, churches, places [number]	0	
	C9. Existence (3221)	Conservation significance Number of sites in protected areas (e.g. Natura2000, Biosphere reserves, etc.)	2	Data base of MOEW

Step 3: How to assess

The applicants should collect precise data by each parameter and further on it will be subject of valuation. There are various methods for ecosystem services assessment but common standards require being quantifiable, replicable and affordable. Burkhard et al. (2012) proposed general matrix for ecosystem service demands and provisions including all main ecosystem types presented by land cover classes and selection of ecosystem services. This matrix could be applied at national and regional levels for decision making. For more accurate estimation, also for valuation economic potential, it should be considered that each service type is dependent on two factors: ecosystem area and ecosystem condition. The better condition and larger area is related with higher value of service which should be provided. It is not appropriate to compare between services as they are represented by different measurements therefore the scoring scheme proposed by Burkhard et al. (2012) gives the opportunity to transform all assessment scores into one unified system applicable for all ecosystems. This necessitates to develop a procedure for transformation of quantitative data from different sources and different units into such unified scoring system. The assessment scale consists of six from 0 to 5. A 0-score indicates that there is no relevant capacity to supply particular services and a 5-score indicates the highest relevant capacity for the supply of these services. Scores of 2, 3 and 4 represent respective intermediate capacities. In our case 0-score will be assigned for ecosystems that are not relevant for particular service therefore there is no capacity. For the other ecosystems the 1 to 5 scores will be assigned.

Filling the data matrix will allow set up the dimensions of each indicator's parameter. Applicant should analyze the dimensions obtained and to elaborate appropriate scoring system. Scores are assigned on the basis of group consensus after discussions. The dimensions of the intervals depend on the specific characteristics of the indicator and should be defined by the expert based on scientifically sound approach. The scores 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 scores should be filled in the corresponding field in table 9.

Table 9. Scoring table for ecosystem service assessment

Ecosystem services						**Assessment score**					
Section	**Division**	**Group**	**Class (CICES codes)**	**Indicator**	**Parameter's Units**	**Score 0** (not relevant)	**Score1** (low relevant capacity)	**Score2** (relevant capacity)	**Score3** (medium relevant capacity)	**Score4** (high relevant capacity)	**Score5** (very high relevant capacity)
Provisioning	Nutrition	Biomass	1114	P1.Heads of wild animals for hunting	Number of species	0	1	2-4	5-7	8-10	>10
Regulation & Maintenance	Maintenance of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	2311	R1.Pollination potential	scale	0	1	2	3	-	-
			2312	R2.Biodiversity maintaining	number	0	1-11	12	13-16	17-20	⩾21

Ecosystem services						Assessment score					
Cultural	Physical and intellectual interactions with biota, ecosystems, and land-/seascapes [environmental settings]	Physical and experiential interactions	3111, 3112	C1.Wilderness experiences	Number per year	0	1-2	3	4-6	7-8	⩾9
		Intellectual and representative interactions	3121	C2. Scientific interest	Number	0	1-9	10-11	12-20	21-30	⩾31
			3122	C3.Education potential	Number	0	1-2	3	4-6	7-8	⩾9
			3123	C4. Cultural interaction	Number	0	1	2	3	4	⩾5
			3124	C5. Entertainment events potential	Number per year	0	1	2	3	-	-
			3125	C6. Aestetic experienc	Number	0	1	2	3	4	⩾5
	Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes [environmental settings	Spiritual and/or emblematic	3211	C7. Symbolic species	Number	0	1	2	3-4	5-6	⩾7
			3212	C8. Sacred and religious tourism	Number	0	1 (up to 2km far from the ecosystem)	1 (up to 100 m far from the ecosystem)	1 (in the ecosystem)	⩾2	⩾2 (in the ecosystem)
		Other cultural outputs	3221	C9. Conservation significance	number	0	1 (up to 2 km far from the ecosystem)	1 (up to 100 m far from the ecosystem)	1 (partly overlaped with ecosystem)	1 (absolutely overlaped with ecosystem)	⩾2 (in the ecosystem)

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.

The proposed example relates to the Coastal dunes and sandy shores ecosystem located between Hadzhijska river and hotel Burgas in Sunny beach resort. This is the same case study used for assessing of ecosystem condition above.

Table 10. Matrix of scores given to each Class of ESs presented by ES/ES subtype – Example of scoring

Ecosystem subtype	Coastal dunes and sandy shores ecosystem	**ESs capacity Score**
ESs class code	P1	0
	R1	1
	R2	4
	C1	5
	C2	4
	C3	2
	C4	1
	C5	2
	C6	4
	C7	1
	C8	0
	C9	2

0 = not relevant ; 1 = low relevant capacity, 2 = relevant capacity, 3 = medium relevant capacity, 4 = high relevant capacity and 5 = very high relevant capacity

Each ecosystem service relevant to and provided by sparsely vegetated ecosystems then should be assessed at national level. After analysing information for the listed indicators, describing relevant ecosystem services for different types of sparsely vegetated ecosystems, the lowest and the highest values should be determined at national level. The assessment score of relevant class of ecosystem service is the basis for further mapping of the real capacity of sparsely vegetated ecosystem to supply specific ES at national level as shown in Table 10.

Step 4. Fullfill the matrix

The ecosystem service matrices consist of ecosystem services (currently 1 provisioning, 2 regulating and 9 cultural services; according to Tables 7) on the y-axis are ecosystem services and on the x-axis are ecosystem types on level 3. At the intersections, the different sparsely vegetated ecosystems sub-type for realized ecosystem service supply should be assessed on a scale from 0 (no relevant supply) to 5 (maximum relevant supply) for a hypothetical 'normal' sparsely vegetated ecosystem defined by the experts at regional (national) level after completing step 3, having into consideration the complexity of ecosystems and their specifics. The score (1 to 5) obtained in Table 10 should be used as a basis to define the scores for each ecosystem service and the relevant ecosystem subtypes and the results should be filled in table 11. All services which are defined as not relevant for particu-

lar sparsely vegetated ecosystem subtypes (see annex 7) will have 0 score in table 11. Furthermore, the ecosystem services marked as “not supported by data’’ will have 0 score. This indicates that they have no relevant capacity at the time of the assessment due to the lack of data but could have higher scores in future assessments. The normalization to this relative 0-5 scale aims at making different ecosystem services (measured and assessed by various indicators and units) comparable with each other. The values obtained in the matrix are useful for detailed mapping of pilots and monitored regions (see Monitoring Guide). It should be underlined that these values are indicative only for sparsely vegetated ecosystems

The following table 11 presents an example matrix. The scores are expert evaluations and are based on a combination of expert judgement/experience with statistical data.

Table 11. Summarized data for the sparsely vegetated ecosystem subtypes at national level (example values are given in the first row).

		Sparsely vegetated ecosystem subtypes				
		Coastal dunes and sandy shores	Coastal shingle	Costal Rock cliffs, ledges and shores, including the supralittoral	Screes	Inland cliffs, rock pavements and outrcrops
ESs class codes CICES	1111	0	0	0	0	0
	1112					
	1113					
	1114					
	1115					
	1116					
	1121					
	1122					
	1211					
	1212					
	1213					
	1221					
	1222					
	1311					
	1312					
	.....					
	.....					
	3221					
	3222					

The assessment scale reaches: 0 = no relevant capacity of the current sparsely vegetated ecosystem 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

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:

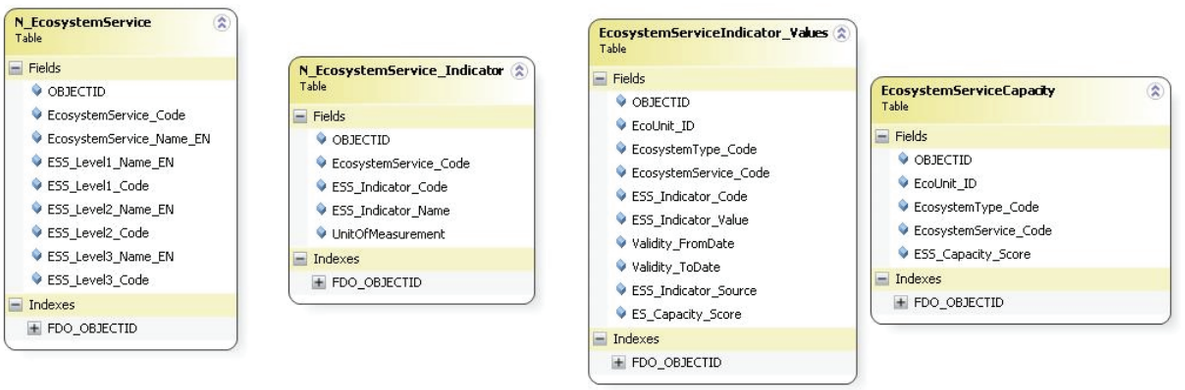


Figure 3: Ecosystem Services Database Schema

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_NOMENCLATURES_XLS / N_EcosystemService_Indicator.xls. It has the following fields:

- EcosystemService_Code: integer codes for ecosystem service at level 4;
- ESS_Indicator_Code: integer codes for indicators used to assess the ecosystem services at level 4;
- ESS_Indicator_Name: name of indicators used to assess the ecosystem services at level 4;
- UnitOfMeasurement: units of measurement for each indicator.

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

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

- EcoUnit_ID: field to relate with the feature class;
- EcosystemType_Code: integer codes for ecosystem types at level 3;
- EcosystemService_Code: integer codes for ecosystem service at level 4;
- ESS_Indicator_Code integer codes for indicators used to assess the ecosystem services at level 4;
- ESS_Indicator _Value: value of calculated indicator used to assess the ecosystem service at level 4;
- Validity_FromDate: starting date for validity of the indicator;
- Validity_ToDate: end date for validity of the indicator;
- ESS_Indicator_Source: free text to describe the source of the data used to calculate the value of the indicator;
- ES_Capacity_Score: calculated value for ES; how to define the score for each indicator is explained in Chapter 6.2. / Step 1;

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

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

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

- EcoUnit_ID: field to relate with the feature class;
- EcosystemType_Code: integer codes for ecosystem types at level 3;

- EcosystemService_Code: integer codes for ecosystem service at level 4;
- ESS_Capacity_Score: final score for each service calculated on the bases of all indicators selected for its evaluation. The values here should be between 1 and 5 and 0 for not relevant capacity;

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

6.3.3. Accuracy and validation

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

6.3.4. Digital Maps for Ecosystem Services

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

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

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

At least one set of maps for the ecosystem services should be prepared. The maps representing the results for calculating the ecosystem services capacity is mandatory. 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-B6

Terms and definitions

Term	Definition
Aerohaline communities	Plant communities at the coastal areas affected by salt water spray of waves
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 areas.
Habitat	Terrestrial or aquatic areas distinguished by geographic, abiotic and biotic features, whether entirely natural or seminatural.
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.
Psammophyte	A plant that grows in sand or sandy soil
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).
Scree vegetation	Vegetation developed at broken rock fragments
Shingle beach	A shingle beach is a beach which is armored with pebbles or small- to medium-sized cobbles (as opposed to fine sand).
Species diversity	Number of species for specified area
Supralittoral	Zone at the boundary between the sea and the land, occasionally covered by water
Vegetation cover	the observed plant cover on the earth's surface

Annex 2-B6

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-B6

Table of ecosystem types

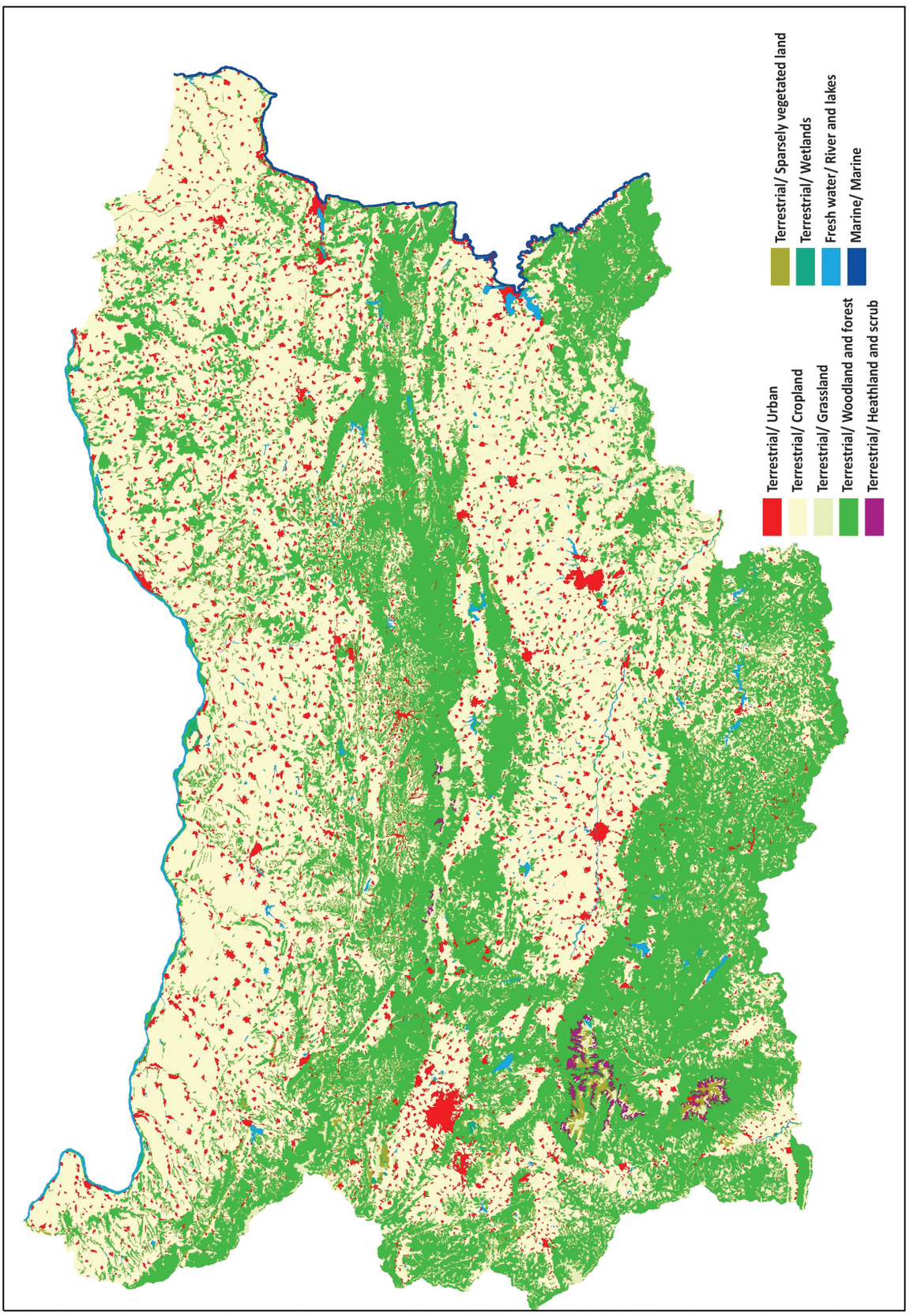
Level 1 (Major ecosystem category)	Level 2 (Sub-classes)	Methodology part
Terrestrial	Urban	B1
	Cropland	B2
	Grassland	B3
	Woodland and forest	B4
	Heathlands and shrubs	B5
	Sparsely vegetated land	**B6**
	Wetlands	B7
Rivers and lakes	Rivers and lakes	B8
Marine	Marine	B9

Sparsely

Level 3 Name	Level 3 Description
Coastal dunes and sandy shores	Sand-covered shorelines of the Black Sea, fashioned by the action of wind or waves. This group includes all types of dune system (embryonic, white, grey dunes etc.) and also sandy beaches used for recreation. Vegetation cover vary from sparsely distributed individuals of *Eryngium maritimum*, *Cakile maritima*, *Salsola ruthenica* etc. close to water-line, throw open and semi-open psammophyte communities to the closed communities rich of mosses and lichens in inner parts
Coastal shingle	Beaches covered by pebbles, or sometimes boulders, usually formed by wave action. On some places with accumulations of drift material, sandy gravels and gravels rich in nitrogenous organic matter occur very open, low formations of annuals and perennials.
Costal rock cliffs, ledges and shores, including the supralittoral	Herbaceous aerohaline communities of the sea-cliffs of the maritime facade of the Stranja, Cape Kaliakra and other areas of Bulgarian Pontic coast, with *Limonium gmelinii*, *Goniolimon collinum*, *Crithmum maritimum*, *Elymus pycnanthus, Cichorium intybus, Atriplex hastata, Kochia prostrata, Convolvulus lineatus*, etc. and the local endemic, as *Silene caliacrae*.
Screes	Accumulations of boulders, stones, rock fragments, pebbles, gravels or finer material, of non-aeolian depositional origin, unvegetated, occupied by lichens or mosses, or colonized by sparse herbs or shrubs. Included screes and scree slopes produced by slope processes, moraines and drumlins originating from glacial deposition. They are represented predominantly in high mountain and mountain belt. A very few pathes form in lowland areas.
Inland cliffs, rock pavements and outrcrops	Unvegetated, sparsely vegetated, and bryophyte- or lichen-vegetated cliffs, rock faces and rock pavements in inland areas.

Annex 4-B6

Map of ecosystem types



Annex 5-B6

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 organic matter	
		Hydrological heterogeneity	Hydrological heterogeneity	
		Geomorphological heterogeneity	Geomorphological heterogeneity	
		Disturbance regime	Soil erosion risk	
			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)	
		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**			
Provisioning	Nutrition	Biomass	Cultivated crops			
			Reared animals and their outputs			
			Wild plants, algae and their outputs	Primary biomass production for food	t/ha	Statistics; Ecosystem condition assessment
			Wild animals and their outputs	number of species for hunting	number/ha OR nimber per poligon	Statistics; Ecosystem condition assessment
			Plants and algae from in-situ aquaculture			
			Animals from in-situ aquaculture			
		Water	Surface water for drinking			
			Ground water for drinking			
	Materials	Biomass	Fibres and other materials from plants, algae and animals for direct use or processing			
			Materials from plants, algae and animals for agricultural use			
			Genetic materials from all biota			
		Water	Surface water for non-drinking purposes			
			Ground water for non-drinking purposes			
	Energy	Biomass-based energy sources	Plant-based resources for energy			
			Animal-based resources			
		Mechanical energy	Animal-based energy			
Regulation & Maintenance	Mediation of waste, toxics and other nuisances	Mediation by biota	Bio-remediation by micro-organisms, algae, plants, and animals			
			Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals			
		Mediation by ecosystems	Filtration/sequestration/storage/accumulation by ecosystems			
			Dilution by atmosphere, freshwater and marine ecosystems ecosystems			
			Mediation of smell/noise/visual impacts			
	Mediation of flows	Mass flows	Mass stabilisation and control of erosion rates			
			Buffering and attenuation of mass flows			
		Liquid flows	Hydrological cycle and water flow maintenance			
			Flood protection			
		Gaseous / air flows	Storm protection			
			Ventilation and transpiration			

Ecosytem services indicators						
				Indicator	Parameters and units	Data sources
Section	**Division**	**Group**	**Class**			
Regulation & Maintenance	Maintenance of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	Pollination and seed dispersal	pollination potential	scale	Joint Research Center - IES
			Maintaining nursery populations and habitats	Biodiversity maintaining	total of species biodiversity	Ecosystem condition assesment
		Pest and desease control	Pest control			
			Disease control			
		Soil formation and composition	Weathering processes			
			Decomposition and fixing processes			
		Water conditions	Chemical condition of freshwaters			
			Chemical condition of salt waters			
		Atmospheric composition and climate regulation	Global climate regulation by reduction of greenhouse gas concentrations			
			Micro and regional climate regulation			
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	Wilderness experiences	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	Wilderness experiences	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	Scientific interest	number of published papers, number of projects	WEB, libraries
			Educational	Education potential	number of activities per year	national data
			Heritage, cultural	Cultural interaction	number of monuments/products	national data
			Entertainment	Entretaiment events potential (Festivals and other cultural events)	number of activities per year	national data
			Aesthetic	Aestetic experience	number of photos uploaded in Google Earth	WEB
	Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes [environmental settings]	Spiritual and/or emblematic	Symbolic	Symbolic speciess	number of species	national data
			Sacred and/or religious	Sacred and religious tourism	number of monasteries, churches, places	national data
		Other cultural outputs	Existence	Conservation significance	Overlaping with protected areas (e.g. NATURA2000, Biosphere reserves,etc.	national data, MOEW
			Bequest			

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

Annex 6-B6

Ecological condition indicators - Sparsely vegetated land

Ecological condition indicator			B1 - Coastal dunes and sandy shores					
Indicator type	***Indicator group***	***Indicator***	***Parameter***	***Dimentions (units)***	***Available data (Y/N)***	***New data needed (tick by "V")***	***Periodicity of measurring (years etc.)***	
Ecosystem structure	Biotic diversity	Vegetation cover	Vegetation cover	%	Y	V	3 years	primary
		Plant diversity	Plant species richness	Number of species per sample plot	Y	V	3 years	primary
		Animal diversity	Animal species richness	number of species	Y	V	3 years	primary
		Red list species	Number of red list species (plant/animal)	number of species	Y		3 years	primary
		Alien and invasive species presence	number of alien and invasive species	number of species	Y		3 years	
		Other biotic diversity indicators (for example, naturalness, habitat diversity, etc.)						optional
	Abiotic heterogeneity	Soil heterogeneity	Soil quality					N/A
			Soil organic matter					N/A
		Hydrological heterogeneity	Hydrological heterogeneity					N/A
		Geomorphological heterogeneity	Geomorphological heterogeneity					optional
		Disturbance regime	Soil erosion risk					N/A
			Pollution	Number of dump sites	Y		5 years	primary
			Fire					optional
		Other abiotic heterogeneity indicators						optional

Ecological condition indicator			B1 - Coastal dunes and sandy shores					
Indicator type	***Indicator group***	***Indicator***	***Parameter***	***Dimentions (units)***	***Available data (Y/N)***	***New data needed (tick by "V")***	***Periodicity of measurring (years etc.)***	
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	3 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	Precipitation					optional
		Efficiency measures	Efficiency measures					optional

Ecological condition indicator			B2 - Coastal shingle					
Indicator type	***Indicator group***	***Indicator***	***Parameter***	***Dimentions (units)***	***Available data (Y/N)***	***New data needed (tick by "V")***	***Periodicity of measurring (years etc.)***	
Ecosystem structure	Biotic diversity	Vegetation cover	Vegetation cover	%	Y	V	3 years	primary
		Plant diversity	Plant species richness	Number of species per sample plot	Y	V	3 years	primary
		Animal diversity	Animal species richness	number of species	Y	V	3 years	primary
		Red list species	Number of red list species (plant/animal)	number of species	Y		3 years	primary
		Alien and invasive species presence	number of alien and invasive species	number of species	Y		3 years	
		Other biotic diversity indicators (for example, naturalness, habitat diversity, etc.)						optional
	Abiotic heterogeneity	Soil heterogeneity	Soil quality					N/A
			Soil organic matter					N/A
		Hydrological heterogeneity	Hydrological heterogeneity					N/A
		Geomorphological heterogeneity	Geomorphological heterogeneity					optional
		Disturbance regime	Soil erosion risk					N/A
			Pollution	Number of dump sites	Y		5 years	primary
			Fire					optional
		Other abiotic heterogeneity indicators						optional

Ecological condition indicator			B2 - Coastal shingle					
Indicator type	***Indicator group***	***Indicator***	***Parameter***	***Dimentions (units)***	***Available data (Y/N)***	***New data needed (tick by "V")***	***Periodicity of measurring (years etc.)***	
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	3 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	Precipitation					optional
		Efficiency measures	Efficiency measures					optional

Ecological condition indicator			B3 - Costal rock cliffs, ledges and shores, including the supralittoral					
Indicator type	***Indicator group***	***Indicator***	***Parameter***	***Dimentions (units)***	***Available data (Y/N)***	***New data needed (tick by "V")***	***Periodicity of measurring (years etc.)***	
Ecosystem structure	Biotic diversity	Vegetation cover	Vegetation cover	%	Y	V	3 years	primary
		Plant diversity	Plant species richness	Number of species per sample plot	Y	V	3 years	primary
		Animal diversity	Animal species richness	number of species	Y	V	3 years	primary
		Red list species	Number of red list species (plant/animal)	number of species	Y		3 years	primary
		Alien and invasive species presence	number of alien and invasive species	number of species	Y		3 years	
		Other biotic diversity indicators (for example, naturalness, habitat diversity, etc.)						optional
	Abiotic heterogeneity	Soil heterogeneity	Soil quality					N/A
			Soil organic matter					N/A
		Hydrological heterogeneity	Hydrological heterogeneity					N/A
		Geomorphological heterogeneity	Geomorphological heterogeneity					optional
		Disturbance regime	Soil erosion risk					N/A
			Pollution	Number of dump sites	Y		5 years	primary
			Fire					optional
		Other abiotic heterogeneity indicators						optional

Ecological condition indicator			B3 - Costal rock cliffs, ledges and shores, including the supralittoral					
Indicator type	***Indicator group***	***Indicator***	***Parameter***	***Dimentions (units)***	***Available data (Y/N)***	***New data needed (tick by "V")***	***Periodicity of measurring (years etc.)***	
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	3 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	Precipitation					optional
		Efficiency measures	Efficiency measures					optional

Ecological condition indicator			H2 - Screes					
Indicator type	***Indicator group***	***Indicator***	***Parameter***	***Dimentions (units)***	***Available data (Y/N)***	***New data needed (tick by "V")***	***Periodicity of measurring (years etc.)***	
Ecosystem structure	Biotic diversity	Vegetation cover	Vegetation cover	%	Y	V	3 years	primary
		Plant diversity	Plant species richness	Number of species per sample plot	Y	V	3 years	primary
		Animal diversity	Animal species richness	number of species	Y	V	3 years	primary
		Red list species	Number of red list species (plant/animal)	number of species	Y		3 years	primary
		Alien and invasive species presence	number of alien and invasive species	number of species	Y		3 years	
		Other biotic diversity indicators (for example, naturalness, habitat diversity, etc.)						optional
	Abiotic heterogeneity	Soil heterogeneity	Soil quality					N/A
			Soil organic matter					N/A
		Hydrological heterogeneity	Hydrological heterogeneity					N/A
		Geomorphological heterogeneity	Geomorphological heterogeneity					optional
		Disturbance regime	Soil erosion risk					N/A
			Pollution	Number of dump sites	Y		5 years	primary
			Fire					optional
		Other abiotic heterogeneity indicators						optional

Ecological condition indicator			H2 - Screes					
Indicator type	***Indicator group***	***Indicator***	***Parameter***	***Dimentions (units)***	***Available data (Y/N)***	***New data needed (tick by "V")***	***Periodicity of measurring (years etc.)***	
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	3 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	Precipitation					optional
		Efficiency measures	Efficiency measures					optional

Ecological condition indicator			H3 - Inland cliffs, rock pavements and outrcrops					
Indicator type	***Indicator group***	***Indicator***	***Parameter***	***Dimentions (units)***	***Available data (Y/N)***	***New data needed (tick by "V")***	***Periodicity of measurring (years etc.)***	
Ecosystem structure	Biotic diversity	Vegetation cover	Vegetation cover	%	Y	V	3 years	primary
		Plant diversity	Plant species richness	Number of species per sample plot	Y	V	3 years	primary
		Animal diversity	Animal species richness	number of species	Y	V	3 years	primary
		Red list species	Number of red list species (plant/animal)	number of species	Y		3 years	primary
		Alien and invasive species presence	number of alien and invasive species	number of species	Y		3 years	
		Other biotic diversity indicators (for example, naturalness, habitat diversity, etc.)						optional
	Abiotic heterogeneity	Soil heterogeneity	Soil quality					N/A
			Soil organic matter					N/A
		Hydrological heterogeneity	Hydrological heterogeneity					N/A
		Geomorphological heterogeneity	Geomorphological heterogeneity					optional
		Disturbance regime	Soil erosion risk					N/A
			Pollution	Number of dump sites	Y		5 years	primary
			Fire					optional
		Other abiotic heterogeneity indicators						optional

Ecological condition indicator			H3 - Inland cliffs, rock pavements and outrcrops					
Indicator type	***Indicator group***	***Indicator***	***Parameter***	***Dimentions (units)***	***Available data (Y/N)***	***New data needed (tick by "V")***	***Periodicity of measurring (years etc.)***	
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	3 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	Precipitation					optional
		Efficiency measures	Efficiency measures					optional

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

Annex 7-B6

Ecosystem services indicators

Section	Division	Group	Class	CICES codes	Indicator	Parameters and units	Data sources	Sparsely vegetated land: B1. Coastal dunes and sandy shores	B2. Coastal shingle	B3. Costal Rock cliffs, ledges and shores, including the supralittoral	H2. Screes	H3. Inland cliffs, rock pavements and outcrops
1. Provisioning	1. Nutrition	1. Biomass	1. Cultivated crops	1111								
			2. Reared animals and their outputs	1112								
			3. Wild plants, algae and their outputs	1113								
			4. Wild animals and their outputs	1114	1. Heads of wild animals for hunting	1. number of species for hunting	1. Statistics; 2. Ecosystem condition assessment	X	X	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								
			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								

								Sparsely vegetated land				
Section	Division	Group	Class	CICES codes	Indicator	Parameters and units	Data sources	B1. Coastal dunes and sandy shores	B2. Coastal shingle	B3. Costal Rock cliffs, ledges and shores, including the supralittoral	H2. Screes	H3. Inland cliffs, rock pavements and outrcrops
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								
			2. Buffering and attenuation of mass flows	2212								
		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	1. Joint Research Center - IES; 2. Expert knlowledge	X	X	X	X	X
			2. Maintaining nursery populations and habitats	2312	1. Biodiversity maintaining	1. total of species biodiversity	Ecosystem condition assessment	X	X	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	Soil formation					X		X
			2. Decomposition and fixing processes	2332								
		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								

								Sparsely vegetated land				
Section	**Division**	**Group**	**Class**	**CICES codes**	**Indicator**	**Parameters and units**	**Data sources**	**B1. Coastal dunes and sandy shores**	**B2. Coastal shingle**	**B3. Costal Rock cliffs, ledges and shores, including the supralittoral**	**H2. Screes**	**H3. Inland cliffs, rock pavements and outrcrops**
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,	1. national data	X	X	X	X	X
			2. Physical use of land-/seascapes in different environmental settings	3112								
		2. Intellectual and representative interactions	1. Scientific	3121	1. Scientific interest	Amount of scientific studies 1. number of published papers; 2. number of	1. WEB; 2.libraries	X	X	X	X	X
			2. Educational	3122	1. Education potential	1. number of educational activities (festivals, visiting centers, green school, etc.)	1. national data	X	X	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	X	X
			4. Entertainment	3124	1. Entretaiment events potential (Festivals and other cultural	1. number of events per year	1. national data	X	X	X	X	X
			5. Aesthetic	3125	1. Aestetic experience	1. number of photos uploaded in Google Earth	1. WEB	X	X	X	X	X

Annex 8-B6

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Annex 9-B6

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/