Methodology

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

Part B3

ES Types (Level 1/ Level 2)	Methodology Part
Terrestrial/ Urban	B1
Terrestrial/ Cropland	B2
Terrestrial/ Grassland	**B3**
Terrestrial/ Woodland and forest	B4
Terrestrial/ Heathland and scrub	B5
Terrestrial/ Sparsely vegetated land	B6
Terrestrial/ Wetlands	B7
Fresh water/ River and lakes	B8
Marine/ Marine	B9

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Table of contents

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 **Grassland ecosystems;**
2. Assessing the **Grassland ecosystems' potential to deliver ecosystem services** (biophysical valuation).

The methodology is relevant to Grassland 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 status 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 grassland ecosystems

We consider "grassland ecosystem" as a natural or mostly seminatural vegetation type. It is part of farm holdings (pastures, meadows, hedges, ridges, field margins, buffer strips, uncultivated land, etc.). The ecosystems represent an integration of social and ecological systems, and can be considered from different disciplinary standpoints (social, economic, ecological). Grasslands include the lands used for production of natural resources for animal consumption as food, for production of fiber or for livestock services. The "grassland ecosystems" include dynamic associations of different plant species, intergated with livestock, other fauna, soils, water, and the atmosphere.

The proposed typology of "Grassland ecosystems" corresponds with the ecosystem classification of MAES (2013), combined with the habitat classification types of European Nature Information System (EUNIS). It is also related to some of 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 grassland ecosystems in Bulgaria

Level 1	Level 2	Level 3
Terrestrial	**Grassland**	E1. Dry grasslands
		E2. Mesic grasslands
		E3. Seasonally wet and wet grasslands
		E4. Alpine and subalpine grasslands
		E6. Inland salt steppes

2.2. Detailed ecosystem typology of grassland ecosystems in Bulgaria

A selection of EUNIS classification on level 2 is proposed for detailed typology as level 3 for target ecosystem type. Total number of 5 grassland types are selected. They correspond to levels "E1", "E2", "E3", "E4" and "E6" from EUNIS group "E". 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 are presented in Table 2.

Table 2. Descriptions of Grassland ecosystem subtypes (Level 3)

Subtype	Description	Nomenclature(s)
Dry grasslands	Dry lands dominated by grass or herbs mostly with low productivity but high species richness. They could be open or closed, arid, floristically rich, steppe-like, typically with species of genus *Stipa* and *Festuca*. In Bulgaria within this group are included also communities dominated by *Dichantium (Botriochloa) ischaemum*, *Chrysopogon gryllus* and *Poa bulbosa*. They are often semi-natural in term of origin, developed on places of termophile oak forests.	EUNIS – E1; Bondev (1991)-129, 130; HD 92/42/EEC – 6210, 6220, 6240, 6250, 6260, 62C0, 62A0,
Mesic grasslands	Lowland and montane mesotrophic and eutrophic pastures and hay meadows. They are generally more productive than dry grasslands. The soils are moistened by underground or surface water supplied by slope runoff. Species richness is generally high. Typical dominant species are *Arrhenatherum elatius, Festuca pratensis, Alopecurus pratensis, Trisetum flavescens*.	EUNIS E2 , Bondev (1991)- 26, 44, 73, 74, 148; HD 92/42/EEC – 6510, 6520
Seasonally wet and wet grasslands	Grasslands of occasionally flooded river terraces, of depressions where rain water collects. Very typical are humid meadows rich in clover (*Trifolium* spp.), mostly developed below the montane level.	EUNIS – E3; Bondev (1991)- 148; HD 92/42/EEC – 6410, 6420, 6430, 6440, 6510
Alpine and subalpine grasslands	Primary and secondary grass- or sedge-dominated communities of the alpine and subalpine levels. Part of these grasslands form dense, closed, chionophilous grasslands of acid substrates at the 1800-2500 m of high mountains.	EUNIS – E4; Bondev (1991)- 1, 2, 8, 9; HD 92/42/EEC –6150, 6170, 6230, 62D0

	These grasslands are usually submitted to pasture regimes. Particular group are alpine and subalpine grasslands of base-rich soils. Habitats with sparse vegetation on stony serpentine soils in the mountains occupy small area.	
Inland salt steppes	Salt steppes and their associated salt-tolerant herbaceous communities and other sub-halophyte plant communities. In Bulgaria large areas of halophyte vegetation occurs in south-eastern parts of country on plain territories with salty soils. Dominant species are *Puccinelia convoluta*, *Puccinelia distans*, *Camphorosma monspeliaca*, *Camphorosma annua*, *Crypsis aculeata*, *Elymus elongatus*, *Artemisia santonicum*, etc.	EUNIS-E6; Bondev (1991)- 146; HD 92/42/EEC –1340, 1530

3. Data availability

3.1. Existing data sources, gaps, uncertainty of data

For mapping and assessing of grassland 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 grassland ecosystem condition and services in the smaller scale. 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, cadaster, statistics). Available spatial and quantitative database for grassland 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, often using sub-national species distribution data and conservation indices.
In the tables proposed there is a list of parameters for primarily and optional indicators. Primary indicators are mandatory, while optional are those for which there are no data and additional investigations and/or case-studies are needed. The majority of these optional indicators are case-specific and could be produced by several research groups. Specific case is the pollination services, where no existing national data was identified although there 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 of part A of METHODOLOGY.

Table 3. *Sources of spatial and quantitative/qualitative database*

Ecosystem subtype	**DATABASE Sources – main stakeholders**	
	Spatial	**Quantitative/Qualitative**
Dry grasslands	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
Mesic grasslands	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
Seasonally wet and wet grasslands	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
Alpine and	Maps of Restored Property,	MOEW - CORINE project,

subalpine grasslands	MOEW - CORINE project, national data bases; NATURA 2000 mapping and database; Additional remote sensing data	national data bases; NATURA 2000 mapping and database; Scientific publications
Inland salt steppes	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 of ecosystem types

4.1. Description of the mapping procedure

The workflow for mapping of ecosystem types comprise several main steps:

- generation of vector dataset with representation of polygon features each of them containing information on level 3 ecosystem type;
- assembling the product in the geodatabase schema provided in the Annex 9 (Annex 9.00_EcosystemDatabase_Schema);
- validation of the product accuracies, 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 this section. As the outcome of each level 2 mapping project will be used for preparation of national dataset for ecosystem types at level 3, it is mandatory to follow each requirement described bellow.

4.2. Data format

Output data have to be delivered in GIS compatible vector format - geospatial standards of OGC and INSPIRE.

The vector format should be with polygon topology:

- One complete coverage in a single layer;

- The vector layer has to be delivered in topologically correct geometries: see Polygon rules in http://webhelp.esri.com/arcgisdesktop/9.3/index.cfm?TopicName=Topology_rules.

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 their geometric resolution, as well as the level of detailisation of 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:

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

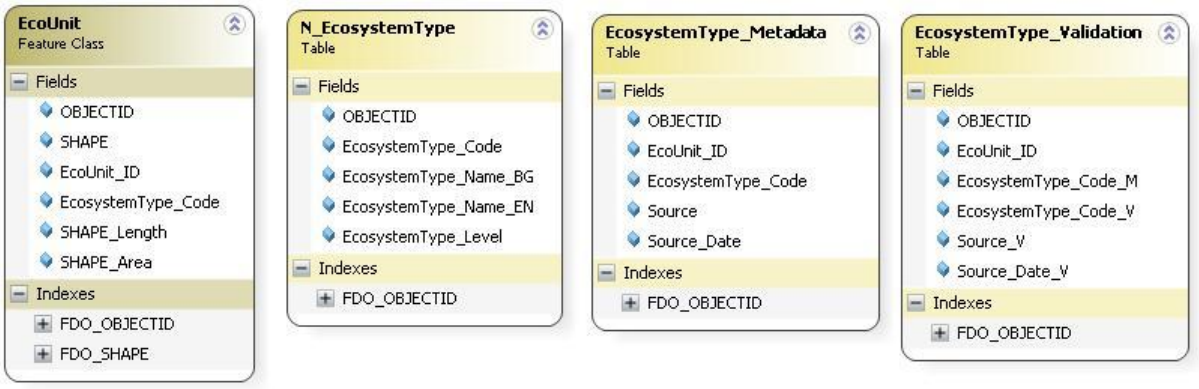
The minimum mapping area should be between 0.1 and 0.25 ha also depending on the source data used and ecosystem type mapped. The same apply for minimum mapping width for representing linear features: minimum 10 and up to 30m.

The Applicant should present in the proposal which scale and minimum mapping units will apply for each ecosystem type with description on the decision why the specific parameter has been chosen.

4.5. Data structure/schema

The data structure should follow the one provided in the Annex 9.00 – both on number of vector and tables delivered, as well as 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 Personnel DataBase format – OCG and INSPIRE compatible.

The schema of the database for the ecosystem types is the following:



The detailed technical description of the classes and tables of the ecosystem types database is provided in Annex 9.01_Schema_Report_ES_Database / 9.01_1_Schema_Report_ES_Types_Database.htm.

The main steps of generation of the geodatabase are the following:

- Feature Class “EcoUnit”: This is the vector file with polygon geometry 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 polygon should have unique ID;

- EcosystemType_Code: this field should contain 3 digit value of the ecosystem type at level 3. 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.

The Applicant should develop in details which data described in *Table 3. Sources of spatial and quantitative/qualitative database* will be used for extracting information for each ecosystem type. On the other hand the Applicant should take into account the description of the ecosystem type determined in *Table 2. Descriptions of Grassland ecosystem subtypes (Level 3).*

The Applicant could propose the use of other datasets for determination of ecosystem types at level 3, as well as applicable models to be implemented for data processing of existing/proposed and other data which to serve the same purpose.

- 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 applicant should propose scientifically sound approach which will be used for validation of the product thematic accuracy.

Apart from providing information in Table “EcosystemType_Validation”, the Applicant should generate Quality Control/Quality Check Reports for each ecosystem type.

The geometric accuracy is not a subject for validation process, as the Applicant should mainly rely on the quality of the available data. Although, if the Applicant will generate new vector data, or modify the existing ones, a methodology for validating the geometric accuracy should be proposed.

4.7. Digital Maps for Ecosystem Types

For each ecosystem at level 2 maps in scale 1:125 000 should be delivered in PDF and paper format, at size A2.

Each data frame should contain one cell from the EEA reference grid at 50km, hence 77 maps should be delivered 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. 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://projects.eionet.europa.eu/eea-ecosystem-assessments/library/draft-ecosystem-map-europe/map-ecosystem-types/download/en/1/Map%20of%20Ecosystem%20types.pdf

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, all of the level 3 grassland 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 coded 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

Each applicant should prepare map layout containing all the attributes for the Map of Ecosystem Types and deliver it for discussion. The final map layout which to be used for all the ecosystem mapping projects will be prepared and will be mandatory to be used for map generation.

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 grassland ecosystem condition

5.1. Assessment of Ecosystem condition (Grasslands)

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). In this regard grassland indicators cover agriculture and rural sector variables; agricultural policy variables; agricultural inputs and the environment; and agricultural output and trade. The impacts – both harmful and beneficial – of agriculture and agricultural policies on the environment are a major issue. 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 grasslands;
- assist policy makers to better understand the linkages between the causes and effects of the impact of grasslands 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.

A major challenge is to provide a solid conceptual and methodological basis to support the empirical analysis of agri-environmental linkages, especially in terms of quantifying the impact of agriculture on the environment. Amongst the specific characteristics of grasslands as a source of agricultural activities in relation to the environment the following are of particular importance:

- agricultural activities produce a diverse range of harmful and beneficial impacts on environmental quality. Farming can lead to deterioration in soil, water and air quality and the loss of habitats and biodiversity. But agricultural activity can contribute to environmental benefits such as acting as a sink for greenhouse gases, conserving and also enhancing biodiversity and landscape, and preventing flooding and landslides.
- the relationship between agricultural activities and the environment is frequently complex, site specific and non-linear. Agricultural activities can have impacts on the environment which are determined by different agro-ecological systems and physical attributes of the land, the prevailing economic conditions and production technology, and farmers' management practices in relation to natural conditions.

There are potentially a large number of indicators that could be developed to help quantify the various components and linkages between society and 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 agri-environmental issues as being of importance to policy makers. While the list of issues

is evolving and must be flexible so as to incorporate new issues or abandon old ones where is needed.

• analytical soundness - the criterion of analytical soundness concerns, in particular, the extent to which the indicator can establish links between agriculture activities and environmental conditions, and thus refers more specifically to the attributes which provide the basis to measure the indicator. It should also be possible for the indicator to explain a link between agriculture and an environmental issue which is easy to interpret and applicable to a wide set of farming systems. The indicator should also be able to show trends and ranges of values over time, which might be complemented by nationally defined targets and thresholds where these exist;

• primary data contribution and measurability - the criterion of measurability, relates to the appropriate data available to measure the indicator. The indicator should be developed from established national or sub-national data, scientific data and publications, data from other data sets available in third parties preferably using an expert based and long time series where this is available given the lengthy time period for many environmental effects to become apparent. Present work has revealed that while a considerable national 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. farm, sectoral, regional, national), the indicator can be meaningfully applied for policy purposes and not to conceal more than it reveals. This criterion highlights the issue of encapsulating the spatial and temporal diversity of the environment and the geographical scale of different environmental issues ranging from the single farm to the global scale. In many cases national agricultural 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 grassland ecosystems, their structure and functional processes. Among the proposed indicators, which are representative for conditions of all sub-types, the defined 17 specific indicators (6 primary and 11 optional) for assessing grassland 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 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 grassland habitat diversity the following primary indicators are proposed: *"Plant diversity",* *"Animal diversity",* *"Alien invasive species"* Plant and animal diversity indicators are of primary importance, positively correlated to the biotic diversity. Alien invasive species although contributing to the overall diversity are negatively correlated to the ecosystem condition. Possible (optional) indicators are: *"Other biotic diversity indicators (for example, naturalness, habitat diversity, etc.)".* The ecosystem service projects using other indicators, must define them consistently to the current methodology.
Abiotic heterogeneity	Spatial or temporal variability of abiotic resources and factors. To determine abiotic factors and abiotic heterogeneity in grasslands, the following primary indicators are proposed: *"Soil heterogeneity",* *"Disturbance regime"* Possible (optional) indicators are: *"Hydrological heterogeneity",* *"Geomorphological heterogeneity",* *"Other abiotic heterogeneity indicators"* The ecosystem service projects using other indicators, must define them consistently to the current methodology.
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 grasslands ecosystems possible (optional) indicators are: "*Energy balance (capture, storage)*", "*Metabolic efficiency*", "*Other energy budget indicators*" The ecosystem service projects using other indicators, must define them consistently to the current methodology.
Matter budget	Matter budget describes the cycle in which matter is transformed from one state to another within the components of grassland ecosystems. To account matter budget in grassland ecosystems the proposed primary indicator is : *"Matter storage"* Other possible (optional) indicators are: *"Matter balance (input, output)"* *"Element concentrations (other state variables)"* *"Efficiency measures"* The ecosystem service projects using other indicators, must define them consistently to the current methodology.
Water budget	The cyclical movement of water between the atmosphere and the ground surface at local scale of grassland areas, considering precipitation, evaporation, and runoff. The following indicators are possible (optional): *"Water balance (input, output)",* *"Water storage",* *"Efficiency measures"* The ecosystem service projects using other indicators, must define them consistently to the current methodology.

Step 2: Identify the parameters of each indicator

For the set of indicators describing grassland ecosystem condition different parameters of evaluation are proposed. They are listed in *Annex 1*. 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 grassland 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 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 grassland 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.

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

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*

Step 4: How to assess parameters – fulfill Table, as indicated below:

Table 5. Ecosystem conditions indicator assessment for grassland ecosystems

GRASSLANDS ECOSYSTEMS										
Ecological condition indicators		**Parameter**	**Unit**	**Measurement approach**	**Periodisity of measuring (years)**	**Assessment scale**				
						Score 1 (very bad)	**Score 2 (bad)**	**Score 3 (moderate)**	**Score 4 (good)**	**Score 5 (very good)**
Type	**Indicator Group**									
Ecosytem structure	**Biotic diversity**	Vegetation cover	percent	estimation	3	<10%	11-30%	31-50%	51-70%	>70%
		Plant species richness	number of species per sample plot area	Calculation	3	<5	6-10	11-20	21-30	>30
		Wild animal species richness	number of species per sample plot area	Calculation	3	<20	21-50	51-100	101-150	>150
		Red list species (plant/animal)	number of species per grid unit	Grid data according to the Red Data Book of Bulgaria	3	0	1-4	5-11	12-22	>22
		Alien and invasive species presence	Number per unit area OR Percent cover	Number per grid unit of national data Cover per sample plot	3	>10 >15%	7-9 10-15%	4-6 4-10%	1-3 1-3%	0 0%
	Abiotic heterogeneity	Soil quality	Soil type	Assessment by soil map	5	Anthrosols	Gleysols	Histosols	Arenosols	All other types
		Soil organic matter	Percent	Assessment by soil map	3	0-2.5%	2.6-5%	6-10%	11-15%	16-25%
		Soil erosion risk	score	t/ha/year	3	>10	5-10	2-5	0.5-2	<0.5
		Concentration of pollutants in soil from surrounding areas	number of dump sites	number per grid unit	3	>3	3	2	1	0
		Fire	number of recorded fires	Number per grid unit per	5	>4	3	2	1	0

				5 years						
Ecosystem processes		Matter storage	Biomass (air dry) in t/ha	Estimation/Assessment by available data	3	<1,5	1,6-2	2,1-3	3,1-5	>5,1

The above listed indicators were chosen with aim to serve for a comprehensive assessment of the condition (state) 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.

Table 6. *Ecosystem condition indicator assessment template and calculation - example*
The proposed example relates to the Alpine and subalpine grasslands ecosystem type in the region of Botev peak, central part of Balkan Range.

Indicator type	Indicator group	Indicator	Parameter	Units	Real data measured	Score
Structural	Abiotic heterogeneity	Soil heterogeneity	Soil quality	Soil type	Umbrosols	5
			Soil organic matter	Percent	15	4
		Disturbance regime	Soil erosion risk	Score	<0.5	5
			Concentration of pollutants in soil from surrounding areas	Number of dump sites	0	5

			Fire	Number of recorded fires	0	5
	Biotic diversity	Plant diversity	Vegetation cover	Percent	90%	5
			Plant species richness	Number of species per sample plot	19	3
			Red species richness	Number of species per grid unit	12-22	4
		Animal diversity	Animal species richness	Number of species per sample plot	163	5
			Red species richness	Number of species per grid unit	25	5
		Invasive species	Alien invasive species presence	Number per unit area	0	5
Ecosystem processes	Matter budget	Matter storage	Biomass	Biomass (absolutely dry) in t/ha	5.6	5
						$\Sigma n_i = 56$

$$\Sigma n_i = 56; \Sigma n_i(max) = 60; n = 12$$

$$IP = 56/60 = 0.933$$

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. n *5)

IP – a real number with values between 0 and 1

5.2. Mapping of Ecosystem condition

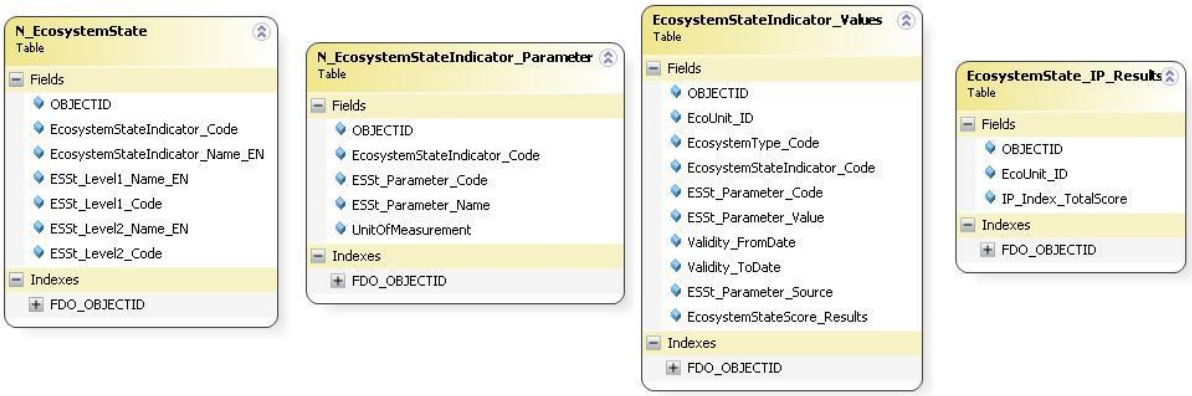
5.2.1. Description of the mapping procedure

The workflow for mapping of ecosystem conditions 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. Data structure/schema

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

The schema of the database for the ecosystem conditions is the following:



The detailed technical description of the classes and tables of the ecosystem condition database is provided in Annex 9.01_Schema_Report_ES_Database / 9.01_2_Schema_Report_ES_State_Database.htm

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

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

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

  - EcosystemStateIndicator_Name_EN: names in English of ecosystem state indicators at level 3;

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

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

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

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

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

  - EcosystemStateIndicator_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_EcosystemStateIndicator_Parameter.xls, as well as the Table 5. *Ecosystem conditions indicator assessment for grassland ecosystems*.

- Table **"EcosystemStateIndicator_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;

- EcosystemStateIndicator_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_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;

- EcosystemStateScore_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:

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

- Table **"EcosystemState_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 6 *Ecosystem condition indicator assessment template and calculation – example*.

5.2.3. Accuracy and validation

The Applicant should provide scientifically sound approach to describe the accuracy reached for each ecosystem state parameter; hence validation approach should be applied. For each validation accuracy reports should be generated and provided.

5.2.4. Digital Maps for Ecosystem State

For each ecosystem at level 2 maps in scale 1:125 000 should be delivered in PDF and paper format, at size A2, presenting the results from calculation of the IP index.

Each data frame should contain one cell from the EEA reference grid at 50km, hence 77 maps should be delivered 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. 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 color ramp should use for class 1 white color (RGB:255;255;255) and for class 5 red color (RGB:255;0;0). All other classes should have intermediate colors between white and red.

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

Each applicant should prepare map layout containing all the attributes for the Map of Ecosystem State and deliver it for discussion. The final map layout which to be used for all the ecosystem mapping projects will be prepared and will be mandatory to be used for map generation.

5.2.5. Metadata

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

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

6. Assessment of ecosystem services

6.1. Identification of indicators, parameters, data

Provisioning services

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

Regulating/Maintenance Services

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

Cultural services

Provision of cultural ecosystem services is deeply rooted in grasslands, and their thousand-year old history of human management. Cultural manifestations of the link between human society and grasslands are numerous and very different throughout the EU, therefore the MAES table, especially for intellectual and spiritual ecosystem services, cannot be exhaustive. Moreover, due to this variety, and also 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 these services is based on indicators describing the experiential use of grasslands. These refer to visitors/tourism in agricultural 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. Certified products (Protected Designation of Origin, Protected

Geographical Identification) that require specific (often traditional) landscape management can be used, since on the one hand these products directly represent cultural heritage linked to agro-ecosystems, and on the other hand, their marketing supports agricultural landscape maintenance. Data on visitors can be used in this context. The number of photos of grassland ecosystems uploaded on websites is becoming an option for estimation spiritual and emblematic services. Grassland 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 related to agricultural landscape, landscape conservation areas, High Nature Value farmland) can be taken as representative of 'existence' and 'bequest' services in the CICES typology. The synthesis of the different layers is the product of a spatial overlay and not of the sum of areas.

The indicators and parameters for assessing the ecosystem services of grasslands ecosystems are listed in Table 7 below.

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

Table 7. *Indicators for assessing and mapping Ecosystem Services in grassland ecosystems*

Section	Division	Group	Class	Indicator	Parameters and units	Data sources
Provisioning	Nutrition	Biomass	Reared animals and their outputs	Yield as % of country average depending on ecosystem condition	livestock units/ha	Statistics; Ecosystem condition assessment
			Wild plants, algae and their outputs	% of primary biomass production for food	t/ha	Statistics; Ecosystem condition assessment
			Wild animals and their outputs	Heads of animals reared for hunting	number/ha	Statistics; Ecosystem condition assessment
	Materials	Biomass	Fibers and other materials from plants, algae and animals for direct use or processing	Harvest/Yield as % of country average depending on ecosystem condition % of primary biomass production for materials Raw material inputs per capita Raw material consumption per capita	T/ha T/ha T per capita T per capita	Statistics; Ecosystem condition assessment
Regulation and Maintenance	Mediation of flows	Mass flows	Mass stabilization and control of erosion rates	vegetation cover + soil erosion risk	area [ha]	available map
			Buffering and attenuation of mass flows	vegetation cover	area [ha]	available map / national data
	Maintenance of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	Pollination and seed dispersal	pollination potential	scale	Joint Research Center – IES data; national observation
			Maintaining nursery populations and habitats	protected areas	ha	national data/MOEW

		Soil formation and composition	Weathering processes	soil organic matter content	g/kg	EU, national soil maps
			Decomposition and fixing processes	soil organic matter content	g/kg	EU; national soil maps
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	farm tourism, visitors (birdwatch, plantwatch, etc.)	Number per year	national data
			Physical use of land-/seascapes in different environmental settings	Visitors, farm tourism, walking and biking trails	Number per year	national data
		Intellectual and representative interactions	Scientific	Amount of scientific studies	number of published papers, number of projects	WEB, libraries
			Educational	educational activities (festivals, visiting centers, green school, etc.)	number of activities per year	national data
			Heritage, cultural	cultural monuments, Products from traditional management landscapes	number of monuments/products	national data
			Entertainment	Festivals and other cultural events	number of activities per year	national data
			Aesthetic	aesthetic landscapes	number of photos uploaded in Google Earth	WEB
	Spiritual, symbolic and other interactions with biota, ecosystems, and	Spiritual and/or emblematic	Symbolic	symbolic species	number of species	national data
			Sacred and/or religious	monasteries, churches, places	number	national data
		Other cultural outputs	Existence	Conservation significance	Number of sites in protected areas (e.g. Natura2000, Biosphere reserves, etc.)	national data, MOEW

	land-/seascapes [environmental settings					

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. The applicants should collect precise data by each parameter and further on it will be subject of valuation.

Step 1: Indicators for Ecosystem services assessment for grasslands

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.

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

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

The indicators and their parameters that should be used to assess ecosystem services for grasslands are listed in table 7 above.

Step 2: Collect data – national datasets

Egohetal et al. (2012) underlines that the primary data leads to more accurate representation of spatial distribution. However, currently most of the data should be derived from existing national and sub-national data sources. Methods that can quantify the uncertainty and validity of ES maps should be further explored.

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.

Table 8. *Data table for grassland ecosystem services - example*

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

Ecosystem services		Parameter/Units	Actual data for the current ecosystem polygon	Source
Provisioning	Reared animals and their outputs	livestock units/ha	0,85 livestock/ha	Data from NP Directorate
	Wild plants, algae and their outputs	% of primary biomass production for food [t/ha]	0,032 t/ha fruits of Vaccinium myrtillus 0,065 t/ha fruits of Vaccinim vitis-idea	Management plan for NP Central Balkan
	Wild animals and their outputs	Heads of animals reared for hunting [number/ha]	0	The territory is a part of National park and hunting is forbidden.
	Fibers and other materials from plants, algae and animals for direct use or processing	Harvest/Yield as % of country average depending on ecosystem condition [t/ha] % of primary biomass production for material [t/ha] Raw material inputs per capita [t per capita] Raw material consumption per capita [t per capita]	0,4 t/ha shoots of Thymus sp. div.	Management plan for NP Central Balkan
Regulation & Maintenance	Mass stabilization and control of erosion rates	Not eroded area [ha]	100 ha	According to ecosystem mapping (total area minus eroded area)
	Buffering and attenuation of mass flows	Flooded area [ha]	Not relevant	
	Pollination potential	scale	No data	
	Maintaining nursery populations and habitats	protected areas [ha]	110 ha	According to ecosystem mapping
Cultural	Experiential use of plants, animals and land-/seascapes in	farm tourism, visitors (birdwatch, plantwatch, etc.)	Average 40 000 visitors/per year	Tourist service Kalofer

	different environmental settings	[Number per year}		
	Scientific interactions	Amount of scientific studies [number of published papers, number of projects]	4 scientific studies	WEB
	Educational interactions	educational activities (festivals, visiting centers, green school, etc.) [number of activities per year]	No data	
	Entertainment	Festivals and other cultural events [number of activities per year]	No data	
	Aesthetic interactions	aesthetic landscapes [number of photos uploaded in Google Earth]	56	Google Earth
	Symbolic interactions	symbolic species [number]	0	Expert knowledge
	Sacred and/or religious interactions	monasteries, churches, places [number]	0	Expert knowledge
	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. 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. 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 output table should look like in the following dummy example:

Table 9. Example for "Scoring" table for ecosystem service assessment

Ecosystem services	**Parameter**	**Units**	**Assessment score**				
			Score 1 (low capacity)	**Score 2** (relevant capacity)	**Score 3** (medium capacity)	**Score 4** (high capacity)	**Score 5** (very high capacity)
Provisioning	Wild animals and their outputs	Heads of animals reared for hunting [number/ha]	<3	4-8	9-10	11-15	>15

The assessment of ecosystem services is based on real parameters (measurable and available) and presents the Real (expert assessed) **ESs Capacity**. The example in Table 10 is based on expert evaluations/scoring of the parameter`s dimensions and can be seen as research hypotheses which are to be tested in further case study applications with data from measurements, modeling or additional expert assumptions.

Table 10. Assessment of ecosystem services – example

Type of ecosystem services	**Division of ESs**	**Class of ESs**	**Real (expert assessed) ESs Capacity**
Provisioning	Nutrition	P1. Reared animals and their outputs	2
		P2. Wild plants, algae and their outputs	2
		P3. Wild animals and their outputs	3

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

Step 4. Fullfill the matrix

The ecosystem service matrices consist of ecosystem services (currently 4 provisioning , 6 regulating and 10 cultural services; according to Table 7) on the x-axis are ecosystem services and on the y-axis are ecosystem types on level 3. At the intersections, the score of the current spatial units' ecosystem subtype services were assessed on a scale from 0 to 5. The scores are expert evaluations and is based on a combination of expert judgement/experience with statistical data.

The following table presents an example matrix of one generalized Alpine and subalpine grassland ecosystem for Bulgaria.

Table 11. *Examples matrix of expert scores given to each pair of ESs and ES type.*

	Subtype	ESs Class code																		
		P1	P2	P3	P4	R1	R2	R3	R4	R5	R6	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Grasslands	Alpine and subalpine grasslands	2	2	3	3	3	4	3	2	3	3	4	3	5	2	1	4	4	2	1	1

The assessment scale reaches: 0 = no relevant capacity of the grassland sub-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.

6.3. Mapping of Ecosystem services

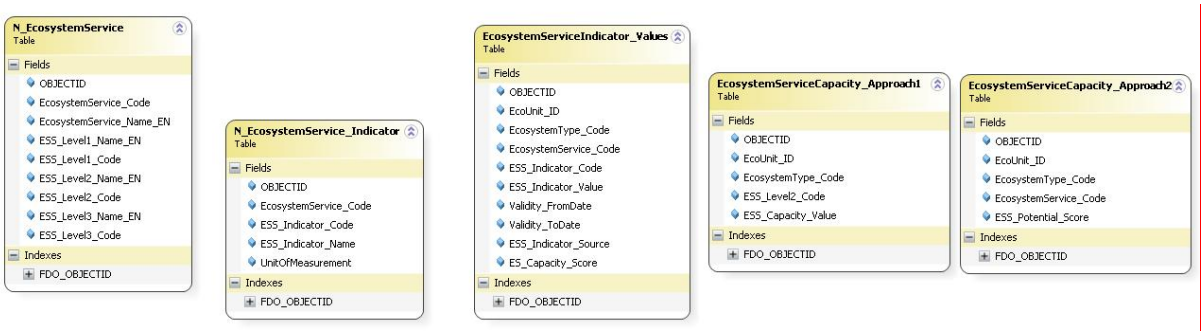
6.3.1. Description of the mapping procedure

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 the following:



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

/ 9.01_3_Schema_Report_ES_Services_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 grassland 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_Approach1"**: This table is the resulting table from the assessment of the ecosystem services and calculation of the Ecosystem capacity (ES) using approach 1 for each ecosystem type at level 3. 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;

- ESS_Level2_Code: ecosystem services code on level 2 (see the nomenclature for Ecosystem Services in Annex 9.02_NOMENCLATURES_XLS / N_EcosystemService.xls);

- ESS_Capacity_Value: calculated value for ecosystem capacity on level 2 (how to calculate the value is described in *Table 9. Data table for grassland ecosystem services – example*

- Table **"EcosystemServiceCapacity_Approach2"**: This table is the resulting table from the assessment of the ecosystem services and calculation of the Ecosystem capacity (ES) using approach 2 for each ecosystem type at level 3. 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;

- ES_Potential_Score: expert calculated value for ES potential capacity; how to define the score for each indicator is explained in Chapter 6.2. / Step 3 and example is given in *Table 10.*

6.3.3. Accuracy and validation

The .Applicant 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

For each ecosystem at level 2 maps in scale 1:125 000 should be delivered in PDF and paper format, at size A2, presenting the results from calculation for Ecosystem Capacity (approach 1 and/or approach 2).

Each data frame should contain one cell from the EEA reference grid at 50km, hence 77 maps should be delivered 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. The EEA reference grid is available at:

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

The Applicant should deliver at least one set of maps for the ecosystem services. The maps representing the results for calculating the ecosystem services capacity using the approach 1 is mandatory. For visualization of the MEAN capacity 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 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

Each applicant should prepare map layout containing all the attributes for the Map of Ecosystem services and deliver it for discussion. The final map layout which to be used for all the ecosystem mapping projects will be prepared and will be mandatory to be used for map generation.

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. REFERENCES

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8. LIST of ANNEXES

Annex 1

Terms definitions

Annex 2

List of acronyms

Annex 3

Table of ecosystem types

Annex 4
Map of ecosystem types

Annex 5
National data sets

Annex 6
Ecosystem state indicators

Annex 7
Indicators of ESS

Annex 8
References