PART B2

METHODOLOGY

For assessment and mapping of CROPLAND ecosystems condition their services in Bulgaria

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

**METHODOLOGY FOR ASSESSMENT AND MAPPING
OF CROPLAND ECOSYSTEMS CONDITION THEIR SERVICES IN BULGARIA**

PART B2

© Authors: Yavor Yordanov, Damyan Mihalev, Vassil Vassilev, Svetla Bratanova-Doncheva, Kremena Gocheva, Nesho Chipev
© Cover design: Alexander Donchev
© Layout: Digital Illusions

ISBN 978-619-7379-05-1

© Clorind, 2017. All rights reserved.
Reproduction is authorized provided the source is acknowledged.

Table of contents

1. Introduction ***5***

1.1. What is this methodology about? 5

1.2. Who is this methodology for? 5

1.3. How to use this methodology? 5

2. Typology of ecosystems in Bulgaria ***6***

2.1. Typology of Cropland ecosystems in Bulgaria 6

2.2. Detailed ecosystem typology of “Croplands” in Bulgaria 7

3. Data availability ***8***

3.1. Existing data sources, gaps, uncertainty of data 8

4. Mapping ecosystem types ***10***

4.1. Description of the mapping procedure 10

4.2. Data format 10

4.3. Geographic projection / Reference system 11

4.4. Geometric resolution – scale and minimum mapping units 11

4.5. Data structure/schema 11

4.6. Thematic accuracy and validation 12

4.7. Digital Maps for Ecosystem Types 13

4.8. Metadata 13

5. Assessment of Cropland ecosystems condition ***13***

5.1. Assessment of Ecosystem condition (Cropland) 13

5.2. Mapping of Ecosystem condition 30

5.2.1. Description of the mapping procedure 30

5.2.2. Ecosystem Condition Data structure/schema 30

5.2.3. Accuracy and validation 32

5.2.4. Digital Maps for Ecosystem Condition 32

5.2.5. Metadata 32

6. Assessment of cropland ecosystem services ***33***

6.1. Main types of services. Identification of indicators, parameters, data 33

6.1.1. Provisioning services 33

6.1.2. Regulating and Maintenance Services 34

6.1.3. Cultural services 36

6.2. Assessment of Ecosystem services 39
6.3. Mapping of Ecosystem services 54
6.3.1. Description of the mapping procedure 54
6.3.2. Data structure/schema 54
6.3.3. Accuracy and validation 56
6.3.4. Digital Maps for Ecosystem Services 56
6.3.5. Metadata 56

7. Annexes 57

1. Introduction

1.1. What is this methodology about?

The current methodology forms a part of the national methodological framework on mapping and assessment of ecosystem condition and services which aims at streamlining the national ecosystems and ecosystem mapping and biophysical assessment process in Bulgaria. 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 **CROPLAND** ecosystems
2. Assessing the **CROPLAND** ecosystems' potential to deliver ecosystem services (biophysical valuation).

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

1.2. Who is this methodology for?

This methodology is to be used by:

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

1.3. How to use this methodology?

The methodological framework provides a combination of information on relevant information sources that may be of interest to a wider circle of stakeholders, while the current methodology is dedicated to specific guidance to assessing ecosystem condition and ecosystem services (including data collection and verification, and mapping guidance).

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

Asthecurrentmethodologyis a livingdocument, commentsarewelcomeinorder to shapeitas a national, widelyreviewedandadoptedguidancedocument.

2. Typology of ecosystems in Bulgaria

2.1. Typology of Cropland ecosystems in Bulgaria

The Cropland ecosystems were considered to result from the manipulation of natural and biological resources byman. Cropland ecosystems therefore represent an integration of social and ecological systems, and can be considered from different disciplinary standpoints (social, economic, ecological) as well at several different levels of organization (crop, farm, community, and watershedICRA (2015).

Cropland ecosystems includes the lands used for production of crops such as grains, vegetables andfruit trees, technicalcrops, which are the cultivated culturesor agricultural produce harvested by people for human or animal consumption as food, for production of fiber, oilsor for use as source of energy,livestock services refer to animals raised and others.

A“cropland ecosystems” includes dynamic associations of crops, pastures, livestock, other flora and fauna, soils, water, and the atmosphere.

Agricultural systems or Cropland ecosystems comply in a strict sense with the definition of an ecosystem (Maes et al., 2011). From this systems perspective, it is important to consider not just the components of the system of interest, but also the interactions between components such as: (i) agro-ecological “niches” (e.g. soil types, vegetation types, crops, woods, water sources, etc), (ii) agricultural infrastructure (roads, wells, farm buildings, etc) and (iii) social units (different stakeholders, social groups, types of farmer, markets,etc).

The proposed typology of “Cropland” 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 the CORINE Land Cover (CLC) classes. The MAES ecosystem typology differentiates two levels, whereas the Level 2 of the MAES proposal follows closely the EUNIS Level 1. The EUNIS level 2 will be the base for the mapping and assessment approach.

Table 1. Typology of Cropland ecosystems in Bulgaria

Level 1	Level 2	Level 3
Terrestrial	**Cropland**	Annual crops (mostly cereals)
		Perennial crops (fruit gardens and vineyards)
		Perennial crops (mostly legumes)
		Mixed cropland
		Livestock farms for large and small animals including bees

2.2. Detailed ecosystem typology of "Croplands" in Bulgaria

To be sufficiently plausible and realistic assessment of ecosystem services must build sufficiently complete and robust structure and typology of ecosystems and on the indicators which will be assessed.

To achieve above mentioned, the proposed cropland ecosystems classification and indicators are selected so as to satisfy the following conditions:

- to provide information on the current state and ongoing changes in the condition of the cropland environment;
- to capture the main positive and negative effects of agriculture on the environment;
- to be easy measurable;
- to track the impact of agriculture on the environment;
- to be comparable with existing ecosystem classifications;
- to be easy aggregated;
- to assess the impact of agricultural and environmental policies on the environmental management of farms;
- to inform agricultural and environmental policy decisions;
- to illustrate agriculture-environmental relationships to the broader public.

Cropland ecosystem classification will be based on EUNIS (I.1, I.1.1,I.1.11/12 and 13 for example) and the proposal of ecosystem typology for the MAES working group. It will take into account data availability and mapping feasibility at national scale and keep compatibility with other national and European mapping approaches.

Descriptions and relations to otherc lassification systems of proposed subtypes of Cropland ecosystems are presented in Table 2.

Table 2. Croplandecosystems typology (Level 3)

	Subtype	Description	Nomenclature(s)
1.	Annual crops (mostly cereals)	Land used primarily for the production and harvest of annual crops - cereals, vegetables.	EUNIS –[I.1xx], [I.2xx], [I1.3xx, I1.4xx, I1.5xx] Large-scale, Medium-scale and Small-scale intensive unmixed crops (>25ha, 1-25ha and <1ha). and other. EUNIS – FB3x, 4x; and X.07 Bondev (1991) – 71, 72, 118, 119, 120, 121, 122, 123, 124, 125, 126; G1.D or other Gx.x - with the exception of olives and other fruit trees covered by main G class - Woodland and forest.
2.	Perennial crops (fruit gardens and vineyards)	Land used primarily for the production and harvest of perennial fruit crops - orchards, fruit gardens, or land used primarily for the production and harvest of perennial crops - vineyards.	
3.	Perennial crops (mostly legumes)	Land used primarily for the production and harvest of perennial crops for forage and pastures. Lands composeof introduced or domesticated native forage species that isused primarily for theproduction of livestock. They could receive periodic renovation and/or cultural treatments, suchastillage, fertilization, mowing, weed control, and may be irrigated.	

	Subtype	Description	Nomenclature(s)
4.	Mixed cropland	Land used primarily for the production and harvest of annual or perennial (polycultures) field, forage, food, fiber, horticultural, orchards, vineyards and/or energy crops	EUNIS –[I.1xx], [I.2xx], [I1.3xx, I1.4xx, I1.5xx] Large-scale, Medium-scale and Small-scale intensive unmixed crops (>25ha, 1-25ha and <1ha). and other. EUNIS – FB3x, 4x; and X.07 Bondev (1991) – 71, 72, 118, 119, 120, 121, 122, 123, 124, 125, 126; G1.D or other Gx.x - with the exception of olives and other fruit trees covered by main G class - Woodland and forest.
5.	Livestock farms for large and small animals including bees	Land associated with farms and ranches that are purposefully managed for animal breeding, food, forage or fiber and are typically associated with nearby production lands. Land used for facilities and supporting infrastructure where farming, animal husbandry and ranching activities are often initiated. This may include dwellings, equipment storage plus farm input and output storage and handling facilities. Also includes land dedicated to the facilitation and production of high intensity animal agriculture in a containment facility where daily nutritional requirements are obtained from other lands or feed sources.	

3. Data availability

3.1. Existing data sources, gaps, uncertainty of data

For mapping and assessing of *Cropland* 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 *Cropland* 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, cadaster, statistics). Available spatial and quantitative database for *Cropland* territories can be found free of charge or after special request to the stakeholders.

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

The most commonly used data to derive ecosystem`s 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 avail-

ability is also reflected in some ecosystem services that are mapped at regional level. Local data are needed to quantify supporting or cultural Ecosystem Services. 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 mostly data sources can be used. Supporting services, mostly 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 found in our review, for which there is no data at all and additional investigations and/or case-studies are needed. The majority of these 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 there exists expert potential. Therefore pollination is proposed as mandatoryimportant 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.

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

<table>
<tr><th rowspan="2">Subtype</th><th colspan="2">DATABASE Sources – main stakeholders</th></tr>
<tr><th>Spatial</th><th>Quantitative/Qualitative</th></tr>
<tr><td>Annual crops (mostly cereals)</td><td rowspan="5">Database– State Fund“Agriculture” – Land and Parcel Information System /LPIS/ and Integrated Administration and Control System /IACS/.

Database– State Fund“Agriculture” – State Digital Orthophoto map.

MoAF – Agrostatistic – BANSIK – statistical survey, Farm Structure survey, Annual bulletin.

National Statistical Institute

MOEW – ExEA – JICA project, National Database for Biodiversity, National Soil Monitoring Network.

EUROSTAT – LUCAS project - Land Use/Cover Area frame statistical Survey.

GMES - Global Monitoring for E nvironment and Security

Master Plans, Site Development plans, State Cadastre.</td><td rowspan="5">Master Plans, Site Development Plans, Maps of restored property, Action Plans for Programmes of Environmental protection, National Concept for Spatial Development 2013-2025, National Statistical Institute, Urban Atlas (EEA, MOEW), JRC, Publications, Project Reports, ME, MRD.MoAF – State Fund “Agriculture”. Professional industry associations. Environmental NGO. Third parties – including survey private companies with high level of reliable data (actual insitu data and high precision model data will be welcome). MOEW – ExEA – Inventarization plans for pesticides storage.</td></tr>
<tr><td>Perennial crops (fruit gardens and vineyards)</td></tr>
<tr><td>Perennial crops (mostly legumes)</td></tr>
<tr><td>Mixed cropland</td></tr>
<tr><td>Livestock farms for large and small animals including bees</td></tr>
</table>

Subtype	DATABASE Sources – main stakeholders	
	Spatial	Quantitative/Qualitative
Livestock farms for large and small animals including bees	National Concept for Spatial Development 2013-2025. EEA – CORINE – Land Cover. JRC - ESTIMAP -Polliniation services model, MetEcoSMap - NINA/IBER project. JRC - Soil maps and their properties.	

4. Mapping ecosystem types

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

4.1. Description of the mapping procedure

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

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

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

4.2. Data format

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

The vector format should be with the following topology:

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

help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/An_overview_of_topology_in_ArcGIS/006200000001000000/.

4.3. Geographic projection / Reference system

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

- http://inspire.jrc.ec.europa.eu/documents/Data_Specifications/INSPIRE_DataSpecification_RS_v3.2.pdf, and;
- http://www.eionet.eu.int/gis

4.4. Geometric resolution – scale and minimum mapping units

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

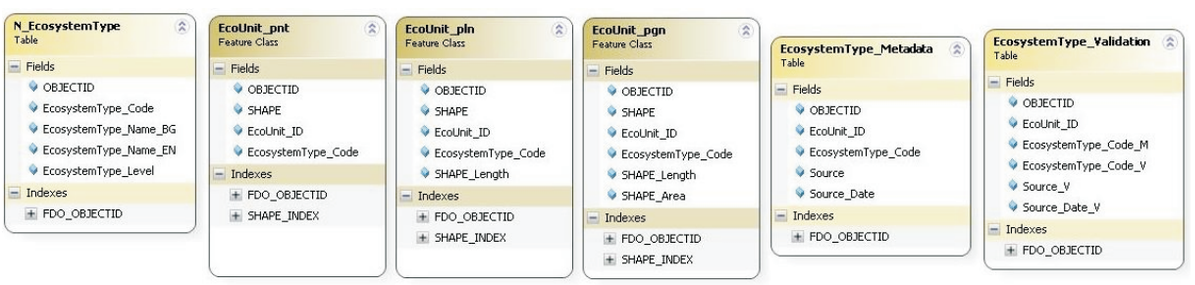
- the used source data;
- the ecosystem type on level 3.

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

4.5. Data structure/schema

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

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



Fifure 1: Ecosystem Types Database Schema

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

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

- Feature Class **“EcoUnit”** - this is the vector feature class which contains the information on ecosystem types at level 3. The attribute fields of the feature class which have to be filled are as follows:
- EcoUnit_ID: each object should have unique ID;EcosystemType_Code: this field should contain 3 digit value of the ecosystem type at level
- The value for the ecosystem code should be taken from the nomenclature table N_EcosystemType/EcosystemType_Code provided in Annex 9.02_NOMENCLATURES_XLS. This field is used for relating all the tables and feature classes in the database.

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

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

- Table **“N_EcosystemType”**: Nomenclature table for ecosystem type levels at level 2 and 3. This table should not be changed. It has the following fields:
  - EcosystemType_Code: integer codes for ecosystem types at level 2 and 3;
  - EcosystemType_Name_BG: names in Bulgarian of ecosystem types at level 2 and 3;
  - EcosystemType_Name_BG: names in English of ecosystem types at level 2 and 3;
  - EcosystemType_Level: check field defining the level of each ecosystem type with values 2, for level 2 and 3 for level 3;
- Table **“EcosystemType_Metadata”**: Table providing information on datasources used when defining the ecosystem type for each feature from the Feature Class **“EcoUnit”**:
  - EcoUnit_ID: field to relate with the feature class;
  - EcosystemType_Code: integer codes for ecosystem types at level 3;
  - Source: free description of the source used to map the specific ecosystem type for each feature;
  - Source_Date: date of the source used to map the specific ecosystem type for each feature;
- Table **“EcosystemType_Validation”**: Table providing information on work performed to validate the thematic accuracy for the final product:
  - EcoUnit_ID: field to relate with the feature class;
  - EcosystemType_Code_M: integer codes for ecosystem types at level 3 of the final product;
  - EcosystemType_Code_V: integer codes for ecosystem types at level 3 derived in the validation process;
  - Source_V: free description of the source used to validate the ecosystem type;
  - Source_Date_V: date of the source used in the validation.

4.6. Thematic accuracy and validation

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

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

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

4.7. Digital Maps for Ecosystem Types

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

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

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

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

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

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

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

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

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

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

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

4.8. Metadata

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

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

5. Assessment of Cropland ecosystems condition

5.1. Assessment of Ecosystem condition (Cropland)

Step 1: Generally, it is visible that indicators are a subset of the many possible attributes that could be used to quantify thecondition of a particular landscape, catchment orecosystem (Walker, 2002)]. In this regard cropland indicators cover agriculture and rural sector variables; agricultural policy variables; agricultural inputs and the environment; and agricultural output and trade (Harris, 2011). The impacts – both harmful and beneficial – of agriculture and agricultural policies on the environment are a major issue. The developing of agri-environmental indicators within the overall context of need to ensure consistency between environmental and agricultural policies(OECD, 1999).

The choice ofindicatorsshould be seen notonlyby the need tobemapped, butis essentialsubsequentlyto be usedfor furtherassessmentofecosystems and the servicesthey 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 agriculture;
- assist policy makers to better understand the linkages between the causes and effects of the impact of agriculture and agricultural policy on the environment, and help to guide theirresponses to changes in environmental conditions;
- contribute to monitoring and evaluation of the effectiveness of policies in promoting sustainable agriculture.

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 agriculture in relation to the environment below are main one of particular importance:

- agricultural activities produce a diverse range of harmful and beneficial impacts on environmental quality. Farming 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.
- the agricultural sector are characterized by policies delivering high levels of support and government intervention. Farmers' behavior can be significantly affected by these policies, in that they influence the type of crops grown and farmed animals,level of agricultural production, its location, and the farming practices and management systems employed. Also changes in environmental quality can trigger market and societal reactions which may in turn influence agricultural and environmental policy decisions (OECD, 1999).

There are potentially a large number of indicators that could be developed to help quantify the various components and linkages between agriculture and environment. To assist in the choice of an operational set of indicators within this framework each indicator have 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;
- 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 and state database exists from which to calculate indicators, problems of data gathering, data providing, definitions, quality, the regularity of data collection and methods of indicator measurement remain obstacles to progressing the work on certain indicators. In an effort to overcome some of these difficulties there has begun a discussion of developing of approaches and methods of data exchange and providing between state authorities;

- 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 farm through to the global scale. In many cases national agricultural data are often collected on the basis of political and/or administrative units, such as sub-national regions (regions, districts, municipalities. There is no unique way to address the aggregation issue for each indicator and it is most effectively tackled pragmatically, on a country-by-country, 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.

For representing and assessing ecosystem conditions of the cropland ecosystems, we take into account the following components: (i) ecosystem structures - biotic diversity, abiotic heterogeneity, habitat diversity and (ii) ecosystem processes - energy balance, water and matter balance. We have defined and quantified 23 indicators that are relevant for the cropland ecosystem conditions. The indicators represent the ecosystems structure and ecosystem processes of cropland types of ecosystems.

Table 4. Rationales of ecosystem condition (state) indicators

Ecosystem condition Indicator group	Indicators/Rationales
Biotic diversity	Spatial or temporal variability of resources. Biotic diversity is caused by organisms. It may occur even in absence of abiotic heterogeneity. Positive relationships between plant species habitat diversity and animal species diversity are well documented on different scales (Davidowitz&Rosenzweig, 1998), but empirical and theoretical studies have showed contradictory results (Tews et al., 2004). Effects of biotic diversity may vary considerably depending on what is perceived as a habitat by the species group studied. Structural attributes of the vegetation that constitute habitat diversity for one group may be perceived as habitat fragmentation by another taxonomic group (e.g. Okland, 1996). To determine biotic factors and Cropland habitats diversity the following indicators are proposed:

Ecosystem condition Indicator group	Indicators/Rationales
Biotic diversity	*"Plant diversity",* *"!nimal diversity",* *"Habitat diversity",* *"Invasive species",* 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. Abiotic heterogeneity has abiotic origin. To determine abiotic factors and Croplandecosystemsabiotic heterogeneity the following indicators are proposed: *"Soil heterogeneity",* *"Hydrological heterogeneity",* *"Disturbance regime",* *"Geomorphological heterogeneity",* *„Connectivity or fragmentation of the area"* Possible (optional) indicators are: *"!ir 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 lifeblood of ecosystems and of the biosphere as a whole. At the most fundamental level, what ecosystems do is capture and transform energy.Agriculture, in essence, is the human manipulation of the capture and flow of energy in ecosystems. Humans use cropland ecosystems to convert solar energy into particular forms of biomass — forms that can be used as food, fiber, and fuel. All cropland ecosystems — from the simple, localized plantings and harvests of the earliest agriculture to the intensively altered agroecosystems of today — require an input of energy from their human stewards in addition to that provided by the sun. The croplands "modernization" of the last several decades has been largely a process of putting ever-greater amounts of energy into agriculture in order to increase yields. But most of this additional energy input comes directly or indirectly from nonrenewable fossil fuels. Moreover, the return on the energy investment in conventional agriculture is not very favorable: for many crops and animals, we invest more energy than we get back as food. Our energy-intensive form of agriculture, therefore, cannot be sustained into the future without fundamental cropland ecosystem assessments and may be, changes.

Ecosystem condition Indicator group	Indicators/Rationales
Energy budget	"*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 Cropland ecosystems. To account matter budget in Cropland ecosystems the proposed 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 in Cropland areas, considering precipitation, evaporation, and runoff. The following indicators are possible (optional): *"Water balance (input, output)",* *"Water storage",* *"Other condition indicators",* *"Efficiency measures"* *„Recorded precipitation"* *"Soil moisture"* 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 *Cropland* ecosystems condition different parameters of evaluation are proposed. The selected parameters are easy measurable and for most of the indicators there are relevant parameters in current inventories database (land cover, biodiversity, soil conditions, etc.).

Step 3: Collecting data – national data sets

Given the broad spectrum of scientific disciplines that cover the concept of ecosystem services, a full assessment of the impact of drivers and pressures on the provision of ecosystem services requires an interdisciplinary data combining approach. It requires coupling large scale environmental data sets or even very complex models that simulate processes taking place in the atmosphere, watersheds,

soils and ecosystems with models that simulate socio-economic and agricultural systems in close relation with the consequences of resource use on land and ocean dynamics. Such integrated assessment needs to be translated into suitable indicators for cropland ecosystem functions 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 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, (ii) data acquired from European statistical sources, application models and mapping projects at European level 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 database), but other data sources as additional measurements must also be utilized.

- MoAF - National annual Agro statistical reports, Agro statistical surveys - BANSIK, FADN, LUCAS
- State Fund Agriculture - Bulgarian Paying Agency - IACS and LPIS
- MOEW - ExEA - CORINE project, national data bases
- Scientific publications
- In-situ data
- Additional remote sensing data
- EU data sources
- Additional remote sensing data

Step 4: How to assess

The indicators should be viewed as an integrated preliminary set, with caution needed in assessing trends in individual indicators, for a number of reasons discussed below.

- Definitions and methodologies for calculating of indicators are standardised in most cases (e.g. the nitrogen use balance definition), but not all (e.g. definitions of organic agriculture vary). Also, calculatingthe indicators are at different stages of development, with work on some areas having a longerbackground of research, such as nutrient use and soil quality, while for other areas, such as biodiversity,wildlife habitats and landscape, work is at a very early stage.
- Data quality and comparability have been expressed as far as possible in terms of the consistency,coherence and harmonisation of data across different indicators, but deficiencies remain such asthe absence of data series, variability in data coverage and questions related to data sources.
- Spatial aggregation of indicators is at the national level. Because national averages can mask significantvariations at the regional level, where possible the Report highlights the possibility ofdeveloping regionally disaggregated indicators.
- Trends and ranges in indicators are important for comparative purposes across country rather thanabsolute levels for many indicators, especially as local, site specific conditions

vary considerablywithin and across countries. Absolute levels, however, are significant where they are aboveclearly defined scientific limits (e.g. nitrates in water).

- Contribution of agriculture to specific environmental impacts is sometimes difficult to isolate, especially forissues such as soil and water quality, where the impact of other economic activities is significant(e.g. industry) or the natural state of the environment itself contributes to pollutant loadings(e.g. the water may contain high levels of naturally occurring salts).
- Direction of change of the indicators is unambiguous in terms of the impact on the environment of anincrease or decrease in the specific indicator (e.g. changes in agricultural greenhouse gas emissions).However, for some indicators it is not always clear what constitutes an environmentalimprovement or deterioration (e.g. changes in landscape indicators)Organisation for Economic Co-operation and Development, 1999.

The common questions (What?, How?, When?, Where?,) related to any phenomena assessment could be applied in sure in indicator assessment approach(OECD, 1999).

What?

Identification and assessment of underlying agri-environmental linkages relies upon both theoreticalunderstanding and data availability. Theoretical understanding is required to guide the choice ofwhich variables to measure, and the manner in which they should be measured. Data arising fromempirical measurement are required to actually implement construction of an indicator. As theoretical understanding of croplandecosystems continues to advance (e.g. Jakeman et al.,1995), awareness of their complexity deepens. For example, research into nutrient cycles,hydrological cycles and commodity market interactions continues to inform research and policycommunities alike as to the relative importance of, and jointness between, different components ofagri-environmental systems(OECD, 1999).

How?

In addition to identifying which variables to focus upon, theoretical understanding also guides howvariables should be measured. That is, agri-environmental variables are vector rather than scalarmeasures, with several dimensions. In particular, consideration has to be given to quantity and qualityaspects, plus inter-temporal and spatial dimensions.

Whilst it is possible to simply record the presence or absence of a variable, it is more common toquantify its magnitude. Hence, for instance, the presence of landscape features such as ponds andhedgerows is normally supported by a measure of their number or length. Similarly, usage of apesticide is usually quantified rather than simply expressed as usage or non-usage.

Such simple quantification may not, however, convey important information regarding the conditionof the variable. For example, ponds may be old or new, shallow or deep, stagnant or healthy. Hedgesmay be old or new, broken or complete, uniform or varied in species. Pesticide applications may beby spray or contact. Such qualitative differences can have significant agri-environmental impacts. Ananalogy may perhaps be drawn here with economic employment data where the type of job (e.g. full orpart-time, permanent or temporary) is considered a useful piece of information to accompany thenumber of jobs reported.

When?

Croplandecosystems change over time, particularly in response to seasonal fluctuations. Thismeans that measurement values at one time of year may not be directly comparable with, or asmeaningful as, values taken at another time of year. For example, the water content of soil fluctuatesover the year in response to changing rainfall levels and vegetation cover. Winter measurements arenot com-

parable with summer measurements in terms of, for example, describing plant stress and thesubsequent demand for irrigation.

Similarly, the nitrate leaching rate from a given application of fertilizer will depend not only upon thequantify applied, but also the timing of the application and the prevailing meteorological conditions:using annual application and rainfall data will give a different picture to using data temporallydisaggregated to daily events.

Consideration also needs to be given to the time frame over which variables change. Some maychange relatively slowly, for example soil type, whilst others may change relatively rapidly, forexample soil moisture content. Care also needs to be exercised in distinguishing genuine change (atrend) in the system from simply stochastic variation. That is, an apparent change in a variable's valuemay actually be within its usual bounds of variation. For example, average temperatures can fluctuatesignificantly year-on-year without necessarily displaying long-term change.

Where?

Finally, due to the spatially extensive nature of agricultural production and the spatial heterogeneity of agriculture and its underlying environmental resource base, agri-environmental variables have a spatialdimension. This means that they need to be expressed over an appropriate spatial unit ofmeasurement. This may be a hectare, a catchment, an agro-ecological zone, a trading block or anyother unit, depending on the variable of interest.

For example, livestock per hectare is an indicator of grazing intensity and total fertilizer usage within acatchment, which is a indicator of nitrate loading to the sea. Choice of spatial unit is made more complicatedby the fact that agri-environmental systems display spatial connectivity. That is due to, for example,hydrological systems, the dispersal of plants and animals or the movement of farm produce, and whathappens at one location may not be independent of what happens at another location.

Theoretical understanding of agri-environmental systems thus offers some guidance as to whichvariables are important, and how they should be measured and at which points in time and space.Choice of variable(s) and measurement details for inclusion in an indicator is, however, notdetermined solely by theoretical considerations. Rather, choice is constrained by data availability.

Table 5. Ecosystem state indicator assessment for Cropland Ecosystems

CROPLAND ECOSYSTEMS									
Ecological state indicators		Indicator	Parameter (units)	Methodology	Assessment scale				
					Score 1	Score 2	Score 3	Score 4	Score 5
Type	Indicator Group				(very bad)	(bad)	(moderate)	(good)	(very good)
Biotic Heterogeneity	**Biotic diversity**	**Agricultural crop richness (annual, perennial and mixed crops)**	Crop number or Percent	Estimation	0	1	2	3	<more than 3

CROPLAND ECOSYSTEMS									
Ecological state indicators		Indicator	Parameter (units)	Methodology	Assessment scale				
					Score 1	Score 2	Score 3	Score 4	Score 5
Type	Indicator Group				(very bad)	(bad)	(moderate)	(good)	(very good)
Biotic Heterogeneity	Biotic diversity	**Agricultural crop richness - soil cover by vegetation (annual, perennial and mixed crops)**	Ratio/ Percents	Estimation	Up to 10%	10 - 20	20-40	40-60	More than 60%
		Wild plants	Area [ha], number or % from all land] of wild plants associated to crops (buffer strips, strips from flowers supporting pollination for example)	Estimation [satellite images, observation]	0	2%	5%	10%	more than 10%
		Wild animals	Number	Number animals or number of monitored traces from underground animals - worms, moles, insects and more.	By expert assessment – depends on the type observed objects				

CROPLAND ECOSYSTEMS									
Ecological state indicators		Indicator	Parameter (units)	Methodology	Assessment scale				
					Score 1	Score 2	Score 3	Score 4	Score 5
Type	Indicator Group				(very bad)	(bad)	(moderate)	(good)	(very good)
Biotic Heterogeneity	Biotic diversity	Farmed animals (depend of kind)	Number per unit area/% [usually information about the species of animals accompanying information on the number of animals in each farm. Type of animals is important in terms of the different volumes and characteristics of waste generated by the farm, different types of structure and feed etc.]	Number per grid unit of national data	By expert assessment – depend of kind animals				
	Habitat diversity	**Area of natural habitat/s**	Area or ratio [%] between cropland and natural land. [current period of CAP 2014-2020 is underlined as "greening agriculture*" - natural place will be - Environmental Focus Areas, Buffer strips, Field margins, Hedges & trees]	Remote sensing, Records from State Agricultural Fond for example.	0	0 - 5%	5 - 10%	10 - 20%	more than 10%

CROPLAND ECOSYSTEMS									
Ecological state indicators		Indicator	Parameter (units)	Methodology	Assessment scale				
					Score 1 (very bad)	Score 2 (bad)	Score 3 (moderate)	Score 4 (good)	Score 5 (very good)
Type	Indicator Group								
Biotic Heterogeneity	Biotic diversity	**Land use changes/ Land take**	ha, ha/y, %	Calculation	More than 75%	50-75	25-50	20 - 10	Up to 10%
	Invasive species	Invasive species presence [pests or weeds]	presence	Number of records or total amount of applied chemistry	By expert assessment - depend of availability of farm records.				
Abiotic heterogeneity	soil heterogeneity	**Soil quality**	Land properties	Scale assessment by soil conditions (land category) regarding to soil properties	8 - 10	7	4 - 6	3 - 4	1 - 2
		Soil moisture capacity	%	Assessment by soil data	10	20	40	60	More than 60
		Soil nutrient elements storage (depend of nutrients and soil units - example is for K for Chernozems)	mg[K]/100g	Assessment by soil data, measurements	Up to 10%	10 - 15	15 - 20	20 - 30	More than 30
	Hydrological heterogeneity	**Area under irrigation**	ha/% of cultivated land	Number per grid unit of national data	10	20	50	75	More than 75%
		Water bodies precense	location of water bodies in neighbour	distance, approach,	By expert assessment – depends on the type observed objects				

CROPLAND ECOSYSTEMS									
Ecological state indicators		**Indicator**	**Parameter (units)**	**Methodology**	**Assessment scale**				
					Score 1 (very bad)	**Score 2 (bad)**	**Score 3 (moderate)**	**Score 4 (good)**	**Score 5 (very good)**
Type	**Indicator Group**								
Abiotic heterogeneity	geomorphological heterogeneity	**Slope**	[%] or [degrees]	mostly for permanent crops	up to 3^{O}	3 - 6	6 - 9	15-Sep	more than 15^{O}
		exposition (aspect)	World directions [mains & intermediate]	Scale depending of crop cultivated	N	NE/NW	E/W	SE/SW	S
	Other abiotic heterogeneity indicators	Area under wind protection	Area/%	Number per grid unit of national data	10%	10 -20	20-50	50-75	More than 75
	Disturbance regime	**Significant occurrence of hail or late spring frosts or early autumn frosts.**	Recorded records or demaged area or demaged production by tons	[ha] or [t]	By expert assessment – depend of kind of crops and type of the disaster				
		erosion degree	Scale or t/ha/yr		up to 5 t	5 - 10	10 - 20	20 - 40	more than 40 t
		fires (coused by burning of stubble for example)	Number of records or burned area [ha] (example is for burned crop area)	Estimatin, Remote sensing, Stete raccords	10%	10 -20	20-50	50-75	More than 75

CROPLAND ECOSYSTEMS									
Ecological state indicators		Indicator	Parameter (units)	Methodology	Assessment scale				
					Score 1 (very bad)	Score 2 (bad)	Score 3 (moderate)	Score 4 (good)	Score 5 (very good)
Type	Indicator Group								
Abiotic heterogeneity	Disturbance regime	wind and storms (failed crops from hail for xample)	Number of records or demaged area [ha], or lost harvest [t, kg], or scale assessment by hail vulnerability	Estimatin, Remote sensing, Stete raccords	more than 27 hail storms cases	17 - 22	7 - 16	5 - 7	up to 4 hail storms cases
		Polluted areas	Area polluted [ha]	Estimatin, Field measurements, Stete raccords	By expert assessment – depends on the type observed objects (pollutant type and area affected)				
		Salted, swampy and acidic areas	Affected area [ha]	Estimatin, Field measurements, Stete raccords	By expert assessment – depends on the type observed objects (soil unit type, impact type)				
Energy budget	**energy balance**	Carbon storage	Soil carbon storage [t/C/ha or %]	Assessment scale					
		Solar radiation intensity	kW/m2/yr or per growing period	IPCC,	up to 10	10 - 30	30 - 80	80 - 130	more than 130
	metabolic efficiency	**Temperature sum**	Temperature summ for vegetation period [mainly for permanent crops - vineyards for example	Maps, Assessment,	2800^{O}	3100	3500	3700	more than 3700^{O}

CROPLAND ECOSYSTEMS									
Ecological state indicators		Indicator	Parameter (units)	Methodology	Assessment scale				
					Score 1	Score 2	Score 3	Score 4	Score 5
Type	Indicator Group				(very bad)	(bad)	(moderate)	(good)	(very good)
Matter budget	matter balance (input, output) matter storage	Nutrients loss	Loss by leaching or by erosion [kg/ha]						
		Content of soil organic matter	% or [g, kg/ha]	National scale	up to 0.5 %	0.5 - 1 %	1 - 2.5 %	2.5 - 5 %	more than 5 % %
		Biomass	Volume of produsedbiomass [t]	Assessment	By expert assessment – depend of kind of crops an local condition (soil proeperties, climate)				
Water budget	water balance (input, output)	**Evapotranspiration**	[mm]	Rainfalls, or Hidro-termal coeficient for vegetation period for different crops (example is for soy)	up to 0.6	0.6 - 0.9	1.2 - 1.4	0.8 - 1.0	more than 1.0
		Precipitations	mm/y						
	water storage	**Soil water storage capacity**	Scale	Assessment depending of soil type (clay content for example, slope properties, exposition,) example is for clay content	up to 20%	20 - 30	30 - 40	40 - 50	more than 60 %

Bold - key indicators, obligatory

Normal - optional and recommended indicators depents of data availability

***** "greening agriculture" - Green direct payments account for 30% of EU countries' direct payment budgets. Farmers receiving an area-based payment have to make use of various straightforward, non-contractual practices that benefit the environment and the climate. These require action each year. They include:

- diversifying crops
- maintaining permanent grassland
- dedicating 5% of arable land to 'ecologically beneficial elements' ('ecological focus areas').

Under the new rules, farmers receiving payments help conserve the environment and contribute to addressing greenhouse emissions by:

- making soil & ecosystems more resilient by growing a greater variety of crops
- conserving soil carbon & grassland habitats associated with permanent grassland
- protecting water & habitats by establishing ecological focus areas /EFA/. EFA means that farmers with arable areas exceeding 15 ha must ensure that at least 5% of such areas is an 'ecological focus area' dedicated to ecologically beneficial elements. Ecological focus areas cover a broad range of features, including ones that affect biodiversity:
  - directly, such as: fallow land, field margins, hedges & treer, buffer strips
  - indirectly, by cutting use of inputs or better soil protection (e.g. in areas covered by catch crops (fast-growing crops grown between plantings of main crops) or nitrogen-fixing crops).

The total score of each indicator is calculated as average of scores for all of its parameters. The final number should be presented as integer.

The type depended assessments could be vary due to type or kind diversity.

The values of calculated scores of both structural and functional indicators are representative for the condition of the specific cropland ecosystem type. The value obtained must be rounded to the nearest first decimal place, and for the purpose of mapping to an integer.

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 grid used for mapping. More information regarding the efforts at the EU level to determine the most adequate and appropriate indicators to the ecosystem condition can be obtained via the web-pages of the institutions and research centers involved, for ex. 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.

The proposed example:

Table 6. Ecosystem staten indicator assessment template and calculation - example (Region Razgrad,)

Indicator type	Indicator group	Indicator	Parameter	Units	Data measured	Data source
Structural	Abiotic heterogeneity	Soil heterogeneity	Soil quality	Soil type/Land suitability	Scale range From 0 to 100	More than 75 - score = **5**
		Disturbance	Soil erosion risk	Scale - soil loss [t per ha per year]	Scale range From 0 to 100	Less than 5t/ha/y - score =**5**
			Soil acidification risk	Measured pH, soil base saturation [pH value - H_2O or KCl]	Scale range From 0 to 100	Less than 4 = score **1** More than 5 =score **4**
			Soil salinity risk	Measured soil salinity, soil conductivity, cation exchange capacity, content of water-soluble salts;area under irrigation [mS/cm; meq /100g]	Scale range, percent	more than 20% exchangeble of Na (T8,2) in meq/100 g soil = score **1;** less than5**% =** score **5**
			Soil pollution risk	Neighbour industrial areas, surrounding transpotrt facilities [km for distance, mg/kg - for concentratio ns (if exist)]	Limit values for pollutants (heavy metals, oil products, POPs)	Cd > 2 mg/kg = score **1;** <2 mg/kg =score **5**

Indicator type	Indicator group	Indicator	Parameter	Units	Data measured	Data source
	Biotic divercity	Crop divercity	Number and variety of crop types	Nember/ Dencity		One crop per area = score **3**
			Number of crops included in crop rotation	Number/ Years for crop rotation		For 5 year rotation plan = score **5** For more tnan 4 crops included = score **5**
Functional	Matter budget	Organic Matter	Content of soil organic matter or organic carbon	mg/kg		Less than 5 mg/kg = score **1**; more than 25 mg/kg = score **5**
		Total nitrogen content	Content of total nitrogenr	mg	Scale range	Less than 20mg - score **1**; more than 80 mg = score **5**
						Σni = 37

$$\sum n_i = 41; \sum n_i(max) = 45; n = 9$$

$$IP = 41/45 = 0.91$$

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 scores of each indicator measured are then summed up ($\sum n_i$).

An index of **ecosystem performance (IP)** is then calculated, as ratio of the sum of the indicators scores maximum possible indicator sum:

IP = $\sum n_i / \sum n_i(max)$ and belongs to the range (0 and 1)

Where:

$\sum n_i$ – sum of parameter assessment

$\sum n_i(max)$ – sum of the maximum of indicator 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 ecosystem 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 0,927 – 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:

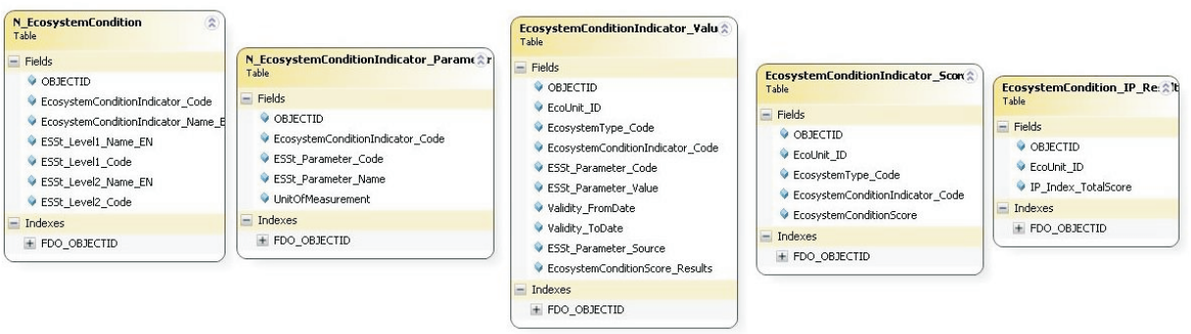


Figure 2: Ecosystem Condition Database Schema

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 cropland ecosystem services

6.1. Main types of services. Identification of indicators, parameters, data

Agro-ecosystems provide provisioning, regulating/maintenance,cultural, habitat or supporting services to human society. These services strongly respond to the socio-economic demands of human beings, but do not always consider the ecological demands of the ecosystem, i.e. the bio physical structure and processes that take place during the agricultural production. Indicators, parameters, dimensions/units and availability of data are given in Table 7. Indicators for assessing and mapping Ecosystem Services in Cropland ecosystems.

Agroecosystems also provide habitat resources such as food, water, shelter of many wild species. These can be species of conservation significance. For example, 70% of the world's population of red-breasted goose winter and feed in wheat fields in Kraymorie Dobrudja. Other species that depend on agroecosystems, which are of significance for conservation, common or pests for agriculture, are pinnacle and steppe poles, phyllons and other rodents, rabbits, partridges, pheasants, quails, oatsaraks, larks and many others. Habitats provide support for genetic diversity, for example, for the listed species are complementary habitats.

6.1.1. Provisioning services

There is significant evidence that most intensively managed agricultural systems produce services in an unsustainable way, in which the natural capital resources are progressively depleted at a high rate and not restored. For example, the changes in natural habitats, which are mostly due to intensive agricultural production systems, are one of the main causes of biodiversity loss and decrease in quality and quantity of ecosystem services. In addition, 30 % of species are threatened by overexploitation (Pérez-Soba et al., 2012).

While many ecosystem services or "benefits that humans derive from nature" are maintained or produced by agriculture, evidence suggests that some agricultural systems provide these services in an unsustainable way.

Caused land changes in crop ecosystems represent the integrating element between the economic, societal and environmental influences on agriculture. For **most** countries agricultural land occupies close to50 per cent of the total land area, with only a small reduction in area over the past 10 years, mainly through agricultural land being converted to forests in marginal farming areas. The change of marginal farming land to other land uses has raised concerns related to the associated harmful environmental and socioeconomic impacts in some countries, but equally the conversion of this land may enhance its biodiversity and related amenity values, OECD 2001, vol. 3.

Agriculture provides substantial ecosystem services which lead to several benefits that humans derive from nature. This report examines the quantitative connection between provisioning agro-ecosystem services in terms of food, fodder, fibers, and fuel supply and the ecological demands of these ecosystems.

The overall questions to be tackled in Assessmentofcropland ecosystemsservices are:

- How agricultural production fits into the existing concepts of ecosystem services?
- More specifically, how the ecosystem services concepts deal with provisioning services from agro-ecosystems, considering the fact that agricultural production results from strongly modified ecosystems and generally needs external anthropogenic energy inputs before a final output of biomass can be delivered;

- How the provisioning services provided by agro-ecosystems can beassessed in a quantitative way? E., Germer, L. and Smith, L., der (2012).

6.1.2. Regulating and Maintenance Services

Regulating ecosystem services are by nature closely related to ecosystem structures, processes and functions (Zhang et al., 2007).

Soil structure and *fertility* play a large role in determining where different kinds of farming take place and the quantity and quality of agricultural output. Earthworms and macro- and micro-invertebrates increase soil structure via burrows or casts and enhance soil fertility through partial digestion and communition of soil organic matter (Edwards, 2004). *Nutrient cycling* maintains soil fertility. Microorganisms (bacteria, fungi, actinomycetes) are critical mediators of this ecosystem service. For example, bacteria enhance nitrogen availability through the fixation of nitrogen from the atmosphere. This occurs most often in plants that have symbiotic relationships with N-fixing bacteria, but free-living soil bacteria can fix nitrogen as well (Vitousek et al., 2002). Microorganisms also enhance soil fertility by liberating nutrients from detrital organic matter (*e.g.* plant leaves) and retaining nutrients in their biomass that might otherwise be lost downstream (Pauland Clark, 1996). Non-crop plants can also be key to soil fertility—they are used to replenish nutrients to agricultural land during fallow periods (Ramakrishnan, 1992) or through the so called "rotation effect" (Pierce and Rice, 1988). While the processes above maintain soil fertility, *soil retention* is key to keeping those nutrients in place and available to crops. To do this, cover crops are used to retain soil and nutrients between crop cycles while hedgerows and vegetation along waterways reduce erosion and runoff from fields. Certain farming practices, such as mechanical plowing, disking, cultivating, and harvesting can decimate the flow of soil-based ES via disturbing the functioning of soil microbial communities. Conservation tillage, including both no tillage and minimum tillage (Brown, 2003) represents a valid approach to conserving these ES.

Insects provide vital ES to agriculture including dungburial, pest control, and pollination. Beetles in the family Scarabaei- dae are especially efficient at providing *dung burial* services (Ratcliffe, 1970). They decompose wastes generated by large animals (a potential EDS from agriculture), thereby recycling nitrogen, enhancing forage palatability, and reducing pest habitat, resulting in significant economic value for the cattle industry (Losey and Vaughan, 2006).

Crop pollination is perhaps the best known ES performed by insects (Losey and Vaughan, 2006). The production of over 75% of the world's most important crops that feed humanity and 35% of the food produced is dependent upon animal pollina¬tion (Klein et al., 2007). Bees comprise the dominant taxa providing crop pollination services, but birds, bats, moths, flies and other insects can also be important. Wild pollinators can nest within fields (e.g., ground nesting bees), or fly from nesting sites in nearby habitats to pollinate crops (Ricketts, 2004).

There has been increasing evidence that conserving wild pollinators in habitats adjacent to agriculture improves both the level and stability of pollination, leading to increased yields and income (Klein et al., 2003a).

Natural control of plant pests is provided by generalist and specialist predators and parasitoids, including birds, spiders, ladybugs, mantis, flies, and wasps, as well as entomopatho- genic fungi (Naylor and Ehrlich, 1997). This ES in the short term suppresses pest damage and improves yield, while in the long-term maintains an ecological equilibrium that prevents herbivore insects from reaching pest status. This important ES, however, is increasingly threatened by biodiversity loss (Wilby and Thomas, 2002), modern agricultural practices (Naylor and Ehrlich, 1997), and human alterations of natural ecosystems. For instance, insecticide use in agriculture tends to decimate natural enemy

populations, often having the unintended consequence of either exacerbating existing pest problems, or actually leading to the emergence of new pests (Krishna et al., 2003).

For beneficial insects to provide the above direct ES to agriculture, a number of subsequent supporting and regulat¬ing services are required. For example, predators and para- sitoids rely on a variety of plant resources such as nectar, pollen, sap, or seeds (Wilkinson and Landis, 2005) as alterna¬tive *food sources* to fuel adult flight and reproduction. Non-crop areas can provide *habitat* where beneficial insects mate, reproduce, and overwinter. Evidence shows that increased landscape complexity, which typically means increased availability of food sources and habitat for insects as compared to mono-culture landscapes, is correlated with diversity and abundance of natural enemy populations (Thies and Tscharntke, 1999), and with enhanced pest control in some cases (Thies et al., 2003). Enhanced abundance and diversity of natural enemies, however, do not necessarily provide enhanced pest control, since pest densities may also respond positively to landscape complexity (Thies et al., 2005).

In the face of evidence of population declines among beneficial insects (Kremen et al., 2002), interest is rising in habitat management to foster beneficial species. “Conserva¬tion biological control” of crop pests is founded on creating a suitable ecological infrastructure within the agricultural landscape to provide resources such as food for adult natural enemies, alternative prey or hosts, and shelter from adverse conditions (Landis et al., 2000). For wild pollinators, the construction of nest boxes, planting of native plant species with sequential flowering, and soil stabilization have been proposed (Vaughan et al., 2004), along with Integrated Pest Management practices that minimize the use of pesticides toxic to pollinators. Beyond specific local practices to protect habitat for beneficial insects, there is a growing evidence that diversified landscapes hold great potential for the conserva¬tion of biodiversity and sustaining ES performed by insects (Bianchi et al., 2006). The issues of coordinated habitat management at landscape scales are discussed in a separate section.

Water provision and *purification* fulfill requirements for water of sufficient quantity, timing, and purity for agricul¬tural production. Vegetation cover in upstream watersheds can affect the amount, quality, and stability of the water supply to agriculture. It is not clear that maintaining forest cover increases the absolute amount of water supplied to downstream areas. Other vegetation may do just as well (Groffman et al., 2004). What is clearer is that forests stabilize water flow to reduce differences in flow between wet and dry seasons (e.g., Yangtze basin (Guo et al., 2000)). Forests can also stabilize soil to reduce sediment load in rivers. In Australia, trees can improve water infiltration within woodlands, reducing surface runoff and soil salinization (Eldridge andFreudenberger, 2005). Wetlands and riparian vegetation can also improve water quality and attenuate floods (Houlahanand Findlay, 2004).

Genetic diversity provides the raw material for natural selection to produce evolutionary adaptations. Similarly, breeders of crops and domestic animals utilize existing genetic variation to select artificially for desirable traits. Failing to maintain sufficient genetic diversity in crops can incur high costs (Hawtin, 2000). For example, the Irish potato famine at the end of the 1830s can be attributed in part to the fact that there were so few different genetic strains of potatoes in the country, making the crop susceptible to the devastating potato blight fungus (Hawtin, 2000). The problem was resolved by using varieties in Latin America, where the potato had originated, that were resistant to the disease (Esquinas-Alcazar, 2001). Genetic diversity is not only important to avoiding catastrophic losses, but also improving or maintain¬ing agricultural productivity. Many important crops could not maintain commercial status without the regular genetic support of their wild relatives (de Groot et al., 2002). In addition, in many crop systems, particularly orchard crops and in the production of hybrid seed, different cultivars (genotypes) are required for seed or fruit set (Free, 1993; Delaplane and Mayer, 2000). Genetic diversity at the species level can also enhance biomass output per unit

of land through better utilization of nutrients and reduced losses to pests and diseases (see Tilman, 1999 for a detailed discussion).

In addition, agro-ecosystems provide habitats and accompanying resources such as food, water, shelter. For many important endangered species. For example, 70% of the world population of Red-breasted Goose wintering and food in wheat fields in coastal Dobrudzha. Other species that depend on agro-ecosystems conservation significance, ordinary or pests for agriculture are colorful and steppe polecat, voles and other rodents, rabbits, partridges, pheasants, quail, ortolan, larks and many others. Habitat provides maintenance of genetic diversity, for example. for listed species are complementary habitats.

Another (abiotic) form of ES to agriculture involves climate, including temperature and precipitation regimes but also the frequency and severity of extreme weather, droughts, floods, etc. Favorable climate confers a cost advantage to those who farm there. Suitable and stable climate relies on atmospheric *regulation*, which like many other ES is influenced by the functioning of multiple ecosystems (Zhang et al., 2007).

6.1.3. Cultural services

Valuation of cultural ecosystem services (CES) remains one of the most difficult and least accomplished tasks in ecosystem services research due to their intangible nature and due to several methodological concerns. Therefore, they are rarely fully considered in ecosystem service assessments ((Plieninger et al. 2013).Most of related quantifications and indicators reduce cultural ecosystem services to marketable services such as (eco)tourism and recreation (see review of Hernandez-Morcillo et al. 2013). More intangible cultural ecosystem services, such as landscape aesthetics, spiritual experience or knowledge systems, have been assessed based on interviews, questionnaires and hedonic price models. More recent studies tend to integrate further assessment tools like landscape metrics to assess landscape aesthetics (Frank et al. 2013), Participatory GIS (PGIS; Palomo et al. 2013; Plieninger et al. 2013; Fagerholm et al. 2012) or Delphi surveys (Scolozzi et al. 2012).

A clear distinction between potentials and flows is not trivial in the case of cultural ecosystem services. Schroter et al. (2014) assessed recreational residential amenity service potentials by delineating suitability of services providing ecosystems a location for second homes. Related ecosystem service flows were indicated based on existing cabins. Regarding to ecosystem services definition, we considered existing facilities such as cabins, hotels or recreational areas as well as occurring events as ecosystem service potentials (stocks). Nahuelhual et al. (2013) applied a comparable method to calculate and map recreation and ecotourism potentials versus recreation and ecotourism opportunities. Potentials were calculated based on tourism attraction capacity for locations with touristic facilities and natural attractions. Opportunities were indicated by tourism carrying capacities (maximum visitor number in the study area depending on physical and biological settings and management). Visitor or consumer carrying capacities can also be used to estimate ecosystem service flows related to potentials for several other cultural ecosystem services. Here, biophysical carrying capacities need to be considered, as well as the sensibility of visitors towards a maximum number of other visitors (Burkhard et al., 2014).

This fact can become relevant in crowded areas or periods (Brandt et al. 2013).

Lautenbach et al. (2011) evaluated demands for recreation services as the possibility for people to access the services. However, access is not always easy to specify for intangible services such as landscape aesthetics. One approach to solve this dilemma is creating viewsheds. Viewsheds can be lines of sight to connect view paths between source locations (e.g. aesthetic landscape features) and

locations for human use (areas of potential enjoyment; Bagstad et al. 2013b). Calculations are mainly carried out using Digital Elevation Models (DEM) in GIS.

The demand for spatially confined ecosystem services was recommended to be mapped at the location where the final beneficiary uses the ecosystem service by Schroter et al. (2012). For the time being, we decided to denote all benefitting entities, such as touristic infrastructure, educational and spiritual facilities, their visitors, communities or households (at home location). as service benefitting areas (or sites). However, we prefer to localise demands for cultural ecosystem services at the consumer's home site, i.e. the place where she/he spends the majority of the year. This strict definition still needs to be proven further. For example, it is not clear for how long recreational or spiritual experiences are "taken home" by the consumer or whether the demand should better be located within the SPUs.

The indicators and parameters for assessing the ecosystem services of *Cropland* 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 Common International Classification of Ecosystem Services (CICES), the classification scheme accepted by the MAES-initiative. As said above concerning the ecosystem condition indicators, after using the indicators for ecosystem services assessment listed in this methodology, the experts involved in the assessment may 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 Cropland ecosystems

Section	Division	Indicators' group	Indicator class	Indicator	Dimension/unit	Data availability
Provisioning	P1 Nutrition	Biomass	P1. Cultivated crops -1111 (kind, structure, ratio) +	harvest as % of country average , kind ratio	%, weight	Y
			P2. Reared animals and their outputs - 1112 +	livestock breeding	number/ha	Y/N
			P3. Wild plants, algae and their outputs - 1113 -	usage of plant biomass	kg/ha	Y
			P4. Wild animals and their outputs - 1114 -	usage of animal biomass	kg/ha	Y/N
			P5. Plants and algae from in-situ aquaculture - 1115 -	usage of plants and algae from in-situ aquaculture	kg/year	Y/N
			P6. Animals from in-situ aquaculture 1116 -	usage of animals from in-situ aquaculture	kg/year	Y/N
		Water	P7. Surface water for drinking 1221 +	Consumption of drinking water by population (PWS) by districts, average per capita	L/day/per capita	Y
				Public water supply	Mill. m3/year	Y
			P8. Ground water for drinking 1122 +	Public water supply from groundwater sources	Mill. m3/year	Y
			P9. Surface water for non-drinking purposes 1221 +	Total gross fresh water abstraction from fresh surface water. Type of facility. Area.	Mill. m3/year, ha	Y
			P10. Ground water for non-drinking purposes 1222 +	Total gross fresh water abstraction from fresh groundwater. Areea	Mill. m3/year, ha	Y

Section	Division	Indicators' group	Indicator class	Indicator	Dimension/unit	Data availability
Provisioning	P2 Materials	Biomass	P11. Fibers and other materials from plants, algae and animals for direct use or processing - 1211 +	Raw material input per capita	tonnes per capita	Y/N
				Raw material consumption per capita	tonnes per capita	Y/N
			P12.Materials from plants, algae and animals for agricultural use 1212 -	Animal and vegetal waste (excl. animal waste of food preparation and products; and excl. animal faeces, urine and manure)	tonnes	Y/N
			P121. Materials from plants, algae and animals for biochemicals and medicine-	Production of biochemicals, medicines	kg/ha	Y/N
			13. Genetic materials from all biota 1213 -	Biodiversity	number of species	Y
		Water	P15. Surface water for non-drinking purposes 1221 +	Total gross fresh water abstraction from surface water.		
				Type of facility.		
				Area.		
			P16. Ground water for non-drinking purposes 1222 +	Total gross fresh water abstraction from fresh groundwater.		
				Areea		
		Mineral resources	P17. Minerals extractable close from surface or above surface (e.g. sand for construction, lignite, gold, salts). +	Minerals available for extraction	t/ha	Y
	P3 Energy	P3 Biomass-based energy sources	P18. Plant-based resources for energy 1311 +	Crops or plants biomass with potential use as energy source	kg/ha, ha	Y/N
			P19. Animal-based resources 1321 -	Animal products used for energy	*kg/capita*	*N*
		P3 Abiotic energy sources	P20. Abiotic energy sources used for conversion – solar +	solar-energy potential, agr. land occupied by PV	kWh/year, ha	Y
	R1 - Mediation of waste, toxics and other nuisances	Mediation by ecosystems	R1. Filtration/sequestration/storage/accumulation by ecosystems 2112 +	Green infrastructure	percentage or the total area	Y
				Total Carbon stock (biomass + soils)	t/ha	Y/N
				Type of vegetation cover	Percentage of vegetation cover	Y
			R2. Dilution by atmosphere, freshwater and marine ecosystems 2122 +	Total emissions in the air	tonnes	Y
			R3. Mediation of smell/noise/visual impacts 2123 -	Registered noise levels /by district and town/	decibels	Y/N
	R2 – Mediation of flows	Mass flows	R4. Mass stabilization and control of erosion rates 2211 +	Average annual soil erosion loss	m/ha/year	Y/N
			R5. Buffering and attenuation of mass flows 2212 -	reclamation sites	number/ reclaimed area	Y/N
		Liquid flows	R6. Hydrological cycle and water flow maintenance 2221 +	Mean annual river discharge	mm/year	Y
				Natural groundwater descharge	l/s/km^2	Y
			R7. Flood protection 2222 -	floods causing damages	number	Y/N
		Gaseous / air flows	R8. Storm protection 2231 -	recorded cases of tournedos	number	Y/N
			R9. Ventilation and transpiration 2232 +	Transpiration/evapotranspiration	mm	Y
	R3 - Maintenance of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	*R10. Pollination and seed dispersal 2311*++	*Bees, birds, bats, moths, flies, wind, non-flying animals contributing to pollen transfer and reproduction of plants.Linear features supporting pollination.*	*ha, m, n.m.*	*N/A [**high importance Class** - data will be available through ESTIMAP model and implemented NINA/IBER project]*
			R11. Maintaining nursery populations and habitats 2312 +*	protected sites/ protected area	number/ m2	
				nursary plantations	number/ m2	Y

Section	Division	Indicators' group	Indicator class	Indicator	Dimension/unit	Data availability
	R3 - Maintenance of physical, chemical, biological conditions	Pest and disease control	*R12. Pest control 2321* +	*Pest density, Crop rotation application.*	*number/ m2*	*N/A*
			R13. Disease control 2322 -	average age of the population	years	Y/N
		Soil formation and composition	R14. Weathering processes 2331 -	soil degradation	soil degradation index	Y/N
			R15. Decomposition and fixing processes 2332 +	Soil organic matter	%	Y
		Water conditions	R16. Chemical condition of freshwaters 2341 +	Water quality parameters	-	Y
		Atmospheric composition and climate regulation	R17. Global climate regulation by reduction of greenhouse gas concentrations 2351 +	Organic matter stock	total t CO_2 eq/ha (t C/ha)	Y
				Green infrastructure area	ha/capita	Y
			R18. Micro and regional climate regulation 2352 -	human thermal comfort in January/July	Stages	Y/N
Cultural	C1 - 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 3111 -	land cover	Number of visitors	Y/N
			C2. Physical use of land-/seascapes in different environmental settings 3112 +	land use (farm tourism, walking and biking trails,etc.)	Number of visitors	Y
		Intellectual and representative interactions	C3. Scientific 3121 -	scientific studies on ecosystems	Number of published scientific papers	Y/N
			C4. Educational 3122 -	educational activities (festivals, visiting centers, green school, etc.)	Number of educated persons; number of activities per year	Y/N
			C5. Heritage, cultural 3123 +	Land cover (cultural monuments, landscapes, etc.)	Number of visitors Number of cultural attractions	Y
			C6. Entertainment 3124 +	leisure and SPA facilities	Number of visitors or facilities Number of tourist attractions	Y
			C7. Aesthetic 3125 -	naturalness land cover	Number of endangered, protected or rare species or habitats; Number of visitors	Y/N
	C2 - Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes [environmental settings]	Spiritual and/or emblematic	C8. Symbolic 3211 +	emblematic sites	number	Y
			C9. Sacred and/or religious 3212 +	sacret and/or religious sites	number	Y
		Other cultural outputs	C10. Existence 3221+	conservation significance	Number of protected areas per ha	Y
			C11. Bequest 3222 +	conservation significance	Number of protected species /trees/protected areas	Y

++ vey important class (data preparation is in progress)

+ important class (with data available or expert assessment c'd be provided)

- important but poor data available, or data is available partly for different areas, or data is unavailable

6.2. Assessment of Ecosystem services

Step 1: Indicators for Ecosystem services assessment for Croplandecosystems

Promising attempts for defining and categorising ecosystem services have beenundertaken for example by TEEB (2010), MA (2005) or CICES. We use the following definition for ecosystem services: "Ecosystem services are the contributions of ecosystem structure and function – in combination with other inputs – to human well-being" (Burkhard et al. 2012). A more detailed look into these contributions reveals difficulties distinguishing between ecosystem structures, functions, stocks, actual flows

and beneficiaries (the “ecosystem services cascade” components; Haines-Young &Potschin 2010). This includes the idea that ecosystems provide a certain potential to supply services based on their functioning (van Oudenhoven et al. 2012). The demand for these potential services from society converts them into real ecosystem services(Burkhard et al., 2014).

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.

Problems with the share of natural ecosystem inputs to the supply of provisioning agro-ecosystem services remain, similarly to problems with regulating ecosystem services. Anthropogenic inputs are likely to be higher in assessed provisioning ecosystem service flows than in related potentials for the same service. This effect can be found in many agricultural systems requiring many inputs.

The supply of other, more nature-based provisioning ecosystem services, such as freshwater for example, can be very hard to localise appropriately based on surface data (such as land cover) alone. If the water is not withdrawn from surface reservoirs but from groundwater, the aquifer’s location has to be considered as service providing unit.

Besides location, temporal aspects are of high relevance when quantifying provisioning ecosystem services. Single events like agricultural harvests, normally taking place only 1-3 times per year (depending on geographical conditions), can definitely be named as hot moments of provisioning ecosystem service supply. During the growing season, the provisioning ecosystem service potential

increases constantly, whereas the flows temporarily remain more or less at zero until the final harvest.

During harvest, the potential decreases dramatically, therefore, rural agricultural landscapes are characterized by regular growth and harvest phases, reflected by related changes in their ecosystem service supply (Burkhard et al. 2012).

Of course, additional agricultural strategies and crops with various growing and harvesting rhythms exist. Better information on these variations is highly relevant for site-specific cropland management, i.e. to optimise additional inputs. Respective seasonal patterns can be found for regulating (e.g. during storm or rain seasons) and cultural ecosystem service (e.g. tourist season) supply (and demand) as well. Other provisioning ecosystem services, such as timber, show much longer rotation periods taking several decades to grow before being harvested rather suddenly. Therefore, the selection and definition of appropriate temporal assessment scales have to be carried out very carefully.

Regulating ecosystem services are by nature closely related to ecosystem structures, processes and functions. For some regulating ecosystem services, such as nutrient flow, water flow or waste regulation, clear overlaps with ecosystem functions like nutrient or water cycling are obvious in almost all current ecosystem service categorisation systems.

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

Many regulating ecosystem services are not perceived as services by the public because they lack clear (direct) benefits to the society, although progress has been made in their evaluation (see Kumar & Wood 2010).

The perhaps most prominent example here is pollination, one of the regulating ecosystem services

assessed and mapped frequently (Schulp et al. 2014; Lautenbach et al. 2011). The final good would be the fruit or flower to be consumed or enjoyed, whereas the pollination process itself (the pollen transfer) would be an intermediate service (according to Fisher et al. 2009), or perhaps even better would be treated as ecosystem function (Boyd and Banzhaf 2007).

The amount of pollinated plants was then used to indicate actual pollination service flow. According to Lautenbach et al. (2011), demand for pollination services is generated by the farmer's decision to plant crops depending on/profit from pollination.

Cropland ecosystem services assessed to be additional anthropogenic system inputs such as fertiliser, water, energy, technology, labour or knowledge affecting especially regulating ecosystem service supply (e.g. regulation of nutrients, erosion, natural hazards or water flows)(Burkhard et al., 2014).

Cultural ecosystem services are difficult to assess due to their intangible nature and due to severalmethodological concerns. Therefore, they are rarely fully considered in ecosystem service assessments (Plieninger et al. 2013). Most of related quantifications and indicators reduce cultural ecosystem services to marketable services such as (eco)tourism and recreation (see review of Hernández-Morcillo et al. 2013). We considered existing facilities such as cabins, hotels, wine cellars, chateaus, bio-farms, freegrazing areas or recreational areas as well as occurring events as ecosystem service potentials. The actual utilisation of these facilities or events is used to indicate cultural ecosystem service.

Ecosystem servicescould be assessed based on tourism attraction capacity for locations with touristic facilities and natural attractions. Opportunities were indicated by tourism carrying capacities (maximum visitor number in the study area depending on physical and biological settings and management). Visitor or consumer carrying capacities can also be used to estimate ecosystem service flows related to potentials for several other cultural ecosystem services. Here, biophysical carrying capacities need to be considered, as well as the sensibility of visitors towards a maximum number of other visitors.

Information on ecosystem service potentials should be used to assess future options for long-term landscape planning and environmental management in terms of sustainable flows of ecosystem services. Ecosystem service maps are useful for sustainable decision making, for example by identifying supplydemand mismatches across landscapes and their changes over time. They should not be used to enhance human exploitation of natural resources. Therefore, appropriate institutions to sustainably manage ecosystem services on spatial and temporal scales that match the scales of the service supply and demand should be established.

Step 2: Collect data – national datasets – Annex 5

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*

Step 3: How to assess

The assessment of ecosystem services is a further step in 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. For the most of the cases the better condition and larger the area the higher value of service could be provided. On some cases the provided ecosystem service doesn't depend strictly on condition of the ecosysytem. 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.

During project implementation the applicants should collect precise data by each parameter and further on it will be subject of valuation. Some of the indicators are easelyparametrized and their ecosystem capacity is based on measerable data. One of the project outputs should be development of "Scoring" table for ecosystem service assessment. Example for such table can be found in Table 8.

The assessment of ecosystem services is based on real parameters (measurable and available) and presents the Real (expert assessed). The assignments in Table 8 are based on expert evaluations 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 8. Scoring table for ecosystem service assessment

Section	Division	Group	Class	Indicator	Parameters andunits	Measurement approach	Ecosystem type	Assesment scale and score				
								Score 1	Score 2	Score 3	Score 4	Score 5
Provisioning	P1 Nutrition	Biomass	Cultivated crops (kind, structure, ratio) +	harvest as % of country average, kind ratio	t/ha or harvested as % of country average		**201**	<0.5	0.5-1.0	1.1-2.5	2.6-4.0	>4.0
							202	<1.5	1.5-3.0	3.1-5.0	5.1-7.0	>7.0
							203	<2.5	2.6-3.5	3.6-4.5	4.6-5.5	>5.5
							204	<0.5	0.5-1.0	1.1-2.5	2.6-4.0	>4.0
							205	<25	25-50	51-100	101-150	>150
			Reared animals and their outputs+	livestock breeding	number/ha	Number of bees per ha from the teritory of the respective municipality	**201**	<1300	1301-2700	2701-4200	4201-8000	>8000
							202	<1300	1301-2700	2701-4200	4201-8000	>8000
							203	<1300	1301-2700	2701-4200	4201-8000	>8000
							204	<1300	1301-2700	2701-4200	4201-8000	>8000
							205	<1300	1301-2700	2701-4200	4201-8000	>8000

Section	Division	Group	Class	Indicator	Parameters andunits	Measurement approach	Ecosystem type	Assesment scale and score				
								Score 1	Score 2	Score 3	Score 4	Score 5
Provisioning	P1 Nutrition	Biomass	Reared ani-mals and their out-puts+	livestock breeding	number/ha	Number of pigs per ha from the teritory of the respective municipality	201	<0.00 1	0.002-0.01	0.02-0.04	0.05-0.2	>0.2
							202	<0.00 1	0.002-0.01	0.02-0.04	0.05-0.2	>0.2
							203	<0.00 1	0.002-0.01	0.02-0.04	0.05-0.2	>0.2
							204	<0.00 1	0.002-0.01	0.02-0.04	0.05-0.2	>0.2
							205	<0.00 1	0.002-0.01	0.02-0.04	0.05-0.2	>0.2
						Number of birds per ha from the teritory of the respective municipality	201	0	1	2.0-3.0	4.0-5.0	>5.0
							202	0	1	2.0-3.0	4.0-5.0	>5.0
							203	0	1	2.0-3.0	4.0-5.0	>5.0
							204	0	1	2.0-3.0	4.0-5.0	>5.0
							205	0	1	2.0-3.0	4.0-5.0	>5.0
						Number of ruminants per ha from the teritory of the respective municipality	201	<0.04	0.04-0.06	0.07-0.1	0.11-0.15	>0.15
							202	<0.04	0.04-0.06	0.07-0.1	0.11-0.15	>0.15

Section	Division	Group	Class	Indicator	Parameters andunits	Measurement approach	Ecosystem type	Assesment scale and score				
								Score 1	Score 2	Score 3	Score 4	Score 5
Provisioning	P1 Nutrition	Biomass	Reared animals and their outputs+	livestock breeding	number/ha	Number of ruminants per ha from the teritory of the respective municipality	203	<0.04	0.04-0.06	0.07-0.1	0.11-0.15	>0.15
							204	<0.04	0.04-0.06	0.07-0.1	0.11-0.15	>0.15
							205	<0.04	0.04-0.06	0.07-0.1	0.11-0.15	>0.15
			Wild animals and their outputs	Usage of wild animal biomass	kg/ha/yr	Wild animal biomass (kg) for potencial usage per ha from the respective state forestry per year	201	<0.5	0.5-0.7	0.8-1.0	1.1-1.5	>1.5
							202	<0.5	0.5-0.7	0.8-1.0	1.1-1.5	>1.5
							203	<0.5	0.5-0.7	0.8-1.0	1.1-1.5	>1.5
							204	<0.5	0.5-0.7	0.8-1.0	1.1-1.5	>1.5
							205	NR	NR	NR	NR	NR
		Water	Surface water for drinking+	Consumption of drinking water by population (PWS) by districts, average per capita (Public water supply)	L/day/per capita or Mill. m3/year	Surface water consumption for drinking by the respective municipality (mill m3/yr)	201	<0.1	0.11-0.25	0.26-0.70	0.71-2.2	>2.2
							202	<0.1	0.11-0.25	0.26-0.70	0.71-2.2	>2.2
							203	<0.1	0.11-0.25	0.26-0.70	0.71-2.2	>2.2
							204	<0.1	0.11-0.25	0.26-0.70	0.71-2.2	>2.2
							205	<0.1	0.11-0.25	0.26-0.70	0.71-2.2	>2.2
			Groundwater for drinking+	Public water supply from groundwater sources	Mill. m3/year	Groundwater consumption for drinking by the respective	201	<0.3	0.31-0.70	0.71-1.40	1.41-3.20	>3.20
							202	<0.3	0.31-0.70	0.71-1.40	1.41-3.20	>3.20
							203	<0.3	0.31-0.70	0.71-1.40	1.41-3.20	>3.20
							204	<0.3	0.31-0.70	0.71-1.40	1.41-3.20	>3.20

Section	Division	Group	Class	Indicator	Parameters andunits	Measurement approach	Ecosystem type	Assesment scale and score				
								Score 1	Score 2	Score 3	Score 4	Score 5
Provisioning	P1 Nutrition	Water	Ground water for drin king+	Public water supply from groundwater sources	Mill. m3/year	municipality (mill m3/yr)	205	<0.3	0.31-0.70	0.71-1.40	1.41-3.20	>3.20
	P2 Materials	Biomass	Fibers and other materials from plants, algae and animals for direct use or processing +	Raw material input per capita or Raw material consumption per capita/ Animal and vegetal waste (excl. animal waste of Animal and vegetal waste (excl. animal waste of faeces, urine and manure)	tonnes/kg per capita/ number	Weight of food inputs per capita at national level (kg(l)/yr)	201a*	<1.5	1.5-4.0	5.0-8.0	9.0-15.0	>15
							201b*	0	0.01-0.04	0.05-0.2	0.3-0.7	>0.7
							202	0	0.01-0.1	0.11-0.2	0.3-0.7	>0.7
							203	<2	3.0-4.0	5.0-7.0	8.0-10.0	>10
							204	0	0.01-0.04	0.05-0.2	0.3-0.7	>0.7
							205a*	<0.2	0.2-0.5	0.6-1.0	2.0-3.0	>3.0
							205b*	<15	15-20	21-30	31-40	>40
							205c*	<10	10.0-15.0	16.0-20.0	21.0-30.0	>30
			Biodi-versity			Number of wild species ancestors of crop and livestock species (number per municipality)	201	<23	23-24	25-26	27-28	>28
							202	<23	23-24	25-26	27-28	>28
							203	<23	23-24	25-26	27-28	>28
							204	<23	23-24	25-26	27-28	>28
							205	<23	23-24	25-26	27-28	>28
		Mineral resources	Minerals extractable close from surface or above surface (e.g. sand for construction, lignite, gold, salts). +	Minerals available for extraction	t/ha	Land occupied by the activity as % of total municipality teritory	201	0	0.01-0.1	0.11-0.2	0.21-0.3	>0.3
							202	0	0.01-0.1	0.11-0.2	0.21-0.3	>0.3
							203	0	0.01-0.1	0.11-0.2	0.21-0.3	>0.3
							204	0	0.01-0.1	0.11-0.2	0.21-0.3	>0.3
							205	0	0.01-0.1	0.11-0.2	0.21-0.3	>0.3

Section	Division	Group	Class	Indicator	Parameters andunits	Measurement approach	Ecosystem type	Assesment scale and score				
								Score 1	Score 2	Score 3	Score 4	Score 5
Provisioning	P3 Energy	P3 Biomass-based energy sources	Plant-based resour-ces for energy+	Crops or plants biomass with potential use as energy source	kg or t/ha, ha	Real capacity to yield rape (Brassica napus) with potential use as a energy source (t/ha)	201	<12	13-18	19-24	25-30	>30
							202	NR	NR	NR	NR	NR
							203	NR	NR	NR	NR	NR
							204	NR	NR	NR	NR	NR
							205	NR	NR	NR	NR	NR
		P3 Abiotic energy sources	Abiotic energy sources used for conver-sion – solar +	solar-energy potential, agr. land occupied by PV	kWh/year, ha	Solar-energy potential (kWh/m2/yr)	201	<1200	1200-1300	1301-1400	1401-1500	>1500
							202	<1200	1200-1300	1301-1400	1401-1500	>1500
							203	<1200	1200-1300	1301-1400	1401-1500	>1500
							204	<1200	1200-1300	1301-1400	1401-1500	>1500
							205	<1200	1200-1300	1301-1400	1401-1500	>1500
Regulating & maintenance	R1 - Mediation of waste, toxics and other nuisances	Mediation by ecosystems	Filtra-tion/s eques tratio n/sto rage/ accu-mula-tion by ecosys-tems +	Total Carbon stock (biomass + soils) or Type of vegetation cover	percentage or t/ha or the total area or Percentage of vegetation cover	Total Carbon stock (biomass + soil) (TC/ha)	201	<20	21-30	31-40	41-50	>50
							202	<20	21-30	31-40	41-50	>50
							203	<20	21-30	31-40	41-50	>50
							204	<20	21-30	31-40	41-50	>50
							205	<20	21-30	31-40	41-50	>50
			Dilution by atmo-sphere, fresh water and marine ecosy stems +	Total emissions in the air	tonnes	Total gas emmisions (Mg per 55 kmx55 km grid per year)	201	<5000	5000-7000	7001-10000	10001 - 19000	>19000
							202	<5000	5000-7000	7001-10000	10001 - 19000	>19000
							203	<5000	5000-7000	7001-10000	10001 - 19000	>19000
							204	<5000	5000-7000	7001-10000	10001 - 19000	>19000
							205	<5000	5000-7000	7001-10000	10001 - 19000	>19000

Section	Division	Group	Class	Indicator	Parameters andunits	Measurement approach	Ecosystem type	Assesment scale and score				
								Score 1	Score 2	Score 3	Score 4	Score 5
Regulating & maintenance	R2 – Mediation of flows	Mass flows	Mass stabili-zation and control of erosion rates +	Average annual soil erosion loss	m/ha/year	Risk of soil erosion (t/ha/yr)	201	>40	20-40	10,0-19,0	5,0-9,0	<5
							202	>40	20-40	10,0-19,0	5,0-9,0	<5
							203	>40	20-40	10,0-19,0	5,0-9,0	<5
							204	>40	20-40	10,0-19,0	5,0-9,0	<5
							205	>40	20-40	10,0-19,0	5,0-9,0	<5
		Liquid flows	Hydro-logical cycle and water flow mainte-nance+	Mean annual river discharge	mm/year or m3/s	Natural surface-water discharge	201	<0.4	0.4-2.0	3.0-15.0	16.0-50.0	>50,0
							202	<0.4	0.4-2.0	3.0-15.0	16.0-50.0	>50,0
							203	<0.4	0.4-2.0	3.0-15.0	16.0-50.0	>50,0
							204	<0.4	0.4-2.0	3.0-15.0	16.0-50.0	>50,0
							205	<0.4	0.4-2.0	3.0-15.0	16.0-50.0	>50,0
		Gaseous / air flows	Storm prote ction	Precence of hedges	ha or %	Storm protected area (ha of hedges/UTM)	201	<3	3.0-10.0	11.0-30.0	31.0-80.0	>80
							202	<3	3.0-10.0	11.0-30.0	31.0-80.0	>80
							203	<3	3.0-10.0	11.0-30.0	31.0-80.0	>80
							204	<3	3.0-10.0	11.0-30.0	31.0-80.0	>80
							205	<3	3.0-10.0	11.0-30.0	31.0-80.0	>80
			Venti-lation and trans-pira-tion+	Transpira-tion/evapo transpi-ration	mm or mm/yr	Potencial of crops to evapotrans pirate (mm/yr)	201	<300	300-400	401-500	501-650	>650
							202	<300	300-400	401-500	501-650	>650
							203	<300	300-400	401-500	501-650	>650
							204	<300	300-400	401-500	501-650	>650
							205	NR	NR	NR	NR	NR
	R3 - Maintenance of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	*Polli-nation and seed disper-sal+ +*	*Bees, birds, bats, moths, flies, wind, non-flying animals contribu-ting to pollen*	*ha, m, n.m., %*	% of municipality cropland occupated by croplands maintaining pollinators	201	<1	1.0-10.0	11.0-20.0	21.0-30	>30
							202	<1	1.0-10.0	11.0-20.0	21.0-30	>30
							203	<1	1.0-10.0	11.0-20.0	21.0-30	>30

Section	Division	Group	Class	Indicator	Parameters andunits	Measurement approach	Ecosystem type	Assesment scale and score				
								Score 1	Score 2	Score 3	Score 4	Score 5
Regulating & maintenance	R3 - Maintenance of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	*Pollination and seed dispersal++*	*transfer and reproduction of plants. Linear features supporting pollination or Croplands maintaining pollinators*	*ha, m, n.m., %*	% of municipality cropland occupated by cropland maintaining pollinators	204	<1	1.0-10.0	11.0-20.0	21.0-30	>30
							205	<1	1.0-10.0	11.0-20.0	21.0-30	>30
			Maintaining nursery populations and habitats+	protected sites/ protected area/ nursary plantations	number/ m2 or %	% of overlaping of AE with protected areas	201	0	0.1-10	11.0-30.0	31.0-50.0	>50
							202	0	0.1-10	11.0-30.0	31.0-50.0	>50
							203	0	0.1-10	11.0-30.0	31.0-50.0	>50
							204	0	0.1-10	11.0-30.0	31.0-50.0	>50
							205	0	0.1-10	11.0-30.0	31.0-50.0	>50
		Pest and disease control	*Pest control+*	*Pest density, Crop rotation application or Natural lands*	*number/ m2/ %*	% of natural lands on municipality level	201	<20	20-30	31-50	51-70	>70
							202	<20	20-30	31-50	51-70	>70
							203	<20	20-30	31-50	51-70	>70
							204	<20	20-30	31-50	51-70	>70
							205	<20	20-30	31-50	51-70	>70
		Soil formation and composition	Soil degradation	Soil degradation	area	Soil degradation index expressed by the reduction of NDVI/ha/yr	201	>8,0	5,0-8,0	3,0-4,9	1,0-2,9	0
							202	>8,0	5,0-8,0	3,0-4,9	1,0-2,9	0
							203	>8,0	5,0-8,0	3,0-4,9	1,0-2,9	0
							204	>8,0	5,0-8,0	3,0-4,9	1,0-2,9	0
							205	>8,0	5,0-8,0	3,0-4,9	1,0-2,9	0
			Decomposition and fixing processes+	Soil organic matter	Weight (%)	Soil organic matter	201	<0.5	0,5-1,0	1,1-2,5	2,6-5,0	>5,0
							202	<0.5	0,5-1,0	1,1-2,5	2,6-5,0	>5,0
							203	<0.5	0,5-1,0	1,1-2,5	2,6-5,0	>5,0

Section	Division	Group	Class	Indicator	Parameters andunits	Measurement approach	Ecosystem type	Assesment scale and score				
								Score 1	Score 2	Score 3	Score 4	Score 5
Regulating & maintenance	R3 - Maintenance of physical, chemical, biological conditions	Soil formation and composition	Decomposition and fixing processes+	Soil organic matter	Weight (%)	Soil organic matter	204	<0.5	0,5-1,0	1,1-2,5	2,6-5,0	>5,0
							205	<0.5	0,5-1,0	1,1-2,5	2,6-5,0	>5,0
		Water conditions	Chemical condition of fresh waters +	Water quality parameters	eco index	Eco_quantity state of groundwater	201	мн/лошо	лошо	умерено	добро	отлично
							202	мн/лошо	лошо	умерено	добро	отлично
							203	мн/лошо	лошо	умерено	добро	отлично
							204	мн/лошо	лошо	умерено	добро	отлично
							205	мн/лошо	лошо	умерено	добро	отлично
		Atmospheric composition and climate regulation	Global climate regulation by reduction of green house gas concentrations+	Organic matter stock	total t CO_2 eq/ha (t C/ha)		201	NR	NR	NR	NR	NR
							202	<5	5	6	7	>7
							203	NR	NR	NR	NR	NR
							204	NR	NR	NR	NR	NR
							205	NR	NR	NR	NR	NR
				Green infrastructure area/Micro and regional climate regulation Human termal confort	ha/capita/ ratio	human thermal comfort in January/July. ratio between January/July temperatures	201	⩽0	0.01-0.02	0.03-0.08	0.09-0.12	>0.12
							202	⩽0	0.01-0.02	0.03-0.08	0.09-0.12	>0.12
							203	⩽0	0.01-0.02	0.03-0.08	0.09-0.12	>0.12
							204	⩽0	0.01-0.02	0.03-0.08	0.09-0.12	>0.12
							205	⩽0	0.01-0.02	0.03-0.08	0.09-0.12	>0.12
	C1 - Physical and intellectual interactions with biota, ecosystems, and land-/seascapes [environmental settings]	Intellectual and representative interactions	Physical use of land-/seascapes in different environmental settings +	land use (farm tourism, walking and biking trails,etc.)	Number of visitors	Physical use of land (number of touristic attractions)	201	0	1	2	3	>3
							202	0	1	2	3	>3
							203	0	1	2	3	>3
							204	0	1	2	3	>3
							205	0	1	2	3	>3
			Scientific	Scientific studies (number)	Scientific studies on ecosystems	Number of published scientific papers	201	0	1	2	4	>4

Section	Division	Group	Class	Indicator	Parameters andunits	Measurement approach	Ecosystem type	Assesment scale and score				
								Score 1	Score 2	Score 3	Score 4	Score 5
	C1 - Physical and intellectual interactions with biota, ecosystems, and land-/seascapes [environmental settings]	Intellectual and representative interactions	Scien-tific	Scientific studies (number)	scientific studies on ecosystems	Number of published scientific papers	202	0	1	2	4	>4
							203	0	1	2	4	>4
							204	0	1	2	4	>4
							205	0	1	2	4	>4
			Heri-tage, cultural +	Land cover (cultural monu-ments, landscapes etc.)	number/ ratio	Number of cultural attractions per 1 km radios around AE	201	0	1	2	3	>3
							202	0	1	2	3	>3
							203	0	1	2	3	>3
							204	0	1	2	3	>3
							205	0	1	2	3	>3
			Enter-tainm-ent+	agrecul-tural festivals	number	number of agrecultura l festivals per year	201	0	1	2	3	>3
							202	0	1	2	3	>3
							203	0	1	2	3	>3
							204	0	1	2	3	>3
							205	0	1	2	3	>3
			Aeste-tic	Naturalness	number or area or ratio	Number of endangered, protected or rare species conected with AE (food or habitat) calculated for the teritory of the respective municipality	201	1	2	3	4	>4
							202	1	2	3	4	>4
							203	1	2	3	4	>4
							204	1	2	3	4	>4
							205	1	2	3	4	>4

Section	Division	Group	Class	Indicator	Parameters andunits	Measurement approach	Ecosystem type	Assesment scale and score				
								Score 1	Score 2	Score 3	Score 4	Score 5
	C2 - Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes [environmental settings]	Spiritual and/or emblematic	Symbo-lic+	emblema-tic sites	number or area or ratio	Number of villages named on cropland or livestock	201	0	1	2	3	>3
							202	0	1	2	3	>3
							203	0	1	2	3	>3
						species per municipality	204	0	1	2	3	>3
							205	0	1	2	3	>3
			Sacred and/or religi-ous+	sacret and/or religious sites	number or area or ratio	Number of sacred and/or religious sites in 1 km radius around AE	201	0	1	2	3	>3
							202	0	1	2	3	>3
							203	0	1	2	3	>3
							204	0	1	2	3	>3
							205	0	1	2	3	>3
		Other cultural outputs	Exis-tence+	conserva-tion significance	Number of protected areas per ha	Number of protected areas per ha	201	0			1	>1
							202	0			1	>1
							203	0			1	>1
							204	0			1	>1
							205	0			1	>1
			Bequest +	conser-vation significance	Number of protected species /trees/protec-ted areas	Number of protected species protected areas per UTM	201	0	1	2	3	>3
							202	0	1	2	3	>3
							203	0	1	2	3	>3
							204	0	1	2	3	>3
							205	0	1	2	3	>3

1	Low relevant	2	Relevant capacity	3	Medium relevant capacity	4	High relevant capacity	5	Very high relevant capacity

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 9. Assessment of cropland ecosystem services

Large-scale intensive unmixed crops (>25ha)	**ES subtype**	**ESs division code**																
		P1	**P2**	**P3**	**P9**	**P10**	**P11**	**P18**	**R1**	**R2**	**R4**	**R6**	**R9**	**R10**	**R12**	**R15**	**R16**	**C2**	**C5**
	I1.11	5	4	1	3	3	4	5	2	3	3	4	4	4	4	3	2	1	1

1	Low relevant	2	Relevant capacity	3	Medium relevant capacity	4	High relevant capacity	5	Very high relevant capacity

Step 4: Fulfill the matrix

The template of the matrix with the proposed subtypes is presented in Table 9.

The ecosystem service matrix consists of cropland ecosystem services (currently 3 regulating, 3 provisioning and 2 cultural services; according to Table 9) on the x-axis and each urban ecosystem subtype (I1.xx to I2.xx) on the y-axis. At the intersections, the different cropland sub-type for realized ecosystem service potential capacity should be assessed on a scale from 1 (no relevant supply) to 5 (maximum relevant supply) according to the mean scores obtained in Table 9 for each ESs type sub-division. The score obtained in Table 9 should be used as integer. For further description of the method see Burkhard et al. (2009, 2012). The normalization to this relative 1-5 scale aims at making different ecosystem services (measured and assessed by various indicators and units) comparable with each other.

Table 10. Summarized data for the cropland ecosystem subtypes at national level (example values are given in the first row).

		Cropland ecosystem subtypes													
		I 1					I 2					FB 3		FB 4	
		I 1.1	I 1.2	I 1.3	I 1.4	I 1.5	I 2.1	I 2.2	I 2.3	X 06	X 07	FB 31	FB 32	FB 41	FB 42
ESs class codes CICES	1111	5	5	5	4	4	4	4	3	5	5	5	4	5	5
	1112														
	1113														
	1114														
	1115														
	1116														
	1121*														
	1122														
	1211														
	1212														
	1213														
	1221														
	.....														
	.....														
	3221														
	3222														

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

6.3. Mapping of Ecosystem services

The following section describes the procedure of mapping the ecosystem services, specifications of the final products for the maps and databases, and gives references to the Annexes to this document where database 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

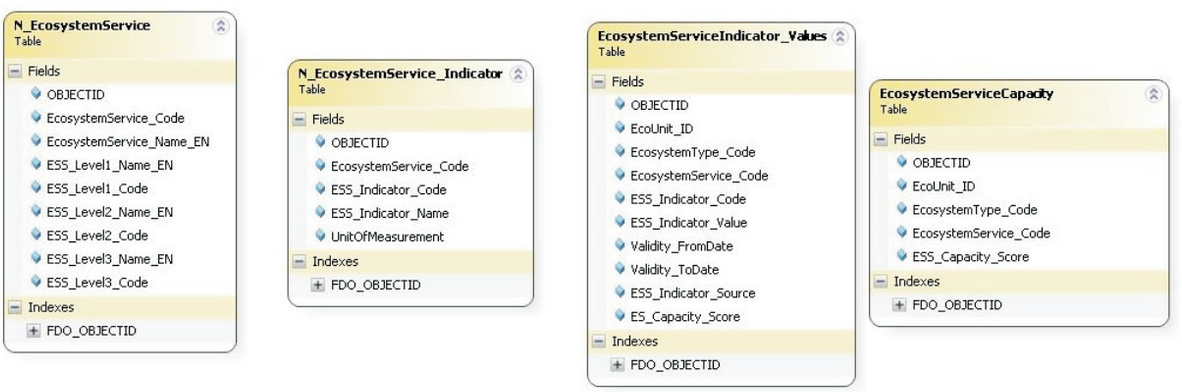


Figure 3: Ecosystem Services Database Schema

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:
  - coUnit_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-B2

Terms and definitions

	Subtype	Description
1.	Annual crops (mostly cereals)	Land used primarily for the production and harvest of annual crops - cereals, vegetables.
2.	Perennial crops (fruit gardens and vineyards)	Land used primarily for the production and harvest of perennial fruit crops - orchards, fruit gardens, or land used primarily for the production and harvest of perennial crops - vineyards.
3.	Perennial crops (mostly legumes)	Land used primarily for the production and harvest of perennial crops for forage and pastures. Lands composeof introduced or domesticated native forage species that isused primarily for theproduction of livestock. They could receive periodic renovation and/or cultural treatments, suchastillage,fertilization, mowing, weed control, and may be irrigated.
4.	Mixed cropland	Land used primarily for the production and harvest of annual or perennial (polycultures) field, forage, food, fiber, horticultural, orchards, vineyards and/or energy crops
5.	Livestock farms for large and small animals including bees	Land associated with farms and ranches that are purposefully managed for animal breeding, food, forage or fiber and are typically associated with nearby production lands. Land used for facilities and supporting infrastructure where farming, animal husbandry and ranching activities are often initiated. This may include dwellings, equipment storage plus farm input and output storage and handling facilities. Also includes land dedicated to the facilitation and production of high intensity animal agriculture in a containment facility where daily nutritional requirements are obtained from other lands or feed sources.

1. Cynthia E Davies, Dorian Moss, Mark O Hill3 (2004) - EUNIS HABITATCLASSIFICATION REVISED 2004

2. Dorian Moss (2008)- EUNIS habitat classification – a guide for users

Annex 2-B2

List of acronyms

BANSIK	Bulgarian poll monitoring agricultural and economic situation
CICES	Common International Classification of Ecosystem Services
CORINE	Geographic Land Cover/Land Use Database
DEM	Digital Elevation Models
EEA	European Environmental Agency
ES	Ecosystem Services
EUNIS	European Nature Information System – habitat classification
ExEA	Executive Environmental Agency
GIS	Geographic Information System
GMES	Global Monitoring for Environment and Security
IACS	Integrated Administration and Control System in agriculture
ICRA	International Centre for development oriented Research in Agriculture
INSPIRE	Infrastructure for Spatial Information in the European Community
JICA	Japan International Cooperation Agency
LPIS	Land Parcel Identification System
LUCAS	Land Use and Coverage Area frame Survey
MAES	Mapping and Assessment of Ecosystems and their Services
MAF	Ministry of Agriculture and Food
ME	Ministry of Economy
MOEW	Ministry of Environment and Water
TEEB	The Economics of Ecosystems and Biodiversity

Annex 3-B2

Table of Ecosystem Types / Cropland

Table of Ecosystem Types

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

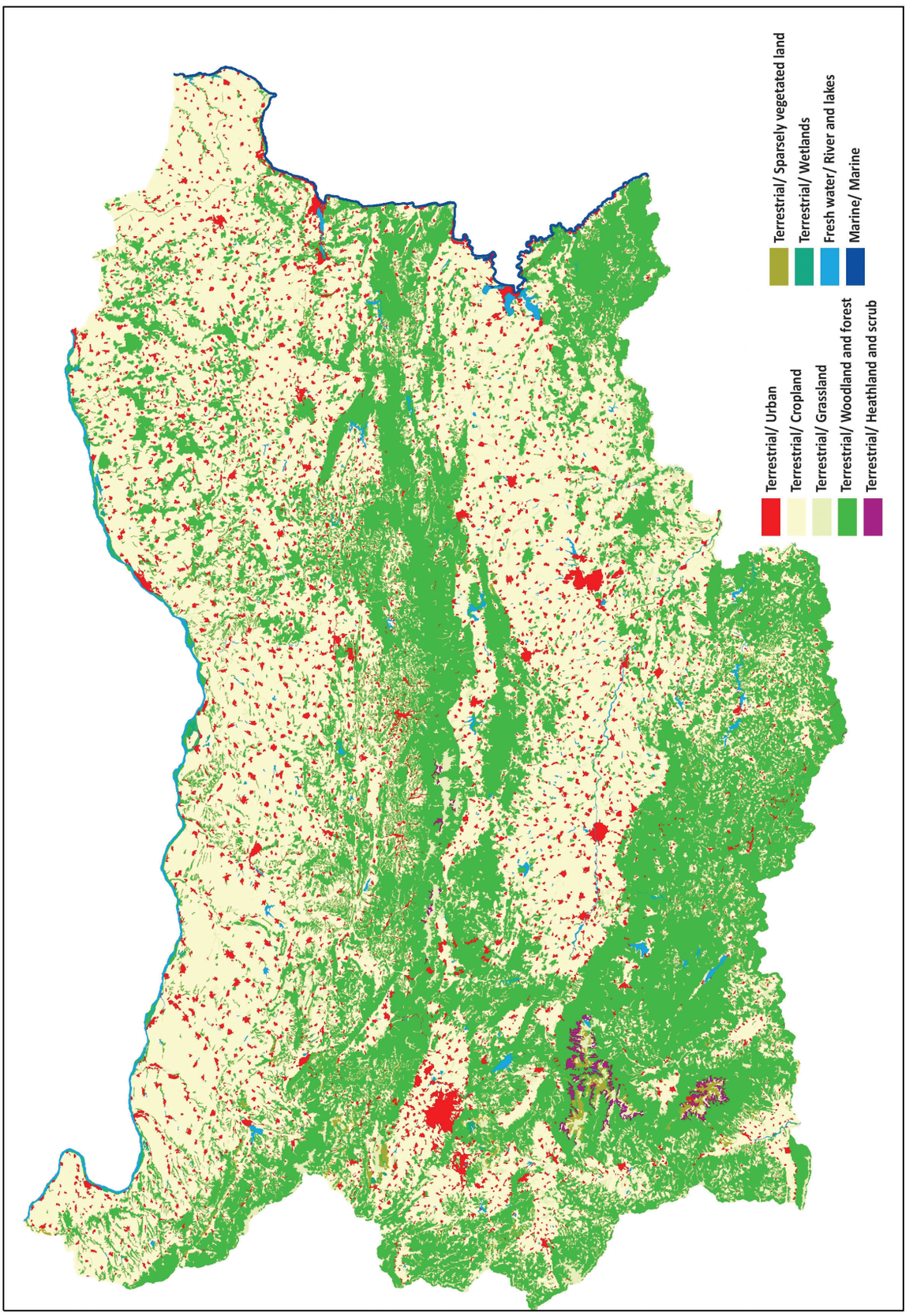
Cropland

	Subtype	**Description**
1.	Annual crops (mostly cereals)	Land used primarily for the production and harvest of annual crops - cereals, vegetables.
2.	Perennial crops (fruit gardens and vineyards)	Land used primarily for the production and harvest of perennial fruit crops - orchards, fruit gardens, or land used primarily for the production and harvest of perennial crops - vineyards.
3.	Perennial crops (mostly legumes)	Land used primarily for the production and harvest of perennial crops for forage and pastures. Lands composeof introduced or domesticated native forage species that isused primarily for theproduction of livestock. They could receive periodic renovation and/or cultural treatments, suchastillage, fertilization, mowing, weed control, and may be irrigated.

	Subtype	Description
4.	Mixed cropland	Land used primarily for the production and harvest of annual or perennial (polycultures) field, forage, food, fiber, horticultural, orchards, vineyards and/or energy crops
5.	Livestock farms for large and small animals including bees	Land associated with farms and ranches that are purposefully managed for animal breeding, food, forage or fiber and are typically associated with nearby production lands. Land used for facilities and supporting infrastructure where farming, animal husbandry and ranching activities are often initiated. This may include dwellings, equipment storage plus farm input and output storage and handling facilities. Also includes land dedicated to the facilitation and production of high intensity animal agriculture in a containment facility where daily nutritional requirements are obtained from other lands or feed sources.

Annex 4-B2

Map of ecosystem types



Annex 5-B2

Data Sources

Subtype	DATABASE Sources – main stakeholders	
	Spatial	Quantitative/Qualitative
Annual crops (mostly cereals)	Database –State Fund "Agriculture" – Land and Parcel Informtion System /LPIS/ and Integrated Administraion and Control System /IACS/. Database– State Fund"Agriculture" – State Digital Orthophoto map. MoAF – Agrostatistic – BANSIK – statistical survey, Farm Structure survey, Annual bulletin. National Statistical Institute MOEW – ExEA – JICA project, National Database for Biodiversity, National Soil Monitoring Network. EUROSTAT – LUCAS project – **L**and **U**se/**C**over **A**rea frame statistical **S**urvey. GMES - Global Monitoring for Environment and Security Master Plans, Site Development plans, State Cadastre. National Concept for Spatial Development 2013-2025. EEA – CORINE – Land Cover. JRC - ESTIMAP -Polliniation services model, MetEcoSMap - NINA/IBER project. JRC - Soil maps and their properties.	Master Plans, Site Development Plans, Maps of restored property, Action Plans for Programmes of Environmental protection, National Concept for Spatial Development 2013-2025, National Statistical Institute, Urban Atlas (EEA, MOEW), JRC, Publications, Project Reports, ME, MRD.MoAF –State Fund "Agriculture". Professional industry associations. Environmental NGO. Third parties – including survey private companies with high level of reliable data (actual insitu data and high precision model data will be welcome). MOEW – ExEA – Inventarization plans for pesticides storage.
Perennial crops (fruit gardens and vineyards)		
Perennial crops (mostly legumes)		
Mixed cropland		
Livestock farms for large and small animals including bees		

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

Annex 6-B2

Indicators_condition

Ecological condition indicators			Indicator	Parameter (units)	Methodology	Available data (Y/N)	New data needed (tick by "V")	Periodicity of measurring (years etc.)
Orientor	Type/Group							
Ecosystem structure	Biotic diversity	Plant diversity	Agricultural crop richness (annual, perennial and mixed crops)	Crop number or Percent	Estimation	Y	V	annual
			Agricultural crop richness - soil cover by vegetation (annual, perennial and mixed crops)	Ratio/ Percents	Estimation	Y	V	annual
			Wild plants	Area [ha], number or % from all land] of wild plants associated to crops (buffer strips, strips from flowers supporting pollination for example)	Estimation [satellite images, observation]	Y	V	2 years
			Wild animals	Number	Number animals or number of monitored traces from underground animals - worms, moles, insects and more.	Y	V	3 years
			Farmed animals	crop number or Percent	Number per grid unit of national data	Y	V	annual
			Area of natural habitat/s	Area or ratio [%] between cropland and natural land. [current period of CAP 2014-2020 is underlined as "greening agriculture*" - natural place will be - Environmental Focus Areas, Buffer strips, Field margins, Hedges & trees]	Remote sensing, Records from State Agricultural Fond for example.	Y	V	2 years
			Land use changes/ Land take	ha, ha/y, %	Calculation	Y	V	annual
			Invasive species presence [pests or weeds]	presence	Number of records or total amount of applied chemistry	Y	V	2 years
	Abiotic heterogeneity	Soil heterogeneity	Soil quality	Land properties	Scale assessment by soil conditions (land category) regarding to soil properties	Y	V	3 years
			Soil moisture capacity	%	Assessment by soil data	Y	V	3 years
			Soil nutrient elements storage (depend of nutrients and soil units - example is for K for Chernozems)	mg[K]/100g	Assessment by soil data, measurements	Y	V	annual
		Hydrological heterogeneity	Area under irrigation	ha/% of cultivated land	Number per grid unit of national data	Y	V	annual
			Water bodies precense	location of water bodies in neighbour	distance, approach,	Y	V	3 years
			Slope	[%] or [degrees]	mostly for permanent crops	Y		
			exposition (aspect)	World directions [mains & intermediate]	Scale depending of crop cultivated	Y		

Ecosystem structure	Abiotic heterogeneity	Other abiotic heterogeneity indicators	Area under wind protection	Area/%	Number per grid unit of national data	Y	V	3 years
		Disturbance regime	Significant occurrence of hail or late spring frosts or early autumn frosts.	Recorded records or demaged area or demaged production by tons	[ha] or [t]	Y	V	2 years
			erosion degree	Scale or t/ha/yr		Y	V	3 years
			fires (coused by burning of stubble for example)	Number of records or burned area [ha] (example is for burned crop area)	Estimatin, Remote sensing, Stete raccords	Y	V	2 years
			wind and storms (failed crops from hail for xample)	Number of records or demaged area [ha], or lost harvest [t, kg], or scale assessment by hail vulnerability	Estimatin, Remote sensing, Stete raccords	Y	V	2 years
			Polluted areas	Area polluted [ha]	Estimatin, Field measurements, Stete raccords	Y	V	2 years
			Salted, swampy and acidic areas	Affected area [ha]	Estimatin, Field measurements, Stete raccords	Y	V	3 years
Ecosystem proceses	Energy budget	energy balance	Carbon storage	Soil carbon storage [t/C/ha or %]	Assessment scale	Y	V	3 years
		metabolic efficiency	Solar radiation intensity	kW/m2/yr or per growing period	IPCC	Y		
			Temperature sum	Temperature summ for vegetation period [mainly for permanent crops - vineyards for example	Maps, Assessment	Y	V	
	Matter budget	matter balance (input, output)	Nutrients loss	Loss by leaching or by erosion [kg/ha]		Y	V	annual
		matter storage	Content of soil organic matter	% or [g, kg/ha]	National scale	Y	V	annual
			Biomass	Volume of produsedbiomass [t]	Assessment	Y	V	annual
	Water budget	water balance (input, output)	Evapotranspiration	[mm]	Rainfalls, or Hidro-termal coeficient for vegetation period for different crops (example is for soy)	Y	V	2 years
		water storage	Precipitations	mm/y		Y	V	annual
			Soil water storage capacity	Scale	Assessment depending of soil type (clay content for example, slope properties, exposition,) example is for clay content	Y	V	3 years

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

Annex 7-B2

Indicators_services

Section	Division	Indicators' group	Indicator class (CICES codes)	Indicator	Dimension/ unit	Data availability
Provisioning	Nutrition	Biomass	P1. Cultivated crops -1111 (kind, structure, ratio) +	harvest as % of country average , kind ratio	%, weight	Y
			P2. Reared animals and their outputs - 1112 +	livestock breeding	number/ha	Y/N
			P3. Wild plants, algae and their outputs - 1113 -	usage of plant biomass	kg/ha	Y
			P4. Wild animals and their outputs - 1114 -	usage of animal biomass	kg/ha	Y/N
			P5. Plants and algae from in-situ aquaculture - 1115 -	usage of plants and algae from in-situ aquaculture	kg/year	Y/N
			P6. Animals from in-situ aquaculture 1116 -	usage of animals from in-situ aquaculture	kg/year	Y/N
		Water	P7. Surface water for drinking 1221 +	Consumption of drinking water by population (PWS) by districts, average per capita	L/day/per capita	Y
				Public water supply	Mill. m3/year	Y
			P8. Ground water for drinking 1122 +	Public water supply from groundwater sources	Mill. m3/year	Y
			P9. Surface water for non-drinking purposes 1221 +	Total gross fresh water abstraction from fresh surface water. Type of facility. Area.	Mill. m3/year, ha	Y
			P10. Ground water for non-drinking purposes 1222 +	Total gross fresh water abstraction from fresh groundwater. Area	Mill. m3/year, ha	Y
	Materials	Biomass	P11. Fibers and other materials from plants, algae and animals for direct use or processing - 1211 +	Raw material input per capita	tonnes per capita	Y/N
				Raw material consumption per capita	tonnes per capita	Y/N
			P12.Materials from plants, algae and animals for agricultural use 1212 -	Animal and vegetal waste (excl. animal waste of excrements, urea etc.)	tonnes	Y/N
			P121. Materials from plants, algae and animals for biochemicals and medicine-	Production of biochemicals, medicines	kg/ha	Y/N
			13. Genetic materials from all biota 1213 -	Biodiversity	number of species	Y

Section	Division	Indicators' group	Indicator class (CICES codes)	Indicator	Dimension/ unit	Data availability
Provisioning	Materials	Water	P15. Surface water for non-drinking purposes 1221 +	Total gross fresh water abstraction from surface water. Type of facility. Area.		
			P16. Ground water for non-drinking purposes 1222 +	Total gross fresh water abstraction from fresh groundwater. Area		
		Mineral resources	P17. Minerals extractable close from surface or above surface (e.g. sand for construction, lignite, gold, salts). +	Minerals available for extraction	t/ha	Y
	Energy	Biomass-based energy sources	P18. Plant-based resources for energy 1311 +	Crops or plants biomass with potential use as energy source	kg/ha, ha	Y/N
			P19. Animal-based resources 1321 -	Animal products used for energy	kg/capita	*N*
		Abiotic energy sources	P20. Abiotic energy sources used for conversion – solar +	solar-energy potential, agr. land occupied by PV	kWh/year, ha	Y
Regulating & maintenance	R1 - Mediation of waste, toxics and other nuisances	Mediation by ecosystems	R1. Filtration/sequestration/ storage/accumulation by ecosystems 2112 +	Green infrastructure	percentage or the total area	Y
				Total Carbon stock (biomass + soils)	t/ha	Y/N
				Type of vegetation cover	Percentage of vegetation cover	Y
			R2. Dilution by atmosphere, freshwater and marine ecosystems 2122 +	Total emissions in the air	tonnes	Y
			R3. Mediation of smell/noise/visual impacts 2123 -	Registered noise levels /by district and town/	decibels	Y/N
	Mediation of flows	Mass flows	R4. Mass stabilization and control of erosion rates 2211 +	Average annual soil erosion loss	m/ha/year	Y/N
			R5. Buffering and attenuation of mass flows 2212 -	reclamation sites	number/ reclaimed area	Y/N
		Liquid flows	R6. Hydrological cycle and water flow maintenance 2221 +	Mean annual river discharge	mm/year	Y
				Natural groundwater descharge	l/s/km^2	Y
			R7. Flood protection 2222 -	floods causing damages	number	Y/N

Section	Division	Indicators' group	Indicator class (CICES codes)	Indicator	Dimension/ unit	Data availability
Regulating & maintenance	Mediation of flows	Gaseous / air flows	R8. Storm protection 2231 -	recorded cases of tournedos	number	Y/N
			R9. Ventilation and transpiration 2232 +	Transpiration/evapotranspiration	mm	Y
	Maintenance of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	R10. Pollination and seed dispersal 2311++	Bees, birds, bats, moths, flies, wind, non-flying animals contributing to pollen transfer and reproduction of plants. Linear features supporting pollination.	ha, m, n.m.	N/A [**high importance Class** - data will be available through ESTIMAP model and implemented NINA/IBER project]
			R11. Maintaining nursery populations and habitats 2312 ++	protected sites/ protected area	number/ m2	
				nursary plantations	number/ m2	Y
		Pest and disease control	R12. Pest control 2321 +	Pest density, Crop rotation application.	number/ m2	N/A
			R13. Disease control 2322 -	average age of the population	years	Y/N
		Soil formation and composition	R14. Weathering processes 2331 -	soil degradation	soil degradation index	Y/N
			R15. Decomposition and fixing processes 2332 +	Soil organic matter	%	Y
		Water conditions	R16. Chemical condition of freshwaters 2341 +	Water quality parameters	-	Y
		Atmospheric composition and climate regulation	R17. Global climate regulation by reduction of greenhouse gas concentrations 2351 +	Organic matter stock	total t CO_2 eq/ha (t C/ha)	Y
				Green infrastructure area	ha/capita	Y
			R18. Micro and regional climate regulation 2352 -	human thermal comfort in January/July	Stages	Y/N

Section	Division	Indicators' group	Indicator class (CICES codes)	Indicator	Dimension/ unit	Data availability
	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 3111 -	land cover	Number of visitors	Y/N
			C2. Physical use of land-/seascapes in different environmental settings 3112 +	land use (farm tourism, walking and biking trails,etc.)	Number of visitors	Y
		Intellectual and representative interactions	C3. Scientific 3121 -	scientific studies on ecosystems	Number of published scientific papers	Y/N
			C4. Educational 3122 -	educational activities (festivals, visiting centers, green school, etc.)	Number of educated persons; number of activities per year	Y/N
			C5. Heritage, cultural 3123 +	Land cover (cultural monuments, landscapes, etc.)	Number of visitors Number of cultural attractions	Y
			C6. Entertainment 3124 +	leisure and SPA facilities	Number of visitors or facilities Number of tourist attractions	Y
			C7. Aesthetic 3125 -	naturalness land cover	Number of endangered, protected or rare species or habitats; Number of visitors	Y/N
	Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes [environmental settings]	Spiritual and/or emblematic	C8. Symbolic 3211 +	emblematic sites	number	Y
			C9. Sacred and/or religious 3212	sacret and/or religious sites	number	Y
		Other cultural outputs	C10. Existence 3221+	conservation significance	Number of protected areas per ha	Y
			C11. Bequest 3222 +	conservation significance	Number of protected species /trees/protected areas	Y

Annex 8-B2

References

Bagstad, K.J.; Johnson, G.W.; Voigt, B., Villa, F. (2013). Spatial dynamics of ecosystem service flows: a comprehensive approach to quantifying actual services. *Ecosystem Services 4, 117–125.*

Bianchi, F.J.J.A., Booij, C.J.H., Tscharntke, T., 2006. Sustainable pest regulation in agricultural landscapes: a review on landscape composition, biodiversity and natural pest control. *Proceedings of the Royal Society of London. Series B, Biological Sciences (273), 1715–1727.*

Brandt, J.; Aagaard Christensen, A.; Roar Svenningsen, S., Holmes, E. (201) Landscape practise and key concepts for landscape sustainability. *Landscape Ecology 28 (6), 1125-1137.*

Brown, L.R., 2003. Plan B: Rescuing a Planet under Stress and a Civilization in Trouble. Chapter 8: Raising Land Productivity. Norton, New York. *Available online at: http://www.earthpolicy.org/Books/PB/PBch8_ss6.htm.*

Burkhard, B. Kroll, F., Müller, F., Windhorst, W. (2009) Landscapes' Capacities to Provide Ecosystem Services – a Concept for Land-Cover Based Assessments. *Landscape Online 15, 1-22. DOI:10.3097/LO.200915.*

Burkhard, B. Kroll, F., Nedkov, S., Müller, F. (2012) Mapping ecosystem service supply, demand and budgets. *Ecological Indicators 21:17-29.*

Burkhard, B., Kandziora, M. Hou, Y., Müller, F. (2014) Ecosystem Service Potentials, Flows and Demands – Concepts for Spatial Localisation, Indication and Quantification, *Landscape online 34: 1-32.*

de Groot, R.S., Wilson, M.A., Boumans, R.M.J. (2002) Atypology for the classification, description and valuation of ecosystemfunctions, goods and services. *Ecological Economics 41, 393–408 (2002).*

Delaplane, K.S., Mayer, D.F. (2000) Crop Pollination by Bees. *CABI Publishing, New York. 344 pp.*

Edwards, C., 2004. Earthworm Ecology. *CRC Press, Boca Raton, FL. 441 pp.*

Egoh, B., Drakou, E.,.Dunbar, M., Maes, J., Willemen, L. (2012) Indicators for mapping ecosystem services: a review, EC JRC, Institute for Environment and Sustainability, Report EUR 25456 EN.Available online at: *http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/26749/1/lbna25456enn.pdf.*

Egoh, B., Drakou, E.,.Dunbar, M., Maes, J., Willemen, L. (2012) Indicators for mapping ecosystem services: a review, EC JRC, Institute for Environment and Sustainability, Report EUR 25456 EN. *Available online at: http://publications.jrc.ec.europa.eu/repository/bitstream/111111111/26749/1/lbna25456enn.pdf.*

E**ldridge, D.J., Freudenberger, D.,** 2005. Ecosystem wicks: woodland trees enhance water infiltration in a fragmented agricultural landscape in eastern Australia. *Austral Ecology 30, 336–347.*

E**squinas-Alcázar, J.** (2001) Making Plant Genetic Resources Beneficial and Accessible for All, Food and Agriculture Organization (FAO), News and Highlights, October 30, 2001. *Available online at: http://www.fao.org/news/2001/011005-e.htm.*

Fagerholm, N.; Käyhkö, N.; Ndumbaro, F., Khamis, M. (2012) Community stakeholders' knowledge in landscape assessments e mapping indicators for landscape services. *Ecological Indicators, 18, 421-433.*

Free, J.B. (1993) Insect Pollination of Crops. *Academic Press, London.*

Groffman, P.M., Driscoll, C.T., Likens, G.E., Fahey, T.J., Holmes, R.T., Eagar, C., Aber, J.D., 2004. Nor gloom of night: a new conceptual model for the Hubbard Brook Ecosystem Study. *Bioscience 54, 139–148.*

Guo, Z., Xiao, X., Li, D., 2000. An assessment of ecosystem services: water flow regulation and hydroelectric power production. *Ecological Applications 10, 925–936.*

Harris, J. (2011) Agriculture, nutrition and health essentials for non-specialist development professionals.A follow-up paper to the 2020 conference Leveraging Agriculture for Improving Nutrition and Health, Delhi 2011. *Available online at: https://www.spring-nutrition.org/sites/default/files/2011_2020_anh_basics_harris.pdf.*

Hawtin, G.C. (2000) Genetic diversity and food security. The UNESCO Courier (May 2000), pp. 27–29. *Available online at: http://www.unesco.org/courier/2000_05/uk/doss23.htm*.

Hernández-Morcillo, M.; Plieninger, T., Bieling, C. (2013) An empirical review of cultural ecosystem service indicators. *Ecological Indicators 29, 434–444.*

Houlahan, J., Findlay, C.S. (2004) Estimating the "critical" distance at which adjacent land-use degrades wetland water and sediment quality. *Landscape Ecology 19, 677– 690.*

ICRA (2015) Agro-ecosystems – Key Concepts, 9 pp. *Available online at: (http://www.icra-edu.org/resources/226/agroecosystems+-+key+concepts).*

Indicators 36, 539–551.

Jakeman, A.J., M.B. Beck and M.J. McAleer (eds) (1995), Modelling Change in Environmental Systems, *John Wiley and Sons, Chichester, United Kingdom.*

Klein, A., Steffan-Dewenter, I., Tscharntke, T., 2003. Fruit set of highland coffee increases with the diversity of pollinating bees. *Proceedings of the Royal Society of London. Series B 270, 955–961.*

Klein, A., Vaissière, B.E., Cane, J.H., Steffan-Dewenter, I., Cunningham, S.A., Kremen, C., Tscharntke, T., 2007.Importance of pollinators in changing landscapes for world crops.Proceedings of the Royal Society of London. *B, Biological Sciences 274 (1608), 303–313.*

Kremen, C., Williams, N.M., Thorp, R.W., 2002. Crop pollination from native bees at risk from agricultural intensification. *Proceedings of the National Academy of Sciences of the United States of America 99, 16812–16816.*

Krishna, V.V., Byju, N.G., Tamizheniyan, S., 2003. In: Radcliff, E.B., Hutchson, W.D. (Eds.), Integrated Pest Management in Indian Agriculture: a Developing Economic Perspective. *IPM World Textbook, St. Paul, MN.*

Landis, D.A., Wratten, S.D., Gurr, G.M., 2000. Habitat management to conserve natural enemies of arthropod pests in agriculture. *Annual Review of Entomology 45, 175–201.*

Lautenbach, S.; Kugel, C.; Lausch, A,.Seppelt, R. (2011) Analysis of historic changes in regional ecosystem service provisioning using land use data. *Ecological Indicators 11 (2), 676–687.*

Losey, J.E., Vaughan, M., 2006. The economic value of ecological services provided by insects. *Bioscience 56 (4), 331–323.*

MA (2005). Millennium Ecosystem Assessment: Ecosystems and Human Well-being: Biodiveristy Synthesis. *World Resources Institute.*

MAES, 2013. Mapping and Assessment of Ecosystems and their Services. An analytical framework for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020. *Discussion paper – Final, April 2013, European Commission.*

Maes, J., Paracchini, M. L., raziaZulian, G.2011. A European Assessment of the Provision of Ecosystem Services: Towards an Atlas of Ecosystem Services, Luxembourg: *Publications Office of the European Union, 81 pp.*

Metzger MJ, Schröter D, Leemans R, Cramer W (2008) A spatially explicit and quantitative vulnerability assessment of ecosystem service change in Europe. *Regional Environmental Change 8, 91-107.*

Nahuelhual, L.; Carmona, A.; Lozada, P.; Jaramillo, A., Aguayo, M. (2013) Mapping recreation and ecotourism as a cultural ecosystem service: An application at the local level in Southern Chile. *Applied Geography 40, 71-82.*

Naylor, R., Ehrlich, P., 1997. Natural pest control services and agriculture. In: Daily, G. (Ed.), Nature's Services: *Societal Dependence on Natural Ecosystems, pp. 151–174. Washington DC.*

OECD, 1999. . Environmental Indicators for Agriculture, Volume 2 Issues and Design. Moxey, A. Cross-cutting issues in developing agri-environmental indicators. *Part III: Agri-environmental Indicators as a Policy Tool 113-128.*

Palomo, I., Martín-López, B.; Potschin, M.; Roy Haines-Young, R., Montes, C. (2013) National Parks, buffer zones and surrounding lands: mapping ecosystem service flows. *Ecosystem Services 4, 104–116.*

Paul, E.A., Clark, F.E., 1996. Soil Microbiology and Biochemistry. *Academic Press, New York.*

P**érez-Soba, M., Elbersen, B., Kempen, M., Braat, L., Staristky, I., Wijngaart, R. van, Kaphengst, T., Andersen, E., Germer, L. and Smith, L., der** (2012). Study on the role of agriculture as provisioning ecosystem service. Interim report to the Institute for Environment and Sustainability (JRC/IES).AlterraWageningen UR, Ecologic Institute, University of Copenhagen and EuroCARE, 103 pp. *Available online at: http://ecologic.eu/sites/files/publication/2013/kaphengst_13_Agriculture%20as%20Provisioning%20Ecosystem%20Service_0.pdf.*

Pierce, F.J., Rice, C.W., 1988. Crop rotation and its impact on efficiency of water and nitrogen use. p. 21–42. In: Cropping Strategies for Efficient Use of Water and Nitrogen. ASA Special Publication 51. *ASA, CSSA, and SSSA, Madison, WI.*

Plieninger, T.; Dijks, S.; Oteros-Rozas, E., Bieling, C. (2013) Assessing, mapping, and quantifying cultural ecosystem services at community level. *Land Use Policy 33, 118– 129.*

Ramakrishnan, P.S., 1992. Shifting Agriculture and Sustainable Development: An Interdisciplinary Study from North-Eastern India. *Parthenon Publishing Group, Park Ridge, NJ.*

Ratcliffe, B.C., 1970. Scarab Beetles.Dung Feeders, Jeweled Pollinations, and Horned Giants, vol. 59. *University of Nebraska News, pp. 1–4.*

Ricketts, T.H., 2004. Tropical forest fragments enhance pollinator activity in nearby coffee crops. *Conservation Biology 18, 1262–1271.*

Schröter D, Cramer W, Leemans R, Prentice IC, Araújo MB, Arnell NW, et al. (2005) Ecology: Ecosystem service supply and vulnerability to global change in Europe. *Science 310, 1333-1337.*

Schröter D, Cramer W, Leemans R, Prentice IC, Araújo MB, Arnell NW, et al. (2005) Ecology: Ecosystem service supply and vulnerability to global change in Europe. *Science 310, 1333-1337.*

Schröter, M.; Barton, D.N.; Remme, R.P., Hein, L. (2014) Accounting for capacity and flow of ecosystem services: *A conceptual model and a case study for Telemark, Norway. Ecological*

Schröter, M.; Remme, R.P., Hein, L. (2012) How and where to map supply and demand of ecosystem services for policy-relevant outcomes? *Ecological Indicators 23, 220-221.*

S**colozzi, R.; Morri, E., Santolini, R.** (2012) Delphibased change assessment in ecosystem service values to support strategic spatial planning in Italian landscapes. *Ecological Indicators 21, 134–144.*

TEEB (2010) The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature: *A synthesis of the approach, conclusions and recommendations of TEEB.*

Thies, C., Roschewitz, I., Tscharntke, T., 2005.The landscape context of cereal aphid–parasitoid interactions. Proceedings of the Royal Society London. *Series B, Biological Sciences 272, 203–210.*

Thies, C., Steffan-Dewenter, I., Tscharntke, T., 2003. Effects of landscape context on herbivory and parasitism at different spatial scales. *Oikos 101, 18–25.*

Thies, C., Tscharntke, T., 1999. Landscape structure and biological control in agroecosystems. *Science 285 (5429), 893–895.*

Vaughan, M., Shepherd, M., Kremen, C., Black, S.H., 2004. Farming for Bees: Guidelines for Providing Native Bee Habitat on Farms. *Portland, Ore, Xerces Society and Princeton University.*

Vitousek, P.M., Cassman, K., Cleveland, C., Crews, T., Field, C.B., Grimm, N.B., Howarth, R.W., Marino, R., Martinelli, L., Rastetter, E.B., Sprent, J.I., 2002.Towards an ecological understanding of biological nitrogen fixation. *Biogeochemistry 57/58 (1), 1– 45.*

Walker, J. 2002. Environmental indicators and sustainable agriculture. In: McVicar, T.R., Li Rui, Walker, J., Fitzpatrick, R.W. and Liu Changming (eds), Regional Water and Soil Assessment for Managing Sustainable Agriculture in China and Australia, ACIAR Monograph No. 84, 323–332. *Available online at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.196.1438&rep=rep1&type=pdf.*

Wilby, A., Thomas, M.B., 2002. Natural enemy diversity and pest control: patterns of pest emergence with agricultural intensification. *Ecology Letters 5, 353–360.*

Wilkinson, T.K., Landis, D.A., 2005. Habitat diversification in biological control: The role of plant resources. In: Wackers, F.L., van Rijn, P.C.J., Bruin, J. (Eds.), Plant Provided Food and Plant–Carnivore Mutualism. *Cambridge University Press, Cambridge, U.K.*

Zhang W., Ricketts T. H., Kremen C., Carney K. and Swinton S. M. (2007) Ecosystem services and disservices to agriculture. *Ecological Economics 64: 253-260.*

Annex 9-B2

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/