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D3.1 Case Study Base Layer dataset for each of the case studies

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Case Study Base Layer dataset for each of the case studies

Deliverable 3.1

30 November 2020

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BESTMAP

Behavioural, Ecological and Socio-economic Tools for Modelling Agricultural Policy

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Preface

This document describes the compilation of the Case Study Base Layer dataset for each of the case studies of the H2020 project BESTMAP. It is accompanied by a list of datasets forming this base layer. This deliverable is based on the Preliminary Case Study Base Layer which was created as milestone MS3 in month 5.

This report aims at documenting the process of data compilation and harmonization as well as data management and access. Furthermore, it briefly describes the use of Case Study Base Layer data in various tasks within BESTMAP.

Summary

The Case Study Base Layer, described in this deliverable, is a harmonised geospatial database spanning across the five case study areas of BESTMAP: South Moravia (Czech Republic), Mulde (Germany), Humber (Great Britain), Backa (Serbia), and Catalonia (Spain). It is based on the Preliminary Case Study Base Layer (MS3) and includes geospatial information on climatic and soil conditions, biodiversity, land use/land cover (including crop types), farm structure and socio-economic data. It serves as a base for biophysical ecosystem service (ES) models as well as socio-economic statistical models. Thereby, the Case Study Base Layer will be crucial for mapping Farming System Archetypes (FSAs) and for building a common agent-based modeling (ABM) framework across all case studies. This report accompanies the data in Deliverable D3.1 and describes the compilation, harmonization, meta-data structure, secure storage and access of case study baye layer data using the BESTMAP instance of the UFZ GeoNetwork.

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1. Introduction and purpose of the Case Study Base Layer

The Case Study Base Layer, described in this deliverable, is a harmonised geospatial database spanning across the five case study (CS, Figure 1) areas of South Moravia (Czech Republic), Mulde (Germany), Humber (Great Britain), Backa (Serbia), and Catalonia (Spain). It includes spatial information on climatic and soil conditions, biodiversity, land use/land cover (including crop types), farm structure and socio-economic data. It serves as a base for biophysical ecosystem service (ES) models as well as socio-economic statistical models. These models will feed into the process of mapping Farming System Archetypes (FSAs) and their change in each regional CS. FSAs will be used for building a common Agent-based Modeling (ABM) framework (see deliverables D1.3 "Guidelines and protocols harmonizing activities across CSs" and D2.2 "BESTMAP Policy Impact Assessment Model Conceptual Framework" for details).

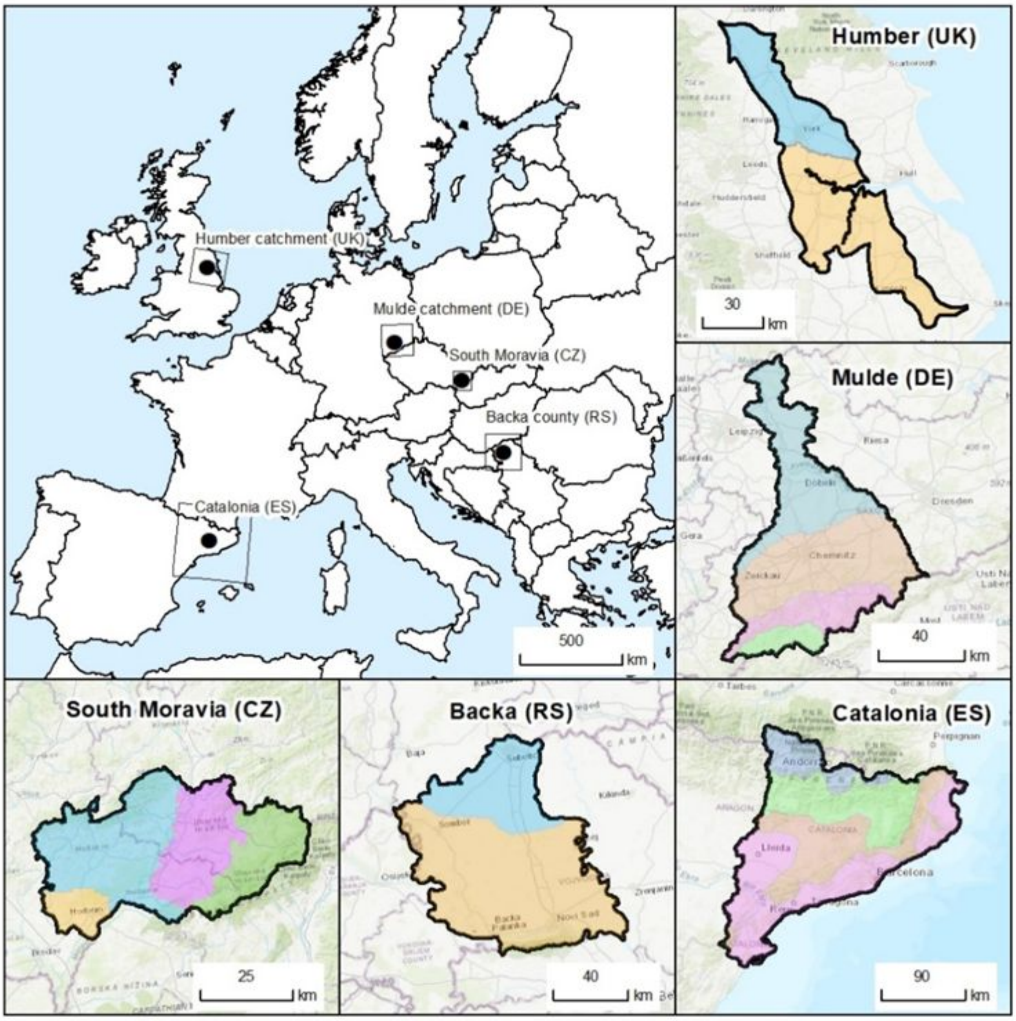

Figure 1: Overview of BESTMAP's five case study areas. Colors in CS insets refer to proto-FSAs as described in milestone MS5 (submitted in month 8).

1.1. Preliminary Case Study Base Layer

In order to facilitate a timely start of the modelling activities in BESTMAP, a Preliminary Case Study Base Layer has been compiled including the most essential variables at the highest possible resolution available in each CS. This preliminary Case Study Base Layer was created as milestone MS3 in month 5.

For this purpose, a list of data requirements (standards in terms of resolution and time periods etc.) was compiled and CS representatives were asked to provide information on existing datasets in their CS area. Since not all relevant datasets were available in all CSs, suitable large-scale datasets were identified to substitute them. Metadata were added to the BESTMAP instance of the UFZ GeoNetwork (https://geonetwork.ufz.de). For the compilation of the final Case Study Base Layer, data has been further harmonized and missing data have been added.

1.2. Use of Case Study Base Layer data within BESTMAP

Farming System Archetypes

The Case Study Base Layer will serve as the repository for data used to define Farming system archetypes (FSAs) in BESTMAP. FSAs are a generalized typology of farming systems defined by e.g. farm size and farm's characteristics and management.There are several aspects to consider which dimensions actually define FSAs. In the BESTMAP proposal, we envisioned that FSAs would be characterized by (1) dominant environmental conditions (e.g. climate, soil), (2) land-use intensities and management practices (e.g. crop types, crop rotations, mechanization, fertilizer application), but also by (3) socioeconomic factors (e.g. land tenure and ownership, size of the fields/agricultural holding) that would serve as a link to farmers' behavioral characteristics.

The dimensions defining the FSAs should at best meet all of the following criteria: They should be (a) mappable for each individual farm in all CSs based on spatial data from public or administration sources (FADN, IACS, LPIS) and also be (b) mappable from FADN microdata. Additionally, they should be (c) based on attributes that farmers can easily and reliably answer in short online surveys. And they should (d) correspond to or be proxies of factors affecting farmers' agri-environmental schemes (AES) adoption.

After defining a set of essential FSA dimensions and a general overview of data available for each CS (see also D1.3), we have started to analyse possible correlations between potential FSA variables. The aim of this was threefold: We wanted to (1) understand which data can be used as a substitute for others (in case of data gaps), we wanted to (2) limit the number of variables to consider in the cluster analysis and we wanted to (3) estimate which variables can serve as a good proxy for others, e.g. farm size as proxy for participation in AES.Currently, the definition and mapping of FSAs is a work in progress. We will define the final set of data to be used within the next months.

Biophysical Modelling

The Case Study Base Layer also serves as the essential collection of input data for the biophysical models in BESTMAP. All models use spatially-explicit data on biophysical and

management conditions to assess the current state of agroecosystems in each case study region and the ecosystem services, biodiversity and socio-economic outputs per Farming System Archetype (FSA). Modelling tasks are distributed among BESTMAP partners as described in the Grant Agreement and range from models on food and fodder, carbon sequestration, water quantity and quality, biodiversity and habitats to socio-economic geostatistical regression models. As far as the available geospatial data and case study characteristics allow, the same modelling methodology will be employed in all case studies. All models will be based on land use information extending across the years 2016 to 2019 and covering data on cultivated crops, farm structure, and AES adoption. Additional model-specific geodata include, for example, CS-specific data on farmland bird and insect abundances for biodiversity modelling. The water quality and quantity model will rely on spatial data on watersheds, discharge, and precipitation, while the carbon sequestration model uses a soil organic carbon map as an input.
All data that have already been collected to implement the biophysical models in BESTMAP has been included in the Case Study base layer. However, this process is ongoing and more data will be added to the Case Study Base Layer during the course of the project.

Agent-Based Modelling
Starting with a spatially implicit model version, in a second step the ABM will have a realistic spatial representation derived from the available data on field parcels managed per farm (which will be included in the Case Study Base Layer). For each field, land use/land cover data will be used to simulate the type of production (e.g. arable crops, grassland) and intensity (e.g. organic, conventional). Soil and terrain characteristics will be incorporated in the model to determine soil quality and expected yields. The spatially explicit representation of farm locations may furthermore be used as a proxy for social influence (e.g. via neighbours) and the sharing of information (e.g. via the same consultant).

The underlying conceptual framework of the ABM will be equal for all case studies. Depending on data availability and the importance of specific influence factors in certain case studies (as revealed by the farmer interviews), some spatial aspects might, however, be less important in some of the case studies. The conceptual ABM framework will therefore be adapted to case study specific conditions. Details will be described in D2.2 and MS6.

2. Data Compilation, Harmonization, Storage and Use

2.1. Metadata curation

Efficient data management is ensured by utilizing the UFZ GeoNetwork application (https://geonetwork.ufz.de). The software *GeoNetwork opensource* is a catalogue application to manage spatial data. It contains tools to edit, search and report metadata as well as a web map viewer functionality (https://geonetwork-opensource.org). Figure 2 depicts an exemplary excerpt of a metadata record in the UFZ GeoNetwork. Metadata was compiled in accordance

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with the ISO19139 standard. The record includes information on spatial and temporal extent of the dataset, keywords, a contact person and a download link to the data.

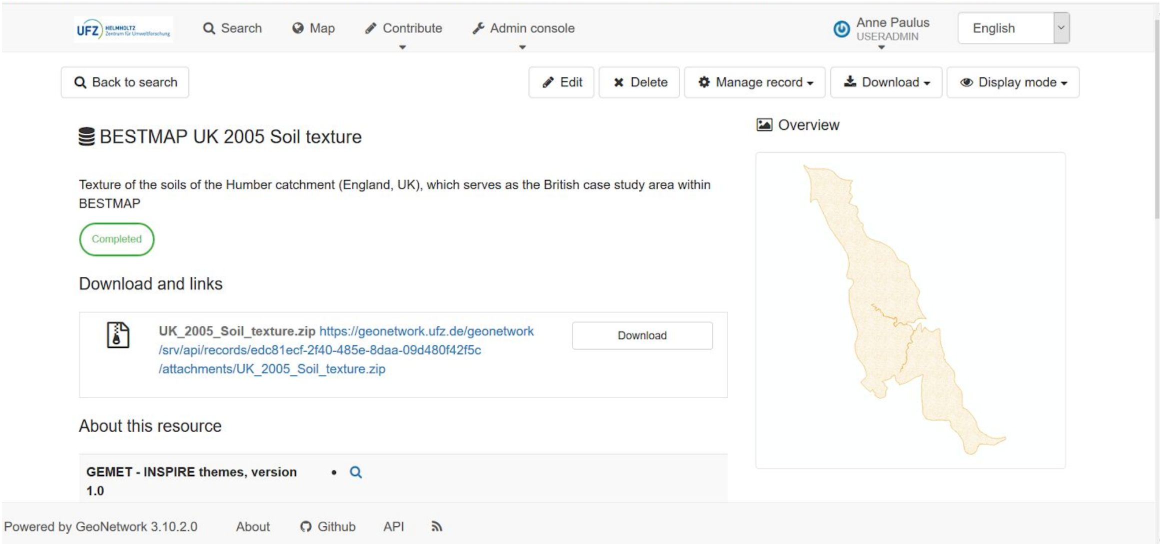

Figure 2: Example of a UFZ GeoNetwork metadata record.

The metadata records follow a consistent naming convention and include a relevant title, a date, an abstract as well as information on spatial and temporal extent (begin date, end date) of the dataset, relevant descriptive keywords, a contact person and a download link to the data (Table 1).

Table 1: Overview of the metadata elements recorded within BESTMAP's GeoNetwork.

Metadata element	Description	Example
Dataset Title	Descriptive title of the dataset	BESTMAP DE 2019 Elevation
Date	Generation | publication (last) revision	2020-10-20 | - | 2020-11-04
Abstract	Short textual description of the dataset	Elevation of the Mulde catchment (Saxony, Germany), which serves as the German case study area within BESTMAP. Digital Elevation Model generated from https://geoportal.sachsen.de/cps/metadaten_portal.html?id=a3dba5b2-0118-4d76-ab78-ba656a1b489e
Spatial extent	If raster, please also include spatial resolution (pixel size) in meters.	grid spatial resolution : 20 Coord. system: 3035
Temporal extent	Begin data, end date	Thu Jan 01 2004 01:00:00 GMT+0100 Fri Dec 31 2004 01:00:00 GMT+0100
Keywords	Must include "Case Study Base Layer", the respective case study (CZ/DE/ES/RS/UK) and a	• Case Study Base Layer • DE • Terrain

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	selection of: Soil, Climate, Land Use/Land Cover, Terrain, Biodiversity or Agriculture.	
Contact person	Gives information about the organisation, address and name of the person who is responsible for the creation of the metadata and the construction, attitude and passing on of the designated data	Helmholtz-Zentrum für Umweltforschung - UFZ Originator : Anne Paulus
Download link	Download link (only accessible for logged in users)	https://geonetwork.ufz.de/geonetwork/srv/api/records/6b9e4cf5-0c8b-4cb9-952f-44a8d51a8ff3/attachments/DE_2019_Elevation.zip
Access constraints	It indicates if the database is public accessible or restricted /embargo	none
Language	Indicate language	english

2.2. Data harmonization

As an initial data harmonization effort, CS-specific datasets were clipped to the respective CS area extent. The bounding box of an UFZ GeoNetwork metadata record shows the regional localization of the respective CS. The datasets were projected to the geographic ETRS89/Lambert Azimuthal Equal Area projection coordinate reference system (EPSG:3035), which has been proposed as a pan-European standard (INSPIRE Thematic Working Group Coordinate Reference Systems & Geographical Grid Systems 2014).

2.3. Data Access, Storage, Use, and Handling

Access to the BESTMAP instance of the UFZ GeoNetwork requires a registered account (to sign up, please contact Anne Paulus, anne.paulus@ufz.de).

After having logged-in, the *Search* element can be used to find all previously created records, e.g. BESTMAP data from all case studies. Metadata records follow a naming convention and include all elements listed in Table 1. The associated datasets are linked as *Associated resources*. Depending on data rights requirements, there are two ways the datasets are linked within the metadata record: either directly downloadable by logged in users through an URL or by links that refer to limited access storage.

In the latter case, data use licences do not allow sharing datasets with the whole project team but e.g. only a specific project partner. For these datasets, metadata records were created linking to a password protected Google GSuite drive where the actual data are

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stored. This way, we could ensure that all metadata are retrievable without violating licences of sensitive data.

Depending on the user group an account has been assigned to, users cannot only view and download data but also edit metadata records or create new records.

Using the UFZ GeoNetwork will establish long-time data availability since BESTMAP's GeoNetwork instance will be continued beyond the running time of the project. Weekly backups ensure data security. Data can be retrieved through UFZ data search and improving discoverability through geonetwork's API is currently being discussed by UFZ IT staff.

2.4. API usage for direct access to data stored in BESTMAP's GeoNetwork

BESTMAP's geonetwork can be accessed directly from R or Python using the geonetwork REST API. In order to retrieve data the following code may be used from within R:

```
#### Header - adjust to make this work
username="XXX" # user credentials for geonetwork.ufz.de
password="XXX"
geonetworklink="https://geonetwork.ufz.de/geonetwork/srv/api/0.1/records/XXX"
# Links to data can be found under "Download and links" in each database
entry
filename="XXX.zip" # chose target filename, files will be downloaded into
active working directory
####

# install.packages ("geonapi", "curl") # run once
library("geonapi", "curl")

# create logged in session for geonetwork.ufz.de
GN <- GNManager$new(
       url = "https://geonetwork.ufz.de/geonetwork", # base URL of the
       Geonetwork
       version = "3.10.2",
       user = username, pwd = password,
       logger = "INFO"
       )

# create handle for curl
h<- curl::new_handle()
curl::handle_setopt(
  handle=h,
  httpauth=1,
  userpwd = paste(username,(":"),password, sep=""),
  verbose=FALSE # set TRUE to show detailed outputs
)

# download
curl_download(url=geonetworklink, filename, handle=h)

# in case of zipped archives are downloaded this way you can use unzip() to
proceed from within R
```

3. Data included in the Case Study Base Layer

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The Case Study Base Layer combines geospatial data from multiple sources for all case studies. Table 2 shows the availability and current status of the collection of CS-specific geodata. In general, environmental data such as soil and terrain variables are widely available. For other variables such as weather and climate variables as well as land use data, availability varies between the CSs. The following provides an overview of the datasets included in the Case Study Base Layer from the perspectives of their purpose and sources.

Table 2: Overview of the CS-specific geodata currently catalogued in the UFZ GeoNetwork (in green). More details on the individual datasets can be found in the accompanying file "D3.1 - Case Study Base Layer Metadata Table" and in the meta-data entries with BESTMAP's GeoNetwork instance (Section 2).

Dataset	**CZ**	**DE**	**ES**	**RS**	**UK**
Case Study Area	■	■	■	■	■
Agricultural land use	■				
Case study area	■	■	■	■	■
Crop types	■	■	■	■	■
Discharge					■
Evapotranspiration			■		■
Elevation	■	■	■		
Farmland birds observations from GBIF	■	■	■	■	■
Farmland birds observations from other sources	■	■			■
Farms and field parcels	■	■	■		■
Growing degree days	■				
Insect observations		■	■		■
Land use/Land Cover	■		■		■
Livestock			■		
Parent material	■	■	■		■
Precipitation	■	■			■
Soil bulk density	■	■	■		■
Soil depth to bedrock	■	■	■		■
Soil organic carbon	■	■	■		■
Soil pH	■		■		■
Soil texture	■	■	■		■
Soil unit types	■				
Temperature maximum		■	■		■
Temperature mean		■			
Temperature minimum		■	■		■
Watersheds					■

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3.1. Geospatial information on farms and agricultural fields

Spatial data on agricultural fields, cultivated crops and AES and the farms they belong to are of particular importance as a base for biophysical models, ABMs and FSAs. The case studies representatives thus spent a lot of effort on compiling this information from LPIS/IACS data and - in case of the Serbian CS - remote sensing and internal databases. Table 3 provides an overview of the availability of these data.

Table 3: Overview of geospatial data on farms and fields in the case studies. Numbers are explained below.

Data requested (R) / available as part of Case Study Base Layer (A) / non-existent (X) / see comment below (numbers)	CZ	DE	ES	UK	RS
Polygon layer of all agricultural fields	A	A	A	A	A
Information on specific crop type reported on all agricultural parcels in 2019	A/4	A	R	A	A/2
Information on specific crop type reported on all agricultural parcels in 2018	A/4	A	R	A/1	A/2
Information on specific crop type reported on all agricultural parcels in 2017	A/4	A	R	A/1	A/2
Information on specific crop type reported on all agricultural parcels in 2016	A/4	A	R	A/1	A/2
Information on specific crop type reported on all agricultural parcels in 2015	A/4	R/7	R	A	A/2
Linking fields of farm business	A	A	A	A	X/3
Cover crops planting per field for every year		A	R	A	X
Fields with AES agreements to use cover crops	X	A		A	X
Grasslands managed with low inputs/management for each year 2015-19 regardless of subsidy		X			X/9
Grasslands with AES agreements of low input/management	A/5	A		A	X
Fields with field margins for every year regardless of subsidy		X		3	X/9
Fields with AES agreements to improve/create margins	A/5	A		A	X
Fields converted from arable to woodland / wetland in last 5 years	X	A			X
Arable conversion fields subsidized with AES agreement	A/6	A		A	X
If farm used organic greening exemption	A	A		A	R/8

Notes:
1: Can be extracted from CEH Land Cover + crops
2: Pixel-based crop classifications of the five 5 most important crops in the CS
3: Available through Agrosense (www.agrosense.eu), a voluntary database that does not cover all farms in the CS

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4: Only area of specific crop types as shares within farmer blocks
5: AES data available only for 2019.
6: The only conversion in AES in CZ is from arable to permanent grassland.
7: Request was declined
8: If farm used subsidies for organic production
9: Satellite based detection will be explored

3.2. Biodiversity data

When compared to data describing e.g. the overall structure and the spatial characteristics of the case studies, the biodiversity data are more diverse and complex. Therefore, in the following paragraph we explain in more detail our approach for these data. They will be used for the development and the subsequent validation of the models of biodiversity and the related ESS pollination and biocontrol. The following aspects were considered in the selection of specific biodiversity taxa to be included in the models:

1. Taxa/species for which farmland is the main habitat, and which are likely to show response to altered agricultural practice,
2. Taxa/species targeted by specific AES,
3. Taxa/species recognised as functional groups and ESS providers (e.g. pollinators, natural enemies),
4. Taxa/species recognised as bioindicators of the condition of the farmed environment (e.g. farmland bird index, grassland butterfly index, HNV farmland indicator),
5. Taxa/species which are generally well-monitored across Europe,
6. Taxa/species of particular interest for the CSs.

The above mentioned considerations led to the selection of the following biodiversity groups/taxa, for which geo- and time-referenced data on occurrence/abundance/species richness is currently being collated:

- farmland birds,
- Lepidoptera (butterflies and moths),
- pollinating species (e.g. wild bees, bumblebees, wasps),
- natural pest enemies (e.g. Spiders, Carabidae, Coccinellidae),
- vascular plants.

The biodiversity data is collected from various sources, including international databases (e.g. the Global Biodiversity Information Facility (GBIF)), as well as national and regional ones. This multiplicity of data sources poses a challenge in terms of data harmonisation across CSs, as different biodiversity monitoring schemes work at varying spatial and temporal resolution across countries. Moreover, data availability also varies across CSs, implying that not all selected ecosystem services and taxa will be modelled in all CSs due to lack of data (e.g. data on natural pests and their enemies is generally sparse and hard to find, vascular plant richness is rarely monitored on agricultural land, etc.), and that some ecosystem services will have to be removed from our list altogether (e.g. biocontrol). The

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collected biodiversity datasets will be uploaded in the GeoNetwork, provided that the original data owners agree for the dataset to be publicly shared.

3.3. Other spatial data required for modelling

BESTMAP is requiring a wide range of data for the five case studies to be used for the development and the subsequent validation of the ecosystem service and biodiversity models (Table 4). While part of the data have already been included in the GeoNetwork catalogue, other data will continue to be collected jointly by biophysical modellers and case study representatives.

Table 4: Datasets requested for biophysical modelling. Asterisks mark data that are stored in non-geodata formats.

Ecosystem Service	Dataset
Food & fodder	*Crop Yield statistics at NUTS2/NUTS3 level
	*Fertilization rates
Water quality and quantity	Digital Elevation Model
	Water abstraction point data
	Water abstraction surface data
	Long-term streamflow data
	Areas with irrigation
	Watercourses vector map
	*N and P application rates per crop type
Sediment retention	Sediment source data
	Sediment flux data
Carbon sequestration	Land cover data
	Land use/crop data
	*Data on carbon pools (above, below, dead, soil)
Pollination	Species occurrence/abundance data of pollinating insects, e.g. wild bees, wasps
	*CS-specific pollinator guild table, with information on floral attractiveness and nesting quality of different land cover types for each pollinator species
Cultural (aesthetics/recreation)	Number of recreational users in specific locations through social media data.

4. Outlook

Building on the Case Study Base Layer a “European Base Layer” will be created. The purpose of this European Base Layer is to collate and store all relevant datasets required for BESTMAP’s modeling activities on the European scale (WP5). Table 5 gives an overview of large-scale datasets that will be incorporated in the European Base Layer. The compilation of European-wide geodata will be continued as part of D3.2 - European Base Layer (due in month 18).

Ultimately, both Case Study and European Base Layers are planned to be used as input layers in BESTMAP’s Policy Impact Assessment Dashboard (MS11, due in month 40).

Table 5: Large-scale datasets amending the Case Study Base Layer.

Variable	Dataset	Spatial Resolution	Temporal Resolution	Reference
Topsoil pH	OpenLandMap Soil pH in H2O	250 m	annual	Hengl 2018
Topsoil bulk density	European Soil Database Derived data	1000 m	-	Hiederer 2013
Topsoil organic carbon	European Soil Database Derived data	1000 m	-	Hiederer 2013
Topsoil clay content	European Soil Database Derived data	1000 m	-	Hiederer 2013
Soil depth to bedrock	European Soil Database Derived data	1000 m	-	Hiederer 2013
Parent material	European Soil Database Derived data	1000 m	-	Hiederer 2013
Digital terrain model	EU-DEM v1.1	25 m	-	Copernicus Land Monitoring Service 2016
Daily precipitation	E-OBS - RR	0.1 degree	daily	Cornes et al. 2018
Multiannual precipitation per month	TerraClimate	2.5 arc min	monthly	Abatzoglou et al. 2018
Daily minimum temperature	E-OBS - TN	0.1 degree	daily	Cornes et al. 2018
Multiannual minimum temperature per month	TerraClimate	2.5 arc min	monthly	Abatzoglou et al. 2018
Daily maximum temperature	E-OBS - TX	0.1 degree	daily	Cornes et al. 2018

Multiannual maximum temperature per month	TerraClimate	2.5 arc min	monthly	Abatzoglou et al. 2018
Multiannual potential evapotranspiration per month	TerraClimate	2.5 arc min	monthly	Abatzoglou et al. 2018
Livestock density	Livestock-Geo-Wiki	5 km	-	Gilbert et al. 2018

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- Tagfalter-Monitoring Deutschland at the UFZ
- LfULG - Sächsisches Landesamt für Umwelt, Landwirtschaft und Geologie
- Rural Payments Agency

6. References

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Copernicus Land Monitoring Service, 2016,European Digital Elevation Model (EU-DEM), version 1.1, https://land.copernicus.eu/imagery-in-situ/eu-dem/eu-dem-v1.1.

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