Interreg
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Danube Transnational Programme
SaveGREEN

SaveGREEN Technical Application Toolbox

Output T1.2 of the SaveGREEN Project

SaveGREEN "Safeguarding the functionality of transnationally important ecological corridors in the Danube basin"

Danube Transnational Programme, DTP3-314-2.3

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1. Introduction

The following document describes the specification and the implemented data model as well as software components of the SaveGREEN Technical Application Toolbox.

The components of the implemented SaveGREEN Application Toolbox cover different phases within the functional monitoring approach (Figure 1). The process is designed in a way that allows to integrate the different aspects relevant within SaveGREEN. This includes the consideration of existing information and data (e.g. data from ConnectGREEN project), the different characteristics of the SaveGREEN pilot areas as well as a robust data exchange process to derive consistent and reliable data on corridors and functional connectivity.

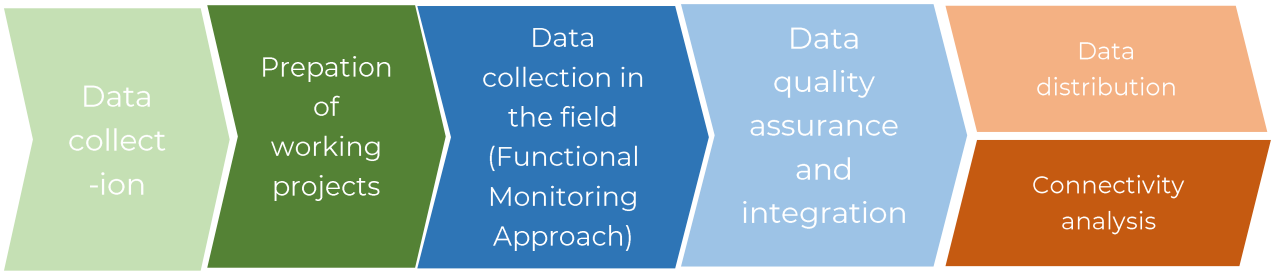


Figure 1: Scheme of phases that are covered by the development process of the Technical Application Toolbox

The toolbox will support the following project activities:

- Consistent and quality-assured storage of all data created within the framework of the project genesis
- Fieldwork and monitoring of functional connectivity within the pilot areas
- Consistent data flows between field work and IT infrastructure
- Publication of data and public availability

To ensure comparable and consistent geodata for all pilot areas, on the one hand a uniform database schema and on the other hand, a method for monitoring functional connectivity is provided.

For the monitoring of the functional connectivity in the course of the fieldwork in the pilot areas, the existing open source mobile GIS-Client software QField was adapted. Based on this mobile GIS Client all relevant parameters like e.g. land use, barriers and wildlife tracks can be collected digitally. The aim of the first monitoring season was to gather experience and to adjust the monitoring

concepts if necessary. Based on the user experience of the first monitoring seasons, all parameters from the functional monitoring, which have great potential to be used for citizen science monitoring approaches, were implemented as an additional Android based mobile device solution.

Thereafter, the existing mobile application "Roadkill" (Figure 2) was extended with these features, thus allowing citizens to easily engage in mapping exercises.

The SaveGREEN Project provides these two different mobile applications for the digital mapping of parameters for the functional connectivity monitoring approach in the course of the fieldwork.

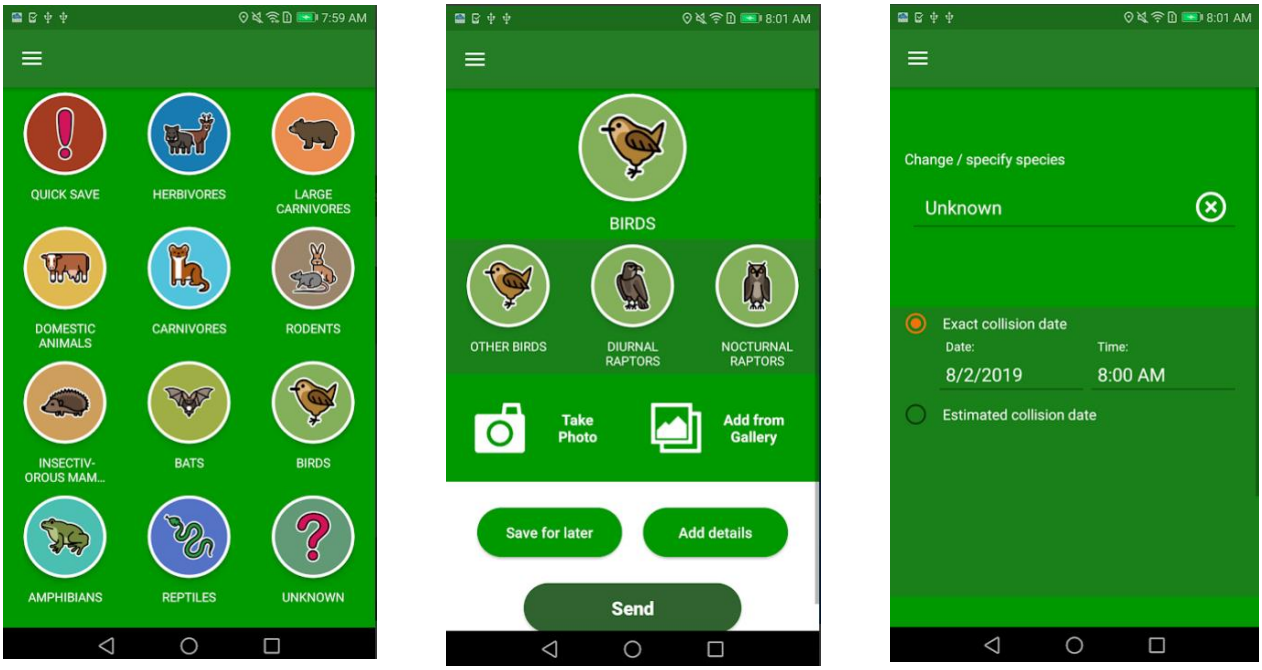


Figure 2: Roadkill application which functionality will be extended to be able to collect relevant parameters for the functional monitoring approach by means of citizen science

The results and all collected and data products of SaveGREEN, such as the designated corridors and the assessment of their functional connectivity, are published for a wide public audience through the following online portals (Figure 3):

- SaveGREEN Geodata-Portal: https://metadata.SaveGREEN.at/
- Carpathian Countries Integrated Biodiversity Information System (CCIBIS: https://ccibis.org/)
- Ecological Networks Europe: ENE: http://www.ecological-network.eu/

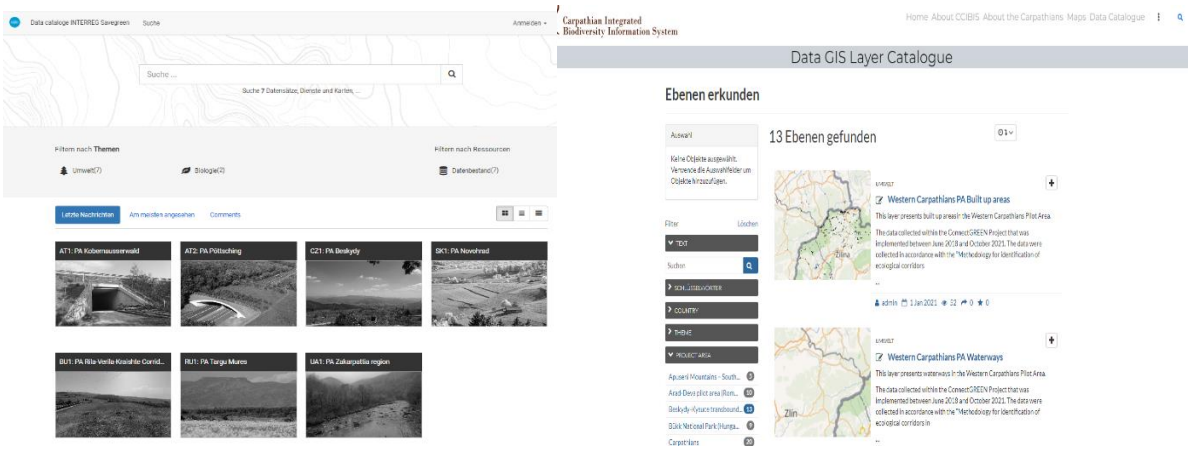


Figure 3: Collected data of the structural and functional monitoring approach in the pilot areas are made available to general public by publishing through the implemented SaveGREEN Distribution Platform (SaveGREEN-DP: https://metadata.SaveGREEN.at) and can be easily integrated in the established thematic web platforms CCIBIS Geoportal (https://geoportal.ccibis.org/) and Ecological Corridors Europe (http://www.ecological-network.eu/)

This integration of project results in the well-established and widely known thematic portals CCIBIS and ENE is a significant contribution to ensure future consideration in planning and furthermore, contributes to raising awareness for ecological connectivity.

The following resources of the SaveGREEN Technical Application Toolbox are shared via the SaveGREEN Project Library (https://www.interreg-danube.eu/approved-projects/SaveGREEN/outputs):

- SaveGREEN Harmonized Data Model (HDM)
  - UML.zip: UML-Diagrams (PDF)
  - SaveGREEN.eapx: Enterprise Architect project file (required to extend the HDM)
  - GML-Application schema HDM
- QField.zip: QGIS-Field Template HDM (Template project which can be used directly in QField to map all objects defined in the HDM)
- Import2PostGIS.zip: Import scripts (all import scripts required to import the QField data sets in the PostGIS database

2. Overall IT architecture

The whole implementation of the SaveGREEN Technical Application Toolbox is based on open source technologies. This is the only way to ensure the reuse of the developed tools in other projects without additional licensing costs. Thus, open source software was used for the development of the toolbox such as QGIS[1] and QField[2] for the in-field monitoring tool, as well as the open source database technology PostgreSQL[3] with the extension PostGIS[4] for the backend to implement a uniform SaveGREEN database schema. The PostGIS extension also enables the storage and analysis of geographic data.

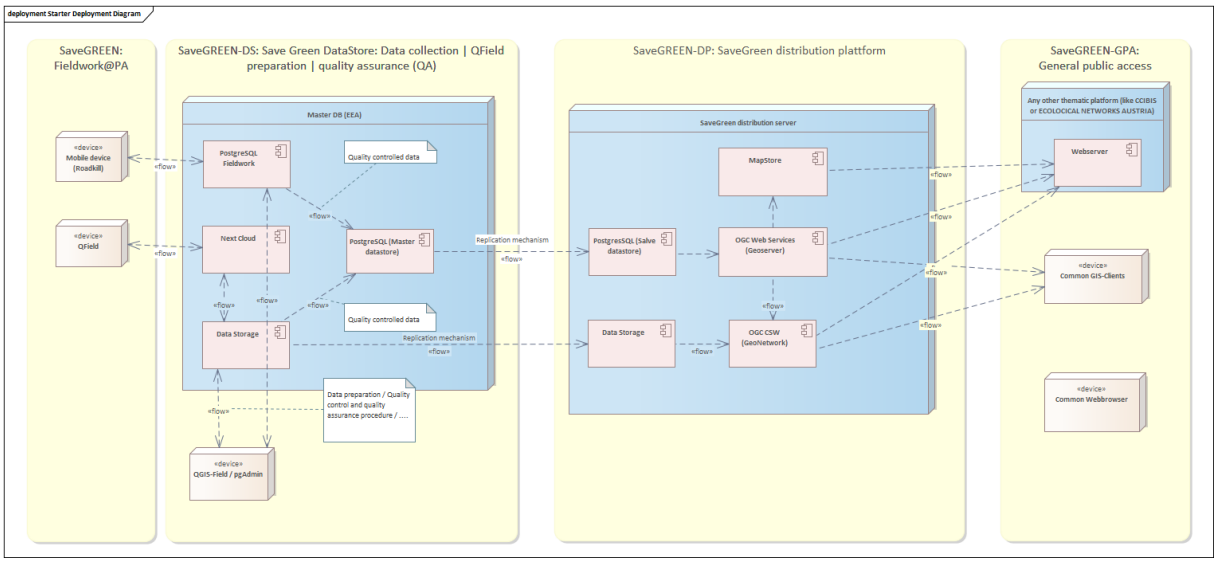


Figure 4: Deployment diagram and overall architecture of the SaveGREEN Toolbox

Figure 4 shows the overall architecture and all components of the SaveGREEN Technical Application Toolbox. Two mobile device applications are available to support the collection of data in the field (Figure 4: SaveGREEN:*Fieldwork@PA*). QField is an existing Android client technology and the mobile frontend GIS of the open source GIS software QGIS. For each pilot area a QField project was configured to support the monitoring of functional connectivity in the field. These prepared projects will include also basemap datasets and the harmonized fieldwork data model. These QField projects are synchronised by using the open

[1] https://qgis.org/
[2] https://qfield.org/
[3] https://www.postgresql.org/
[4] https://postgis.net/

source cloud sharing technology nextcloud[5] to connect the mobile device and the central data storage. After a quality control and quality assurance procedure the fieldwork data are published from the data storage to the PostgreSQL master data store. A detailed description about the QField client and related workflow is given in chapter "*QField – an open access application for monitoring in the field*" (Figure 4: SaveGREEN-DS).

Beside the QField expert client solution, the smart phone mobile application Roadkill was made available for the pilot areas (see chapter *The Roadkill Application – Extension to support the monitoring of functional connectivity for citizen scientists*). This application communicates directly via web services with the PostgresSQL fieldwork database. After a quality control and quality assurance procedure, all datasets are forwarded to the PostgresSQL master data store, which represents the central SaveGREEN data warehouse.

As soon as new data are available in the PostgresSQL master data store the latest changes of this data are replicated to the PostgresSQL slave data store, which is running on the SaveGREEN-DP (Figure 4: SaveGREEN-DP).

The final and latest datasets of the individual pilot regions are available on the one hand as file-based database format Geopackage (including all mapped objects and photos of the pilot region) and on the other hand in the central PostGIS database (data store for the provision of the OGC web services) for further processing and the publication process.

The SaveGREEN Distribution Platform (Figure 4: *SaveGREEN-DP*) provides different technologies and mechanism to integrate the datasets and their documentation (metadata). The integration can be done by using the provided OGC Viewing Services (OGC WMS), OGC download services (OGC WFS) and discovery services (OGC CSW). Furthermore, a direct integration of the provided interactive maps (Figure 4: SaveGREEN-DP-Component MapStore) of the pilot areas via iframe technology and API is provided.

This mechanism allows the integration of all SaveGREEN results and data sets in the well-established and wide known thematic portals CCIBIS and ENE. (Figure 4: *SaveGREEN-GPA*).

[5] https://nextcloud.com/

Furthermore, for GIS experts direct access to the relevant geodata for common GIS clients is provided by standardised OGC web services. For non-GIS users the data can also be accessed and viewed via a standard web browser.

3. Data model

The developed harmonized SaveGREEN data model represents the heart of the whole SaveGREEN application toolbox. It defines the whole model sematic - all objects, their properties and relationships that must be mapped in course of the fieldwork and guarantees and thus ensures the comparability of the results of the individual pilot regions.

The conceptual data model was created according to the standards of the ISO TC211 - Geographic Information using the conceptual modelling language intended for this purpose, in particular Unified Modelling Language (UML)[6]

Using the UML diagrams, the data model and its contents were clarified with the domain experts within SaveGREEN. Furthermore, a GML application schema can be derived directly from the diagrams, which defines the encoding of the data to be exchanged as well as the underlying database structure.

This type of data transfer is also called ‘schema-related data exchange’ because the underlying data model is also transferred during the exchange.

Documentation of the data model

For a better overview, the data model was divided into four areas or so-called UML leafs. The UML leaf "General Data Feature Types" provides two feature types that allow an assignment of all collected and provided spatial objects to the corresponding pilot area and to the corresponding data set. Through this assignment, all spatial objects of a pilot area or a data set can be systematically queried and transferred.

[6] https://www.uml.org/

In the UML leaf "Collected Data Feature Types", data models are defined for those data sets that are made available to support the fieldwork or are created in the context of structural modelling.

In the UML leaf “Fieldwork Data Feature Types”, data models are created for all the topics that are collected during the fieldwork. All three GML leafs have a dependency to the fourth UML leaf in which the model-specific data types, code lists and enumerations are defined (Figure 5).

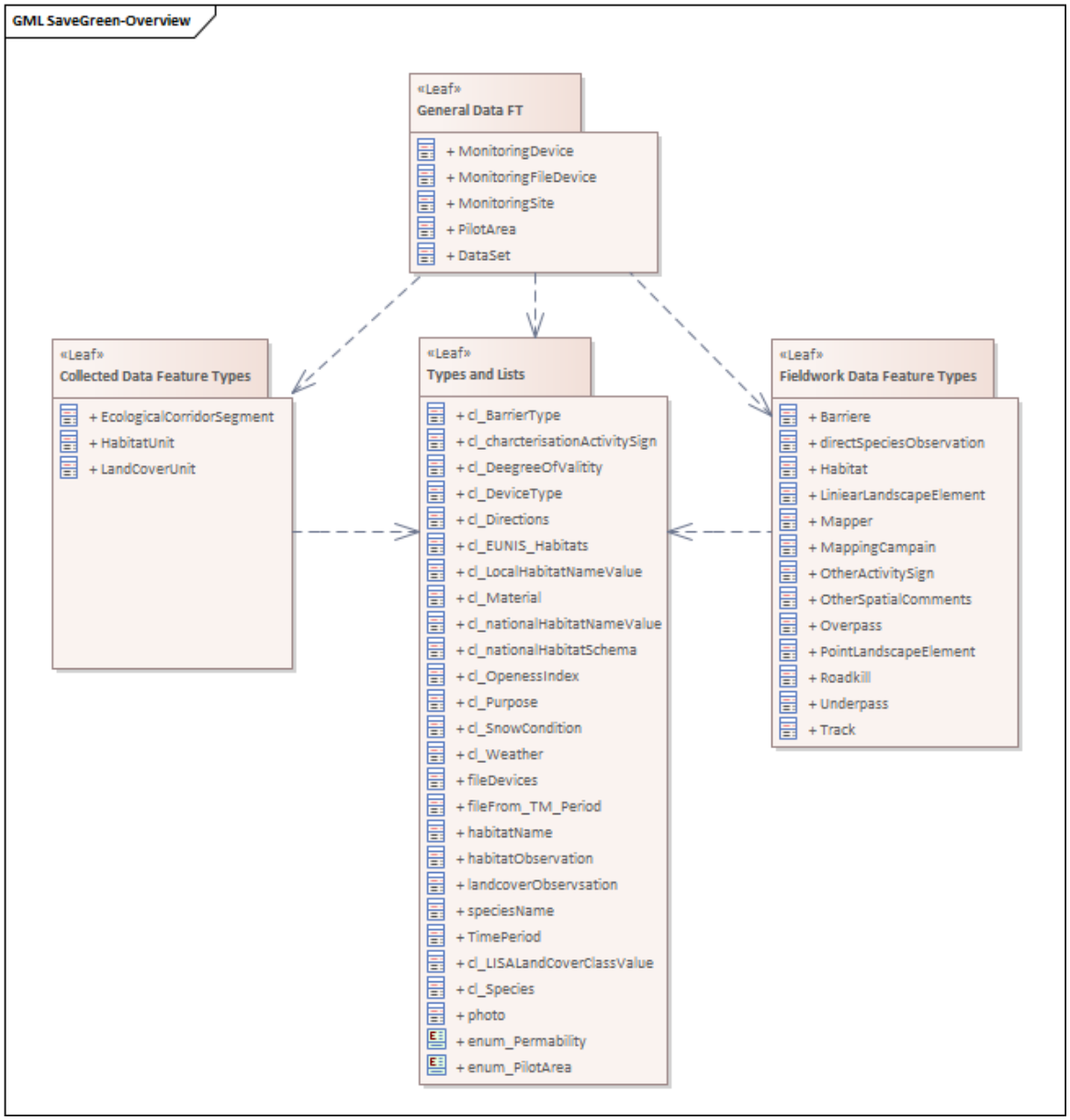


Figure 5: Package diagramm: overview of feature types, data types, codelists, enumerations and their *dependencies*

Basetypes

During the conception of the data model, base data types were defined to be used for the designed feature type (FT) in the SaveGREEN application schema. On the one hand, these are concepts of the INSPIRE Generic Conceptual Model, which are essential for the life cycle management and the ID handling of the spatial objects. In addition to these elements, data types have been defined to facilitate data synchronization between the distributed databases (master-slave databases) and to ensure consistent data management.

INSPRE Base Types used for the SaveGREEN application schema

identifier

External unique object identifier published by the responsible body, which may be used by external applications to reference the spatial object.

NOTE1 External object identifiers are distinct from thematic object identifiers.

NOTE 2 The voidable version identifier attribute is not part of the unique identifier of a spatial object and may be used to distinguish two versions of the same spatial object.

NOTE 3 The unique identifier will not change during the life-time of a spatial object.

- **localId:**
  A local identifier, assigned by the data provider. The local identifier is unique within the namespace, i.e. no other spatial object carries the same unique ID.

  NOTE: It is the responsibility of the data provider to guarantee uniqueness of the local identifier within the namespace.

- **namespace:**
  Namespace uniquely identifying the data source of the spatial object.

  NOTE: The namespace value will be owned by the data provider of the

spatial object and will be registered in the INSPIRE External Object Identifier

- **version:**
  The identifier of the particular version of the spatial object, with a maximum length of 25 characters. If the specification of a spatial object type with an external object identifier includes life-cycle information, the version identifier is used to distinguish between the different versions of a spatial object. Within the set of all versions of a spatial object, the version identifier is unique.

  NOTE 1: The maximum length has been selected to allow for time stamps based on ISO 8601, for example, "2007-02-12T12:12:12+05:30" as the version identifier.

  NOTE 2: The property is void, if the spatial data set does not distinguish between different versions of the spatial object. It is missing, if the spatial object type does not support any life-cycle information.

- **beginLifeSpanVersion**
  Date and time at which this version of the spatial object was inserted or changed in the spatial data set.

- **endLifeSpanVersion**
  Date and time at which this version of the spatial object was superseded or retired in the spatial data set.

Base Types to facilitate data synchronization between the distributed databases:

- **synchronised**

Data type for marking objects synchronized from the working database to the master database.

- **approved**

Once an expert has validated the objects regarding their correctness, the value is set to true and the objects are synchronized into the master database and from there into the slave databases.

General Data Feature Types

The General Data Feature Types (Figure 6) enable an assignment of all spatial objects, which are provided for and collected during the fieldwork, to a specific dataset or a pilot region. Essential information about the pilot areas and the dataset can be documented by using these Feature types (FT). Furthermore, the entire model semantic required for the storage of all the data sets collected by the different devices types (like camera traps or the data logger for noise and light emissions) in the established monitoring sites in the PA is defined.

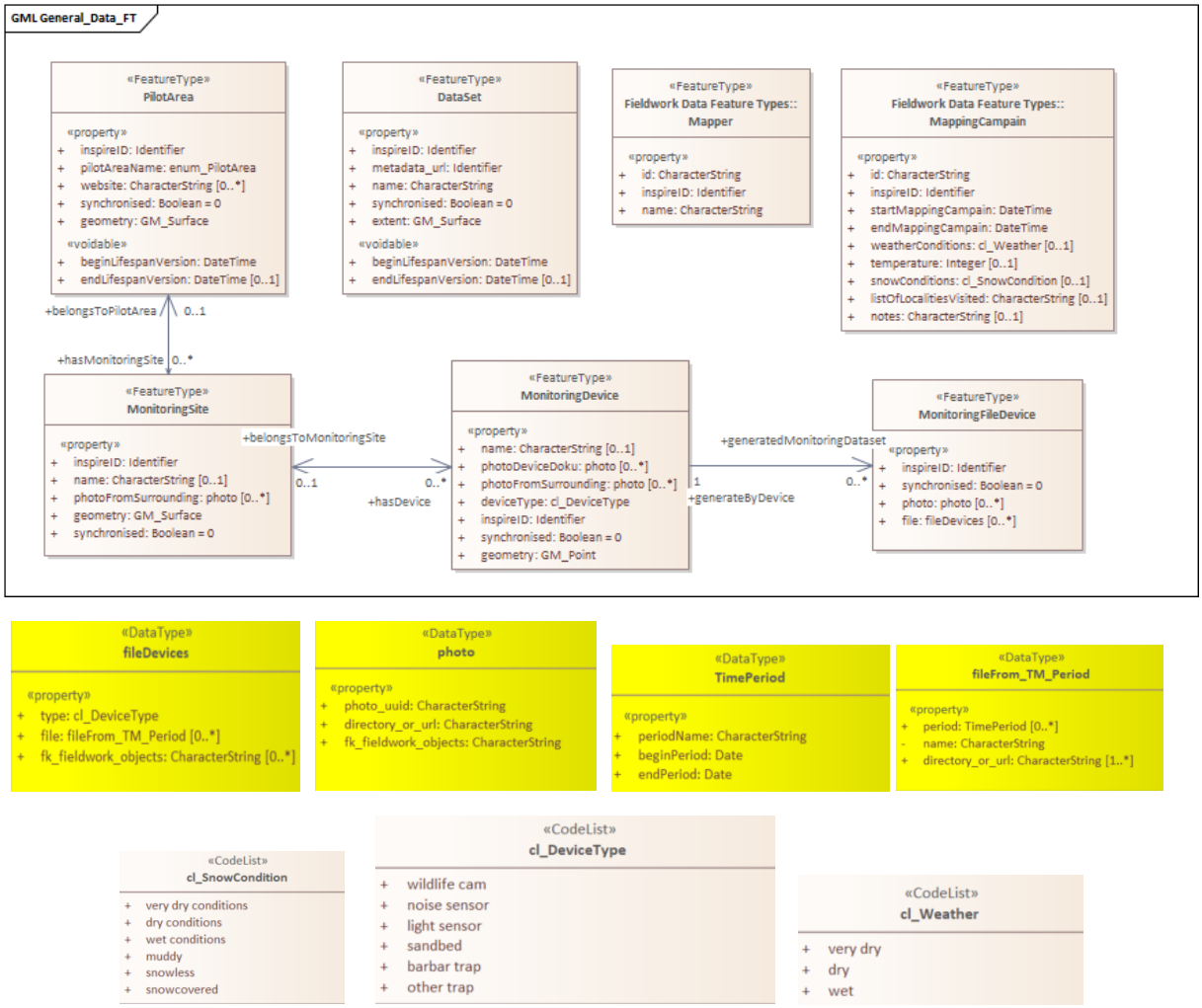


Figure 6: Leaf „General Data Sets" and associated enumeration

FT PilotArea

FT to provide essential information about the pilot area like

- *pilotAreaName*: enum_PilotArea - name of the pilot area
- *website*: CharacterString - if available a link to a website with information describing the pilot area
- *geometry*: GM_Polygon - delimitation of the pilot region

FT DataSet

FT to provide essential information about the dataset

- *name:* CharacterString - name that identifies the dataset
- *metadata_url*: Identifier - Unique URL to metadata record if metadata catalogue is available
- *extent:* EX_GeographicExtent - Spatial extent of the data set

FT MonitoringSite

FT to provide essential information about the monitoring site

- *name:* CharacterString - name that identifies the monitoring site
- *photoFromSurrounding:* Photos to document the surrounding of the monitoring site
- *geometry* : delimitation of the monitoring site

FT MonitoringDevice

FT to provide essential information about the monitoring device used

- *name:* CharacterString - name that identifies the monitoring device
- *photoDeviceDoku*: Photo for the documentation of the device.

- *photoFromSurrounding*: Photos to document the surrounding of the site where the device is established
- *deviceType*: Type of device
- *geometry:* Location of the monitoring device within the monitoring site

FT MonitoringFileDevice

FT to provide essential information about the data generated by the device

- *photo:* data type to store the information of the photo file
  - *photo_uuid:* Identifier of the photo
  - *directory_or_url:* folder or URL where the photo is stored or could be accessed via internet
  - *fk_fieldwork_objects:* foreign key to the used MonitoringDevice
- *file:* data type to store the information of the produced file (e.g. csv- or excel-file)
  - *type:* type of used device (see cl_DeviceType)
  - *file:* information of the stored file
    - periode: Period that is covered by data measurements (data-logger)
    - name: Name of the file
    - directory_or_url: Folder or URL where the file is stored
  - *fk_fieldwork_objects:* foreign key to the used MonitoringDevice

FT Mapper

FT to provide essential information about the mapper concerned with fieldwork

- *name:* CharacterString – name of the person who carried out the fieldwork

FT MappingCampaign

FT to provide essential information about the mapping campaign

- *startMappingCampaign:* Start date and time of the mapping campaign
- *endMappingCampaign:* End date and time of the mapping campaign
- *weaterConditions:* Information about the weather conditions (cl_Wather)
- *temperature :* Average temperature while the mapping campaign
- *snowConditions:* Snow conditions during the mapping campaign (cl_SnowConditions)
- *listOfVisitedSites:* List of all sites which have been mapped

- *notes:* Space for comments and notes about the mapping campaign

Collected Data Feature Types

These FTs were designed to store the information and results from the structural monitoring and additional collected data, which support the fieldwork and represents the ecological status quo of the pilot area (Figure 7). For this purpose, the three Collected Data Feature Types *EcologicalCorridorSegment*, *HabitatUnit* and *LandCoverUnit* are designed.

FT EcologicalCorridorSegment

The FT will be used to provide the information obtained from the structural monitoring. It will show the course of the ecological corridor as well as the evaluation of the corridor in terms of its permeability. For these purposes, the corridor is divided into corridor segments that have the same permeability. Each Corridor Segment has a relationship to the General Feature Types PilotArea (association role = pilotArea) and DataSet (association role = dataset). The feature properties can store the following information:

- *degreeOfPermability: enum_Permability* - Value and its classification according the enumeration *enum_Permability* which is calculated within the structural monitoring procedure. Representing the status quo of the ecological permeability of the corridor segment from a structural connectivity viewpoint.
- bottleneck: Boolean – Corridor segments which represents a bottleneck within the corridor course
- geometry: GM_Polygon – Delineation of the corridor segment. Result of the structural connectivity modelling procedure.

FT HabitatUnit

This FT is designed to provide information on the habitat structure and features in the pilot area. For all pilot regions where data on habitat mapping is available, the national habitat classification system should be translated to the EUNIS habitat classification system in order to ensure comparability of the habitat configuration of the different pilot areas.

Following feature properties are available:

- *habitatType: habitatName* – Complex data type *habitatName* to provide the following information
    - *eunisHabitatName: cl_EUNIS_Habitats* – EUNIS Habitat Name (cl_EUNIS_Habitats). If possible a mapping on EUNIS Habitat Level 2 should be provided
    - *localHabitatName*: cl_nationalHabitatNameValue - The localHabitatSystem should be maintained and documented in a code list registry. If the localHabitatSystem is maintained in a code list registry, please use the URL for the localHabitatNameValue to provide the localHabitatName
    - *localHabitatSchema:* cl_nationalHabitatSchema - If the localHabitatSystem is maintained in a code list registry, please provide the Registry URL to the local habitat schema.
- geometry: GM_Polygon – Delineation of the habitat.

FT LandCoverUnit

This FT is designed to provide information about the land cover structure in the pilot area. In order to ensure the comparability of the land cover between the pilot regions, the so-called LISA Land cover classification system is used, which was designed for pure land cover classes, which can be derived directly from satellite images like Sentinel II. The LISA Classification System is provided and available in the Austrian INSPIRE code list registry (https://registry.inspire.gv.at/codelist/LISALandCoverClassValue). For all pilot areas, a sentinel II based automatic land cover designation based in the LISA Classification System will be provided.

Following feature properties are available:

- *landCoverClass: cl_LandCoverClassValue* – LISA Land Cover Value defined in code list *cl_LisaLandCoverClassValue*
- geometry: *GM_Polygon* - delineation of the land cover class

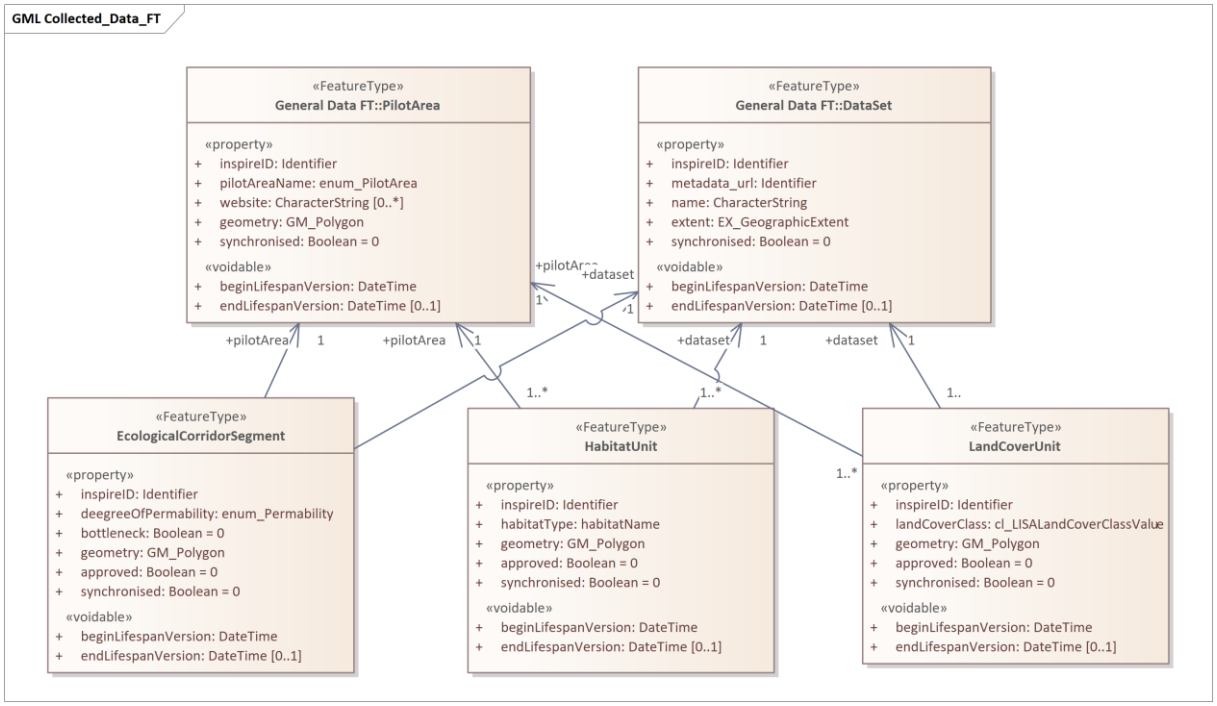


Figure 7: Overview of Feature Types for collected data and their relationships

Fieldwork Data Feature Types

The Fieldwork Data Feature Types (Figure 8) provide the required data structure to store all relevant aspects collected during fieldwork in the pilot areas. All collected objects and their corresponding feature types are associated to a specific pilot area, a dataset and the person (mapper) doing the field work using an GML association (all Fieldwork Data FT are connected to the General Data FT which are placed in the middle (red rectangle) and the FT Mapper (green rectangle) on the bottom of Figure 8).

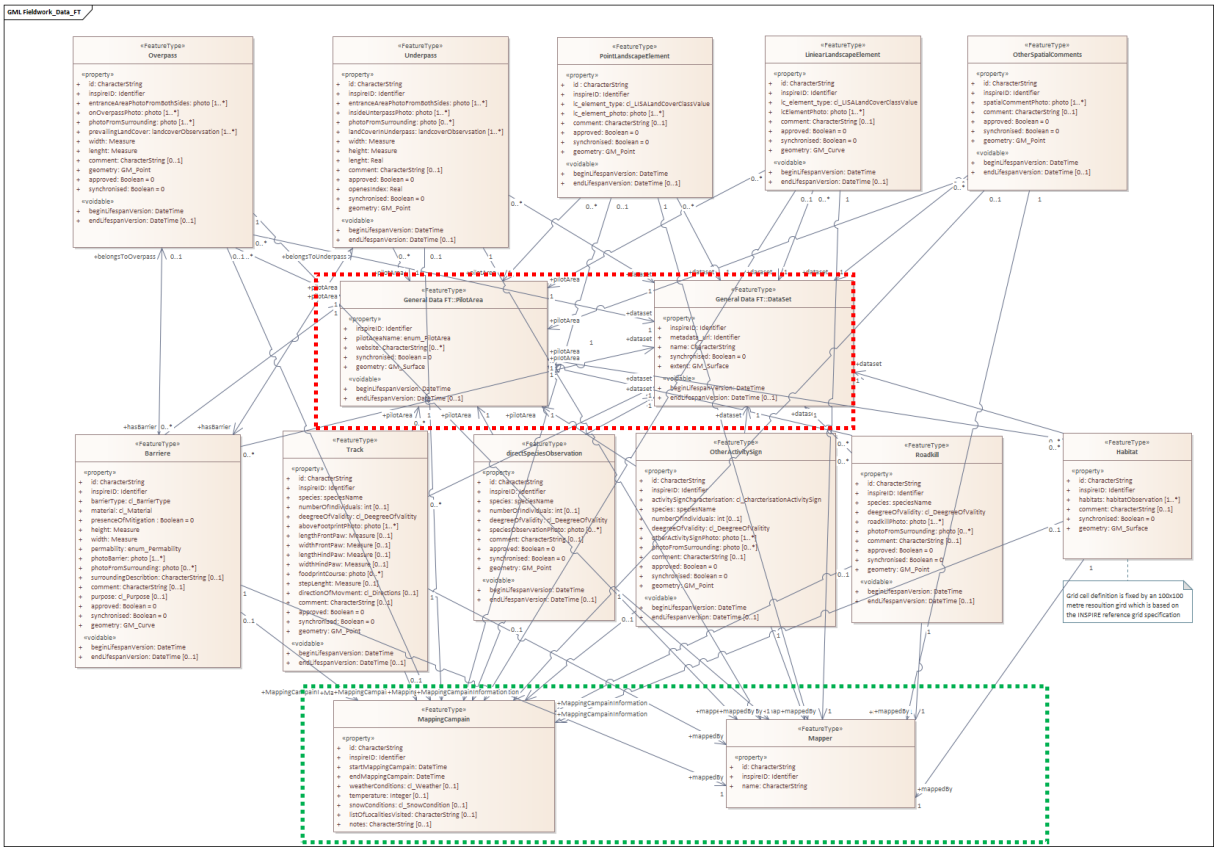


Figure 8: Overview Feature Types for the data collection during fieldwork and their relationships to the General Data Feature Types (red box in the middle). Furthermore all objects mapped during fieldwork have a relationship to the mapper and the mapping campaign (green box)

The following aspects of the fieldwork are covered by the FT data structure:

FT Overpass

FT Overpass (Figure 9) is designed for the mapping of crossing structures on roads and railways. Following characteristics of an overpass are designated for the field mapping campaign.

- *entranceAreaPhotoFromBothSides: photo (1…*)* – One to many photos characterising the entrance area of both sides can be taken
- *onOverpassPhoto: photo (1…*)* – One to many photos characterising the structure on the overpass can be taken
- *photoFromSurrounding: photo (1…*)* – One to many photos characterising the surroundings can be taken
- *prevailingLandCover: landCoverObservation (1…*):* Based on the complex Datatype landcoverObservation the land cover types on the overpass and their shares can be mapped
- *width:Measure* – width of the overpass in meters
- *length: Measure*– length of the overpass in meters
- *comment: CharacterString (0….1)* - comments and remarks regarding the overpass
- *geometry:GM_point:* Centre of the overpass construction
- *Association to FT Barrier: barriers* - Based on this association and the corresponding association role “barrier”, all mapped barriers which are related to overpass can be assigned (Figure 9)

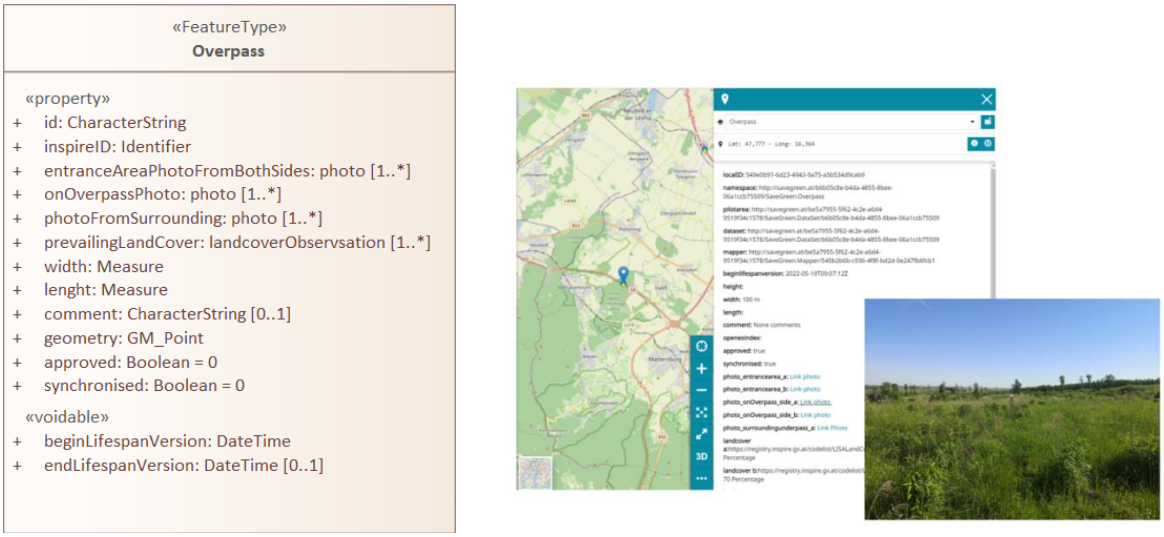


Figure 9: FT Overpass

FT Underpass

FT underpass (Figure 10) is designed for the mapping of underpasses of roads and railways. Following characteristics of an overpass are designated for the field mapping campaign.

- *entranceAreaPhotoFromBothSides: photo (1...*)* – One to many photos characterising the entrance area of both sides can be taken
- *insideUnterpassPhoto: photo (1...*)* – One to many photos characterising the structure in the unterpass can be taken
- *photoFromSurrounding: photo (1...*)* – One to many photos characterising the surroundings can be taken
- *landCoverInUnderpass: landCoverObservation (1...*):* Based on the complex Datatype landcoverObservation the land cover types in the underpass and their relevant share can be mapped
- *width:Measure* – average width (W) of the underpass in meters
- *height:Measure* – average height (H) of the underpass in meters
- *length:Measure-* length (L) of the underpass in meters
- *openesIndex:Real* – the openness index (OI) is automatically calculated based on the following formula. OI =W x H / L
- *comment: CharacterString (0....1)* - comments and remarks according the underpass
- *geometry:GM_point:* Centre of the underpass construction
- *Association to FT Barrier: barriers* - Based on this association and the corresponding association role “barriers”, all mapped barriers which are related to underpass can be assigned (Figure 10)

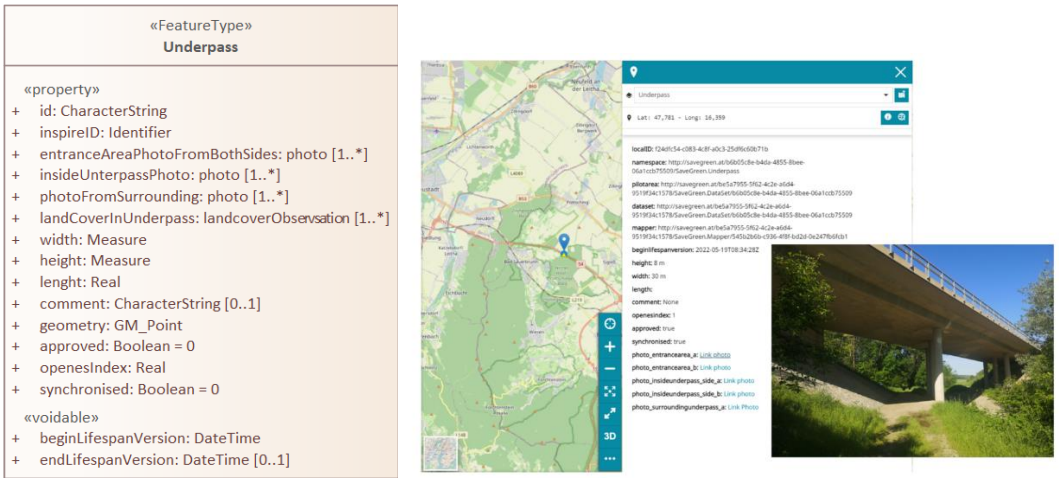


Figure 10: FT Underpass

FT PointLandscapeElement

FT PointLandscapeElement (Figure 11) is designed for the mapping of small punctiform landscape elements. The following characteristics of landscape elements are covered by the data structure of the FT for the field mapping campaign.

- *lc_element_type: cl_LISALandCoverClassValue* – Classification of the landscape element type based on the LISA nomenclature
- *lc_element_photo* - One to many photos characterising the landscape element
- *comment: CharacterString (0....1)* - comments and remarks regarding the landscape element
- *geometry: GM_Point – Point location of the landscape element*

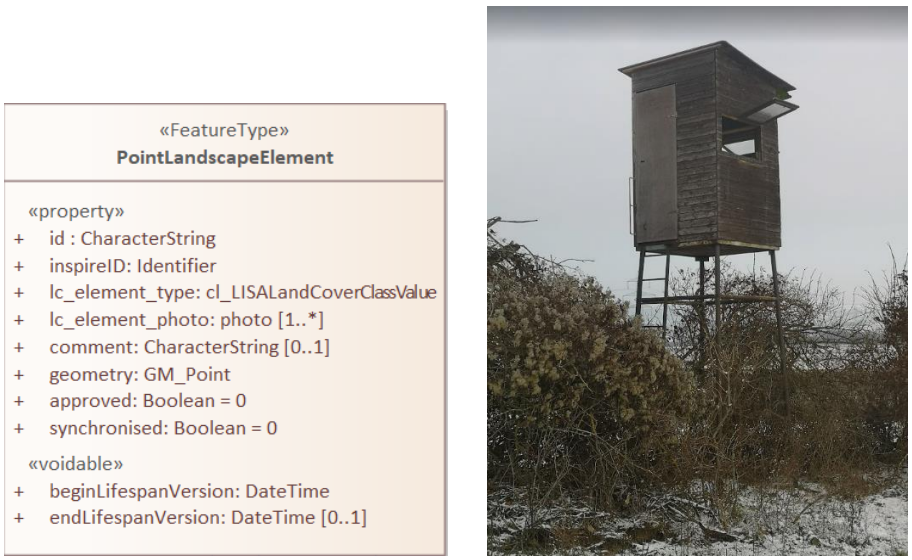


Figure 11: FT PointLandscapeElement

FT LinearLandscapeElement

FT LinearLandscapeElement (Figure 12) is designed for the mapping of linear landscape elements. The following landscape element characteristics are covered by the data structure of the FT for the field mapping campaign.

- *lc_element_type: cl_LISALandCoverClassValue* – Classification of the landscape element type based on the LISA nomenclature
- *lc_element_photo* - One to many photos characterising the landscape lement

- *comment: CharacterString (0....1)* - comments and remarks regarding the landscape element

geometry: GM_LineString – Mapping of the location of the linear landscape element

Figure 12: LinearLandscapeElement

FT OtherSpatialComments

FT OtherSpatialComments (Figure 13) is designed for all relevant information, which is not covered by the other Collected Data Feature Types. The structure of this FT is very simple and shown below

- *spatialCommentPhoto: photo (1...*)* - one to many photos of the spatial comment
- *comment: CharacterString (0....1)* - comments and remarks of information which is not covered by the other Collected Data Feature Types.
- *geometry: GM_Point* – Mapping of the location of the spatial comment

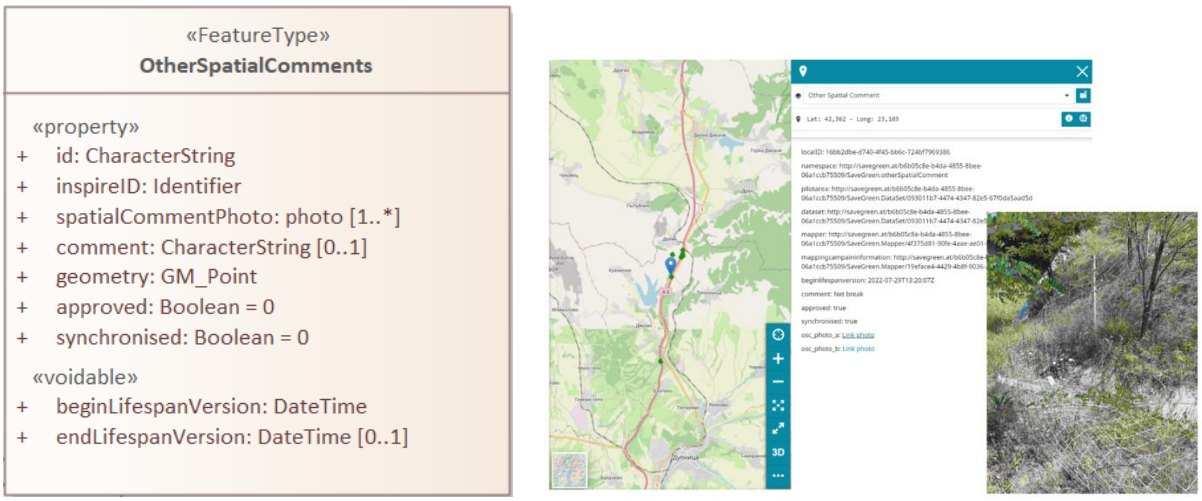


Figure 13: FT OtherSpatialComments

FT Barrier

FT Barrier (Figure 14) provides the data structure to map potential barriers in the ecological corridor environment. Following feature properties are available for the barrier characterisation

- *barrierType: cl_BarrierType* - Classification of the type of barrier based on the code list "cl_BarrierType"
- *material: cl_Material* - Classification of the type of predominant material the barrier is composed of
- *presenceOfMitigation: Boolean* – set true (=1) if some mitigation measure is available / Default value is 0 = false
- *height: Measure* – height of the barrier in meters
- *width: Measure* – width of the barrier in meters
- *permability: enum_Permability* – rough classification of permeability for large mammals and predators (except bear) using the classification system defined in the enumeration *"enum_Permability"*
- *photoOfBarrier: photo (1...*)* – One to many photos characterising the barrier
- *photoFromSurrounding: photo (1...*)* – One to many photos characterising the surroundings
- *comment: CharacterString (0....1)* - comments and remarks according the underpass
- *purpose: cl_purpose:* Classification of the purpose leading to the barrier effect using the classification system of the enumeration "cl_Purpose"
- *geometry:GM_LineString:* Deliniation of the barrier using geometry data type LGM_LineString

- *Association to FT Underpass & FT Overpass:* Based on this association and the corresponding association roles “overpass” and “underpass”, barriers can be assigned to a underpass or overpass if these are functional connected to this constructions (Figure 14)

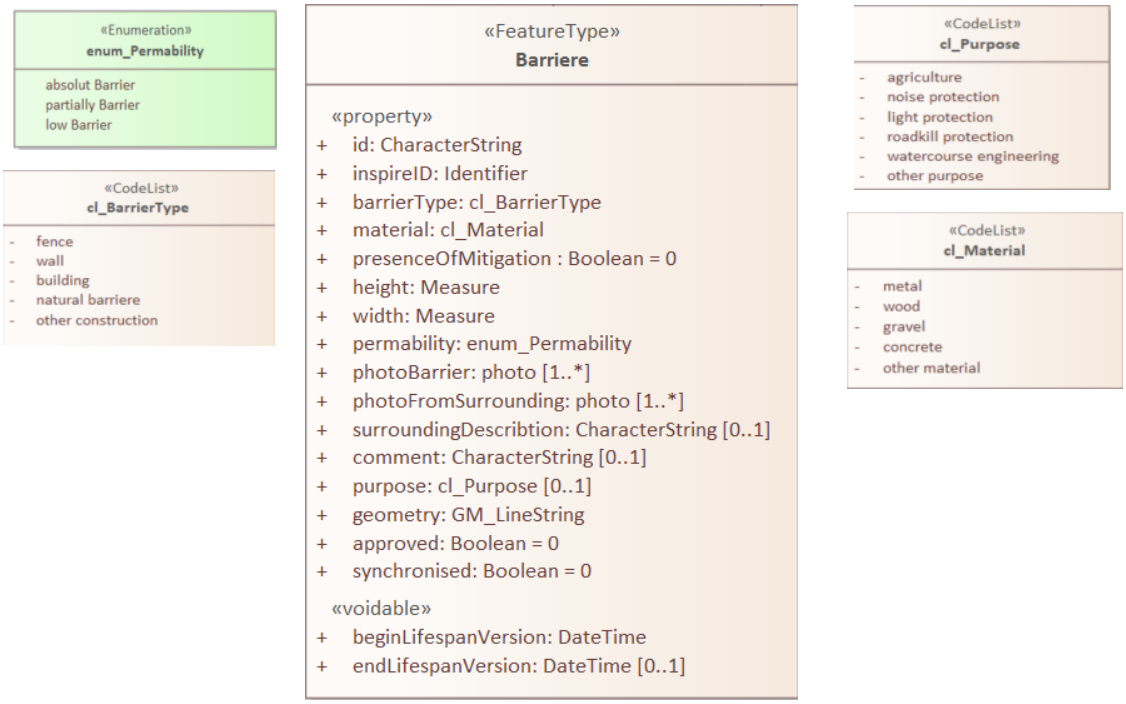
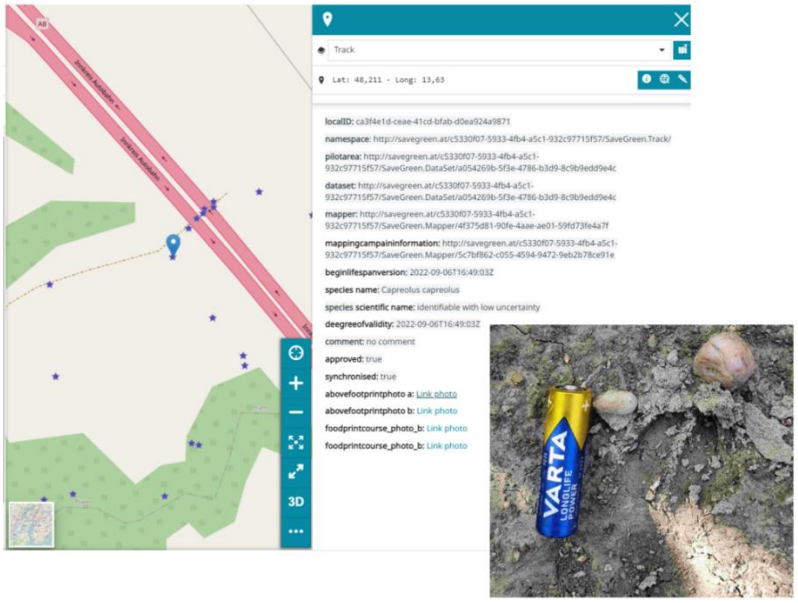


Figure 14: FT Barrier

FT Track



FT Track (

Figure 15) provides the data structure to animal tracks in the pilot are. Following feature properties are available for the classification and characterisation of animal tracks

- *Species: speciesName*
  - *observedSpecies:cl_Species* - Assignment of the animal species of the footprint. The provided code list "*cl_Species"* should be adapted for the relevant umbrella and target species of a pilot area.
  - *scientificName: CharacterString* - Documenting the scientific name listed under the EU-Nomen registry (http://www.eu-nomen.eu/portal/) in addition is recommended.
  - *euNomenGUID:* Global unique Identifier (GUID) for the species provided by the EU-Nomen registry
- *numberOfIndividuals: int* - Estimation of the number of animals that can be assigned to the footprints
- degreeOfValidtity: cl_DegreeofValidtity - estimation of the unambiguous assignment using the classification of code list *cl_DegreeOfValidity*
- *aboveFootprintPhoto: photo (1…*)* – One to many photos of the footprint

- *foodprintCourse: photo (1…*)* – One to many photos of the footprints course which provide important information for experts to classify the species footprints.
- *comment: CharacterString (0….1)* - comments and remarks concerning the footprint(s)
- *geometry:GM_Point:* Location of the footprint

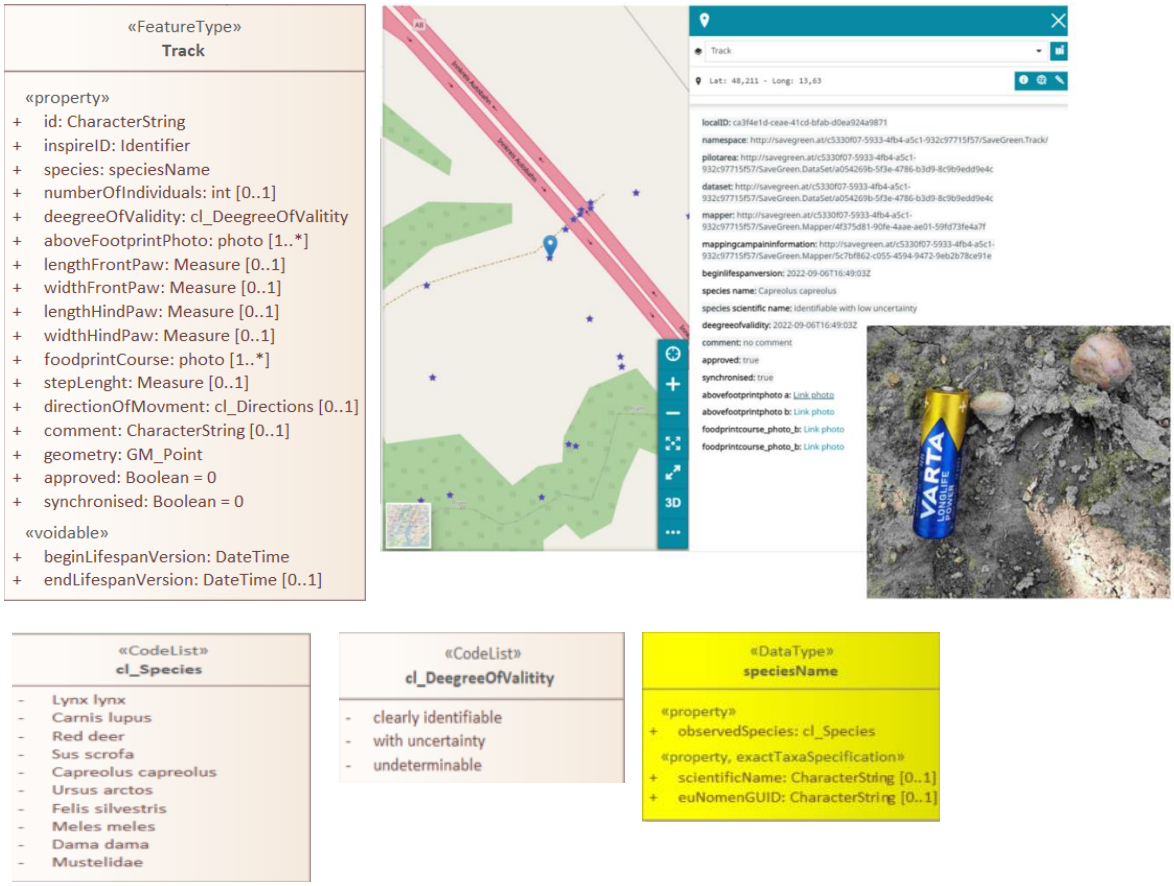


Figure 15: FT Track

FT directSpeciesObservation

FT directSpeciesObservation (

Figure 16) provides the data structure for the documentation of direct species observations. Following feature properties are available for the characterisation of the observation.

- *Species: speciesName*
  - *observedSpecies:cl_Species* - Assignment of the observed animal species. The provided code list "*cl_Species*" should be adapted for the relevant umbrella and target species of a pilot area.
  - *scientificName: CharacterString* - Documenting the scientific name listed under the EU-Nomen registry (http://www.eu-nomen.eu/portal/) in addition is recommended.
  - *euNomenGUID:* Global unique Identifier (GUID) for the species provides by the EU-Nomen registry
- *numberOfIndividuals: int* - Estimation of the number of animals that can be assigned to the footprints
- deegreeOfValidtity: cl_DeegreeofValidtity - estimation of the unambiguous assignment using the classification of code list *cl_DeegreeOfValidity*
- *speciesObservationPhoto: photo (1...*)* – One to many photos of the observed species
- *comment: CharacterString (0....1)* - comments and remarks according the footprint(s)
- *geometry:GM_Point:* Location of the observation

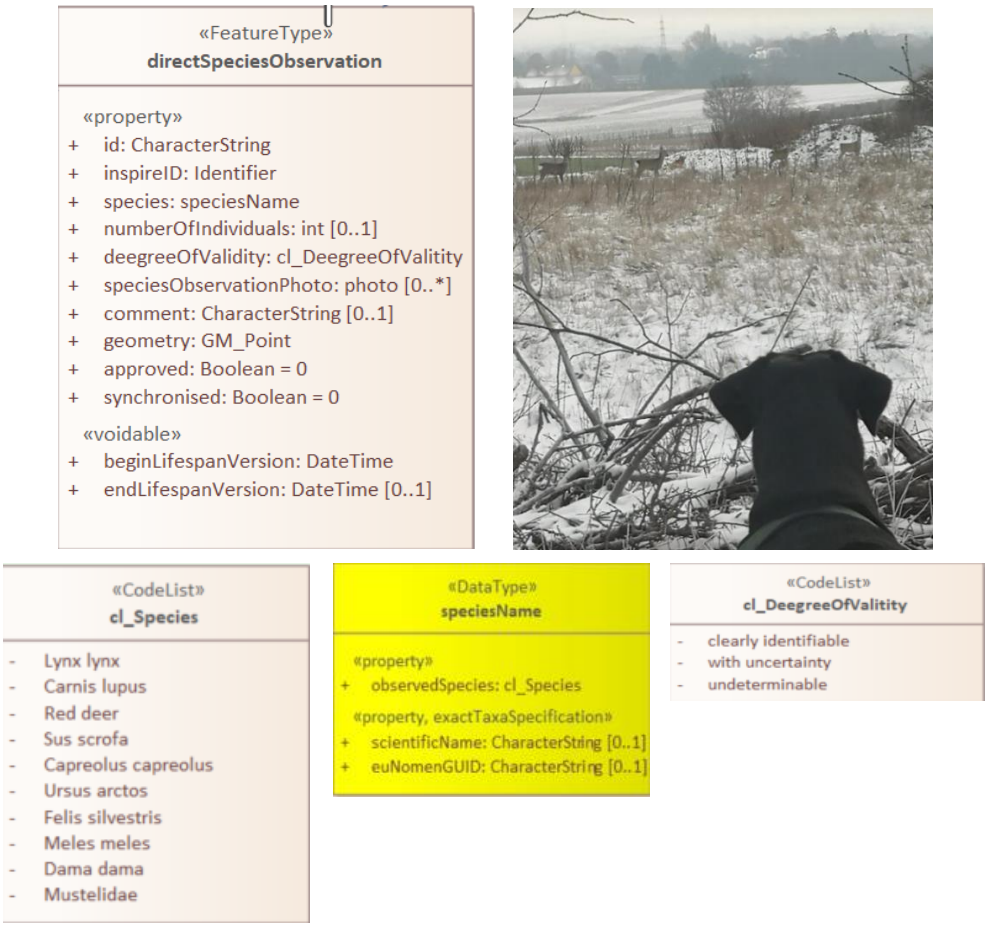


Figure 16: FT directSpeciesObservation

FT otherActivitySign

FT otherActivitySign (

Figure 17) provides the data structure for the documentation of other activity signs of species like scratch marks, hairs, pellets, feeding marks, etc.). Following feature properties are available for the characterisation of the observation.

- *Species: speciesName*
  - *observedSpecies:cl_Species* – if possible, the activity sign should be used to identify the animal species. The provided code list "*cl_Species*" should be adapted for the relevant umbrella and target species of a pilot area.
  - *scientificName: CharacterString* - Documenting the scientific name listed under the EU-Nomen registry (http://www.eu-nomen.eu/portal/) in addition is recommended.
  - *euNomenGUID:* Global unique Identifier (GUID) for the species provides by the EU-Nomen registry
- degreeOfValidtity: cl_DegreeofValidtity - estimation of the unambiguous assignment of the animal species using the classification of code list *cl_DegreeOfValidity*
- *otherActivitySignPhoto: photo (1...*)* – One to many photos of the observed activity
- *comment: CharacterString (0....1)* - comments and remarks according the animal activity
- *geometry:GM_Point:* Location of the observed animal activity

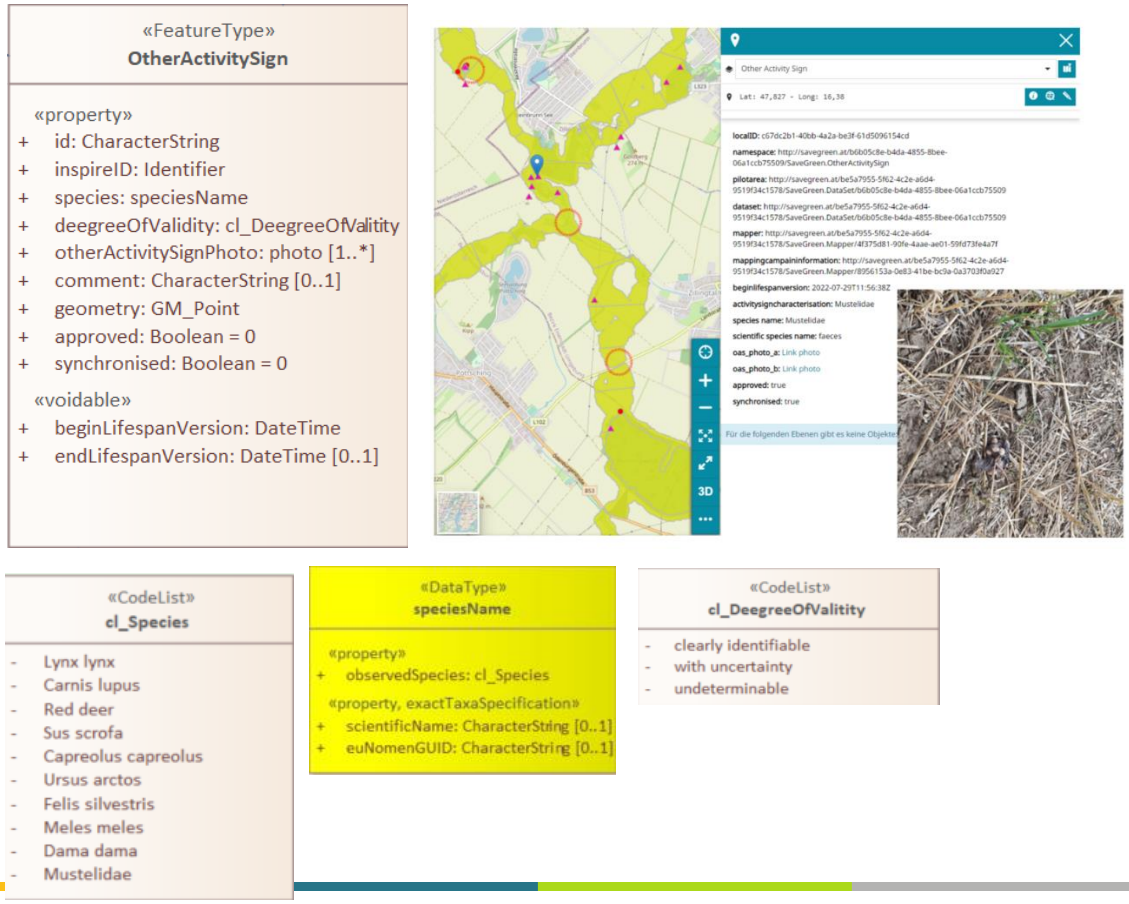
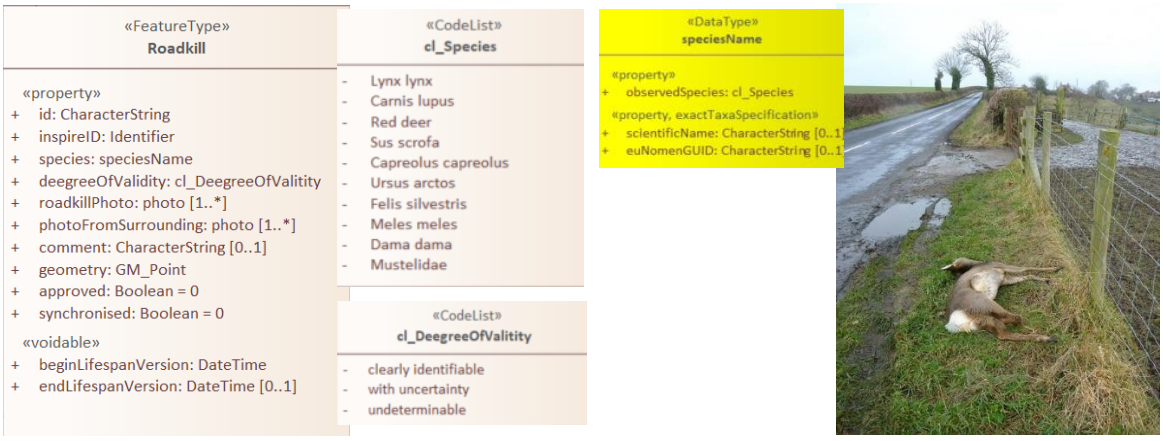


Figure 17: FT OtherActivitySign

FT Roadkill

FT roadkill (Figure 18) provides the data structure for the documentation of roadkills. Following feature properties are available for the characterisation of roadkills

- *Species: speciesName*
  - *observedSpecies:cl_Species* – If possible assignment of the species of the roadkill
  - The provided code list "*cl_Species*" should be adapted for the relevant umbrella and target species of a pilot area.
  - *scientificName: CharacterString* - Documenting the scientific name listed under the EU-Nomen registry (http://www.eu-nomen.eu/portal/) in addition is recommended.
  - *euNomenGUID:* Global unique Identifier (GUID) for the species provides by the EU-Nomen registry
- degreeOfValidtity: cl_DegreeofValidtity - estimation of the unambiguous assignment of the animal species using the classification of code list *cl_DegreeOfValidity*
- *otherActivitySignPhoto: photo (1...*)* – One to many photos of the roadkill
- *fotoFromSourrounding*: photo (1...*) – One or many photos characterising the landscape surroundings of the roadkill
- *comment: CharacterString (0....1)* - comments and remarks
- *geometry:GM_Point:* Location of the observed roadkill



© Copyright Andy Waddington

Figure 18: FT Roadkill

FT Habitats

FT Habitats (

Figure 19) provides the data structure for the documentation of exiting habitats within the pilot area. The spatial reference (unit) for this observation is based on a 100 x 100 meters grid following the INSPIRE grid specification. For each of this 100 x 100 Meter grid cells one to many habitats and their coverage in percent can be estimated. Furthermore, one to many photos (photoOfHabitat) could be taken for the documentation of each mapped habitat type.

Following feature properties are available for the characterisation of the present habitats per 100 x 100 meters grid cell within the pilot areas

- *habitats: habitatObservation (1....*)*
  - *observedHabitat:habitatName* – Complex data type *habitatName* to provide the following information
    - *eunisHabitatName: cl_EUNIS_Habitats* - Eunis Habitat Name (cl_EUNIS_Habitats). If possible, a mapping on Habitat Level 2 of the EUNIS classification should be provided.

- *localHabitatName*: cl_nationalHabitatNameValue - The localHabitatSystem should be maintained and documented in a code list registry. If the localHabitatSystem is maintained in a code list registry, please use the URL for the localHabitatNameValue to provide the localHabitatName
- *localHabitatSchema:* cl_nationalHabitatSchema - If the localHabitatSystem is maintained in a code list registry, please provide the Registry URL to the local habitat schema.

  - *photoOfHabitat: photo (0...*) – one to many photos of the habitat*
  - *percentageCover: Interger (0...1)* - Estimated percentage of the habitat coverage within the 100x100 meter grid cell.

- *comment: CharacterString (0....1)* - comments and remarks to the habitat structure of grid cell
- *geometry: GM_Polygon* – Geometry of the observation unit. 100 x 100 grid cell based on the INSPIRE grid specification

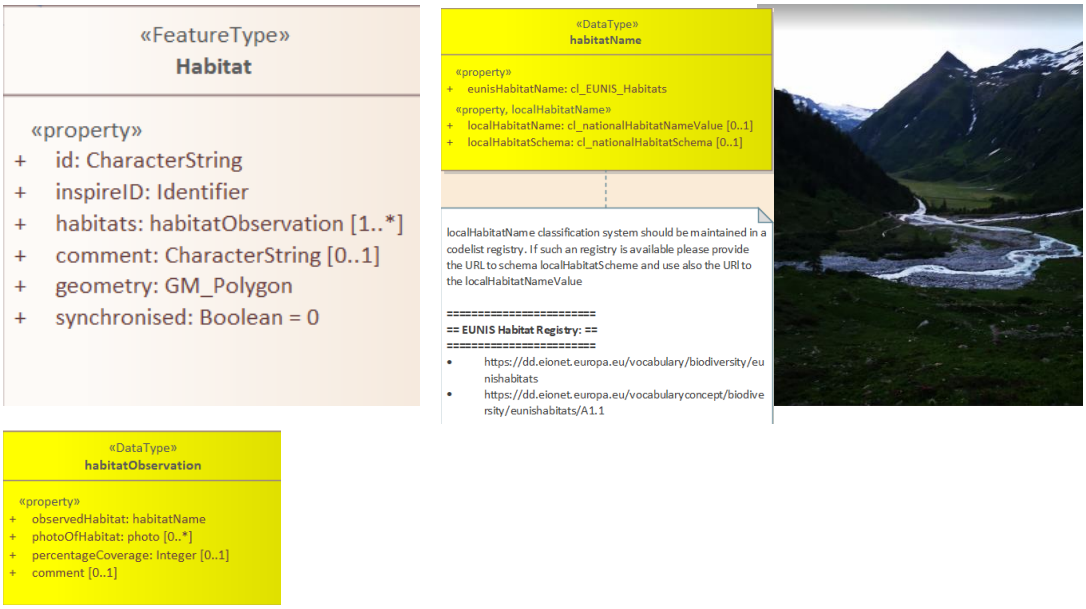


Figure 19: FT Habitats

Figure 20 gives an overview about all provided data types used in the SaveGREEN GML application schema.

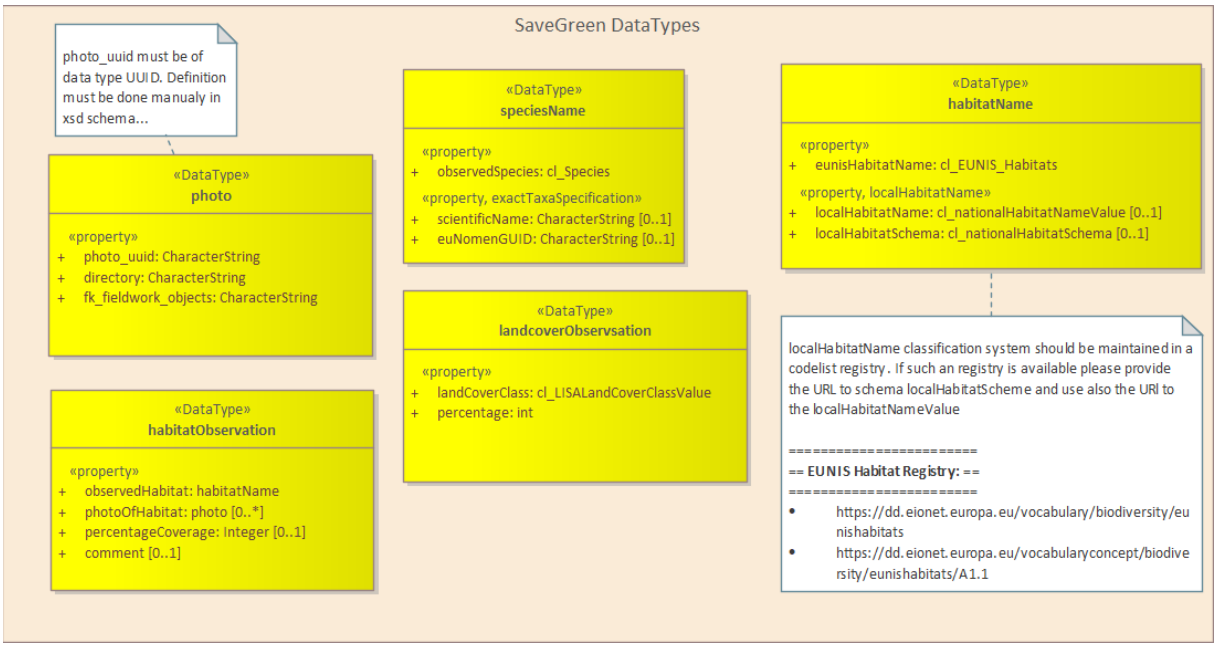


Figure 20: Overview of data types within the SaveGREEN application schema

Figure 21 gives an overview about all provided code lists used in the SaveGREEN GML application schema.

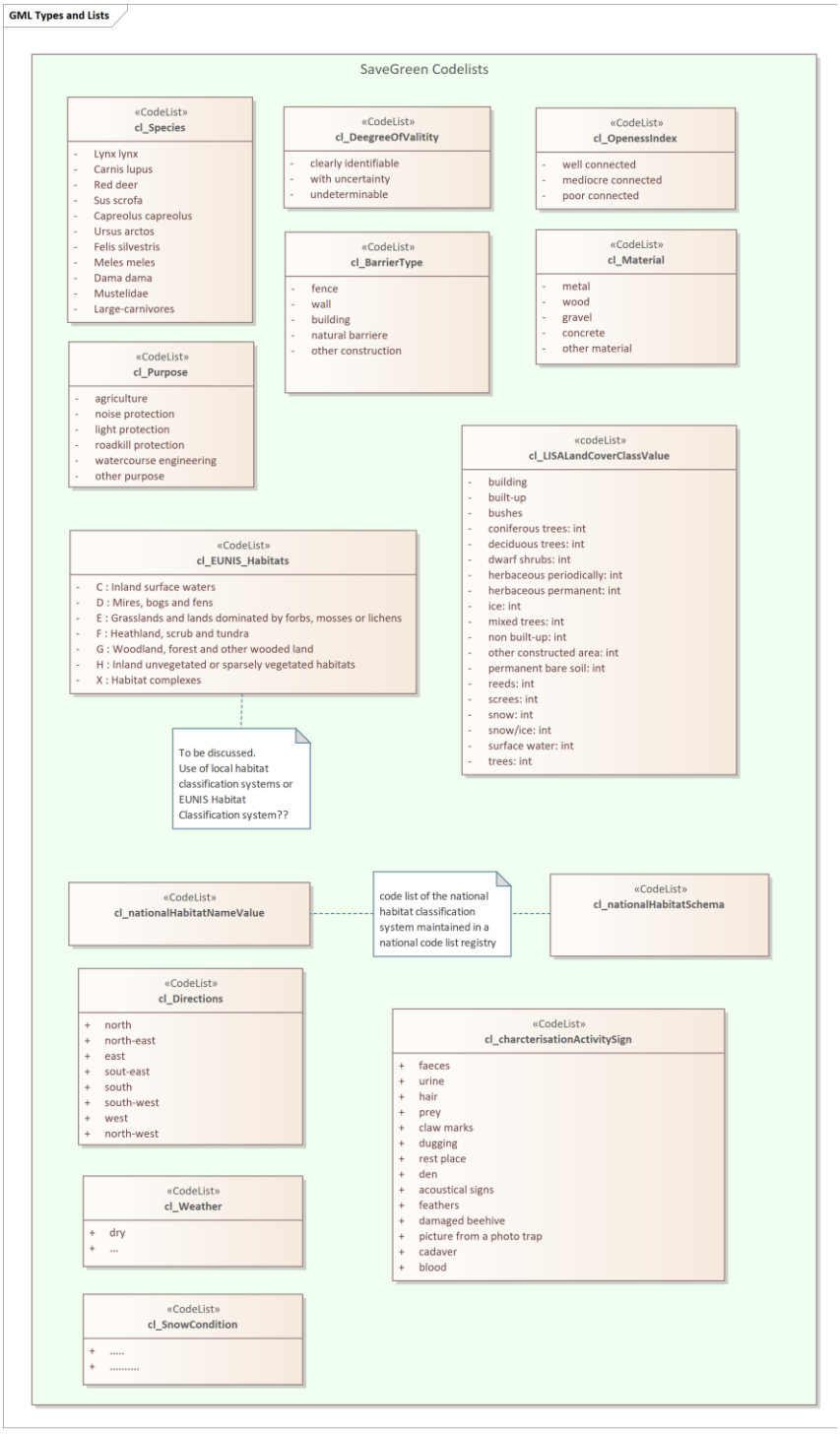


Figure 21: Overview of code lists within the SaveGREEN application schema

Figure 22 gives an overview about all provided code lists used in the SaveGREEN GML application schema.

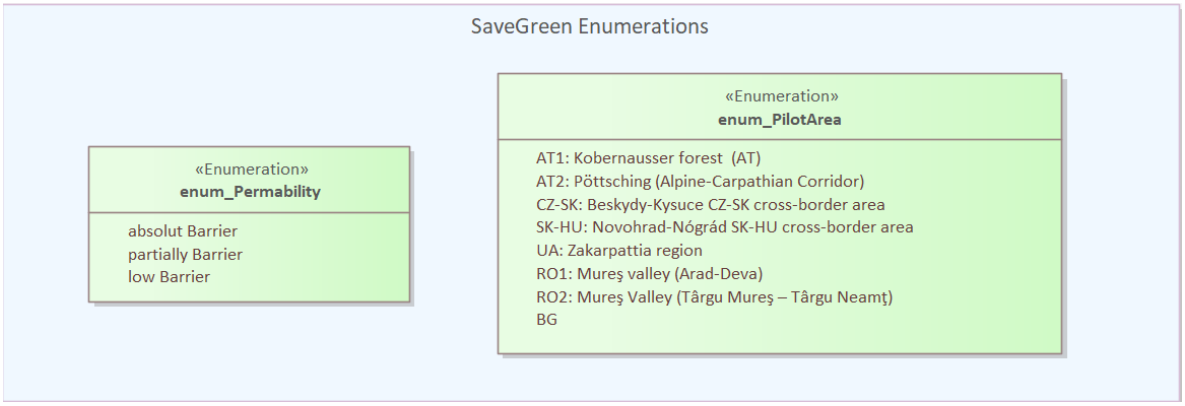


Figure 22: Overview of available enumerations for the SaveGREEN Application Schema

4. Tools to support the functional monitoring approach in course of fieldwork

The functional monitoring approach will be supported by the use of QField, which will be available in both monitoring seasons. In addition for the second monitoring season, the mobile application “roadkill” will be adapted and extended, to be able to collect the most important parameters of the functional monitoring approach. This application enables also citizen science communities to participate actively in future projects to collect data on the functional connectivity in various pilot areas.

QField – an open access application for monitoring in the field

The SaveGREEN pilot areas differ in their size and environmental conditions. Therefore, a flexible tool for in-field monitoring is necessary to derive data that is at least comparable to some extent. The requirements for data monitoring in the field are not the identical to the desktop version of the application. Especially the screen size and the input devices are different. QField[7] is a freely available mobile GIS application that is based on QGIS[8], an open-source geographical information system. It is released under the GNU Public License (GPL) Version 2 or above. Accordingly, the source code can be inspected and modified, and the access to a QGIS based field data collection app is guaranteed. QField can be used with any version newer than Android 5. An iOS version is currently in the making.

QField aims to help the user to perform the tasks he needs without running an overloaded user interface on the mobile device. This means, that only tasks which need to be done in the field are available on the interface. QField leverages the advantage of QGIS to comfortably configure projects that are then to be used in the field for monitoring. A typical workflow (Figure 23) can be described as follows: The preparation of projects is done in QGIS. This means that everything like layer styling, form definitions and other project setup steps should be done on a computer with QGIS installed first. After setting up everything, you can then

[7] https://qfield.org/
[8] https://www.qgis.org/

synchronise your project and any additional files to a mobile device and immediately start with the field work. After collecting data in the field, the created data is transferred back to a desktop respectively central database.

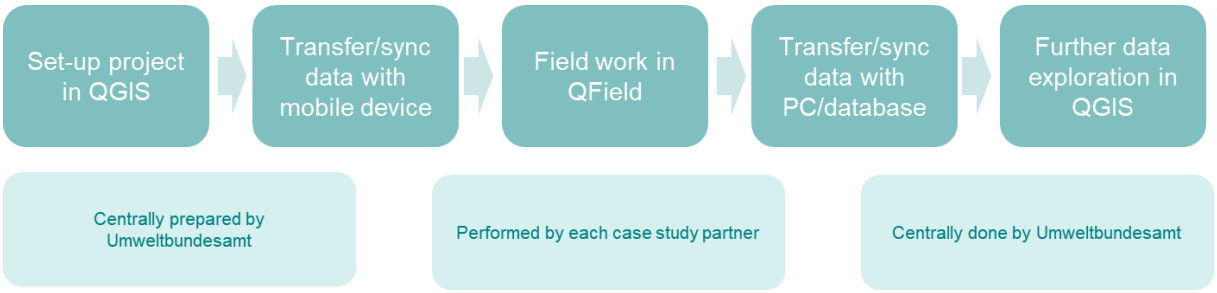


Figure 23: Overview of the whole workflow from setting up a project in QGIS, data exchange with case study partners, and synchronising data back to QGIS; following this workflow data can be synchronised with the central database

The GIS projects to be used in the SaveGREEN pilot areas will be centrally set up by the Environment Agency Austria in QGIS (Figure 24) and then transferred to mobile devices with QField (Figure 25). Data exchange will be based on a tailor-made synchronisation process that is further described in the chapter on Data synchronisation to a central database.

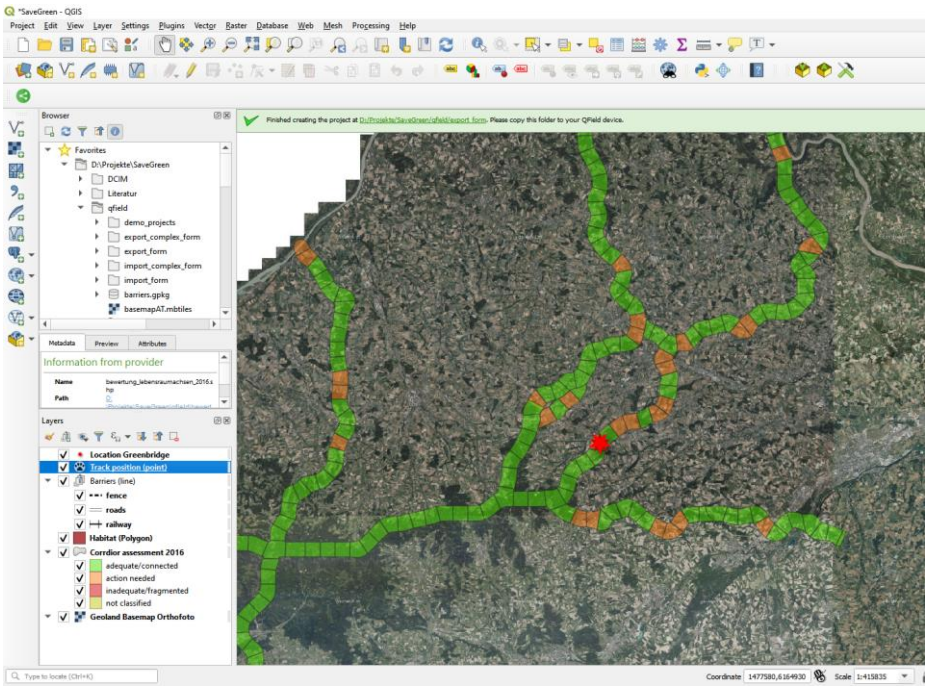


Figure 24: Example of a project prepared in QGIS for the use in QField

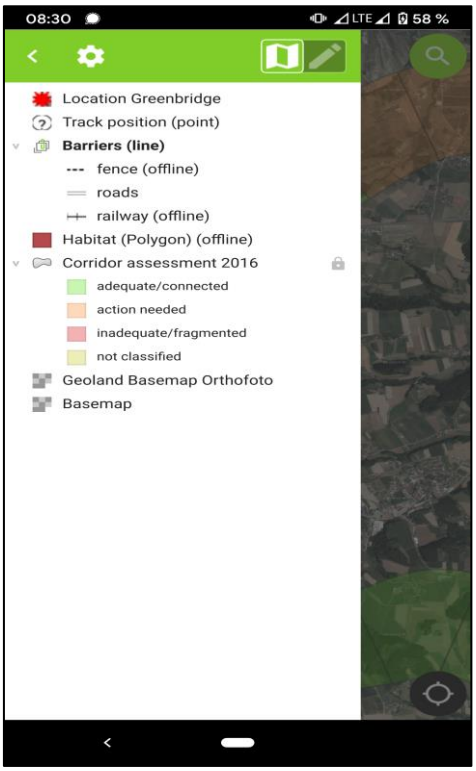


Figure 25: Structure of the project in QField

Data model for QField application

The main aim of the data gathered by the QField application is the monitoring of functional connectivity of corridors in the case studies. As SaveGREEN aims to consider existing information and data from previous projects, the data model has to be able to fulfill these demands. Furthermore, depending on data availability in the pilot areas, pre-processed layers will be created to support an easy handling of the data using the QField application in the field.

The QFIELD data model is a representation of all feature types represented in the UML diagrams (see chapter 3: Data model). 3 aboveFor each feature type of the UML model, a layer is available in QField for the mapping of the properties of the feature type within the field campaign.

Coordinate reference system of spatial data: European coordinate system

ETRS89 - Lambert Azimuthal Equal Area (ETRS89-LAEA; EPSG code: 3035) is recognised as the most appropriate European coordinate system to be used for spatial data analyses and display. ETRS89-LAEA represents an appropriate

coordinate system for pan-European statistical mapping at all scales or other purposes where true area representation is required. Geodetic Datum is the European Terrestrial Reference System 1989 (EPSG:6258). Further details can be found here: https://epsg.io/3035

Data quality control

Data quality refers to the state of qualitative or quantitative pieces of information that are needed for an intended purpose. Data is generally considered high quality if appropriate for the intended use for the foreseen operations. Data quality assurance will also guarantee data consistency. All data that is collected using the application QField will be collected and centrally checked for quality.

Data synchronisation to central database

Synchronising projects that are prepared for field work to the mobile devices of field workers and transferring collected data back can be done in various ways. The two major possibilities are (1) synching data from a central desktop computer to a mobile device using the QFieldSync plugin (copying data from one device to the other and back again), or (2) using a synchronisation application that synchronizes defined folders on the central and mobile device (including wireless data transfer). Both approaches need a central device with QGIS that represents the sending/receiving device of the data. From this central device the data can be then integrated into a central database respectively further used for analysis and/or distribution to platforms. Furthermore, both approaches enable the synching of data collected on remote devices, updating QField projects on remote devices, and exporting collected data from remote devices to be integrated into a central database. The design of the Technical Application Toolbox will provide tailor-made solutions for all pilot areas in respect of data synchronisation.

Synchronisation using the QFieldSync plugin

QField and QGIS can directly communicate through a plugin, the QFieldSync plugin. This plugin helps preparing and packaging QGIS projects for QField and distributing it to mobile devices.

Synchronisation using a synchronisation application

This approach of synchronisation can be done with different applications. At this stage, we envisage to use an application such as Syncthing[9] which is an open source file synchronisation application. However, other cloud-sharing services with similar properties (e.g. Dropbox, Nextcloud) can be used for data synchronisation as well. The choice of the application will also depend on data security aspects. Basically, a synchronisation application compares a shared file or folder on different devices (e.g. a desktop and a mobile device that is used for the field work). If a change in the file or folder on one device is detected (e.g. a new survey has been undertaken using QField) these changes will be synched across the linked devices. In most cases, this sync is done wireless through an online connection of the different devices. However, this sync can be also done by a wired connection of the devices (e.g. a USB-cable). Thus, it is possible to share data between remote devices and a central device. After a QGIS project has been created to enable data collection using the QField mobile GIS application, the folders containing the data have to be exchanged.

Data transferred using Syncthing is secured using TLS encryption. The application allows to sync files across two or more devices each device must be configured with the device ID of the device it is sharing with. A syncing application called QFieldCloud is currently under development that directly integrates a highly customisable, seamless data synchronization of QField.

[9] https://syncthing.net/

The Roadkill Application – Extension to support the monitoring of functional connectivity for citizen scientists

The mobile application is meant as a support for the monitoring of functional connectivity and is designed for using by citizen scientists mostly.

In addition to the QField tool designed especially for the detailed work of experts in the field of permeability monitoring, the mobile phone application will be used for citizen science primarily, but it could serve also for stakeholders like hunters or general ecologists. From this point of view the application is user friendly, intuitive and self-describing. It will be adapted and extended in the second monitoring season to be able to collect the most important parameter from the functional monitoring approach.

The app covers five features: direct species observations, animal vehicle collisions, tracks, other activity signs or other spatial comments (Figure 26: Mobile application data flow) which disappear in short term period and needs to be checked regularly. The long-lasting features expressed by lines or polygons such as barriers or landscape elements will be directly mapped only through QField but users of mobile app will have chance to “report” a potential inconsistencies to be checked by experts.

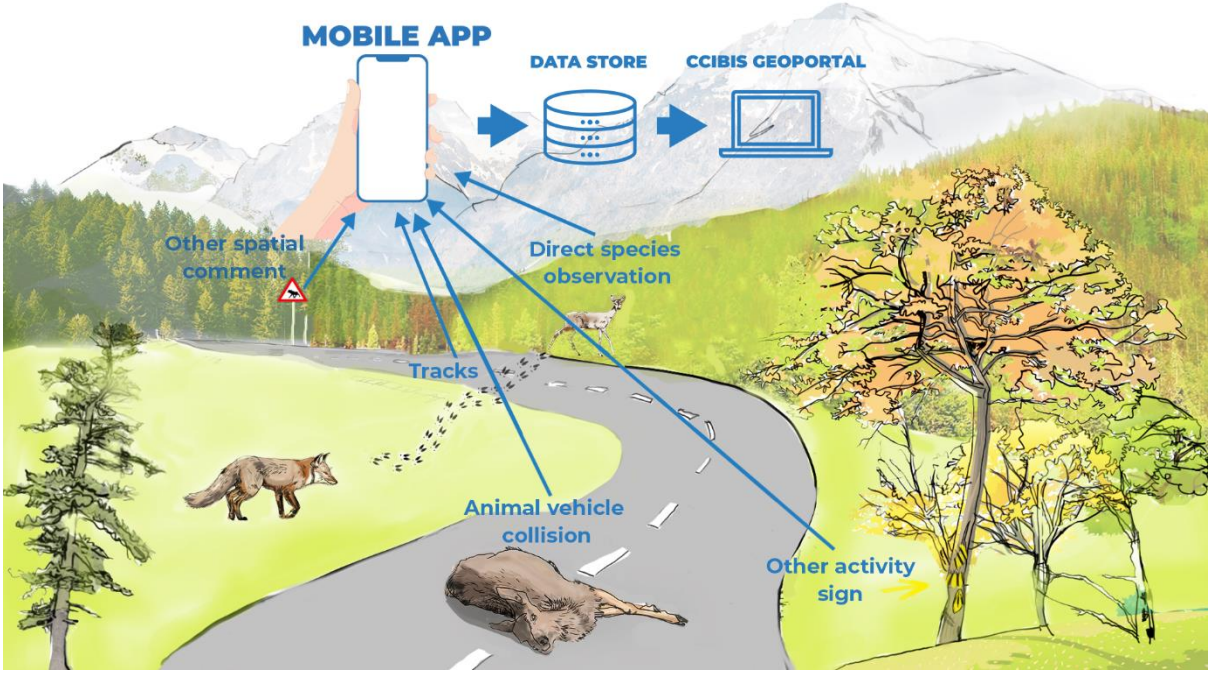


Figure 26: Mobile application data flow

Users gather data by filling a form. Some data (like GPS position or date/time) are provided by the mobile phone itself. The form follows the structure of the SaveGREEN's data model. The application communicates via a server layer with the PostgresSQL Fieldwork database. After a quality control and quality assurance procedure, all datasets are forwarded to the PostgreSQL master datastore that represents the central SaveGREEN data warehouse.

The application is available for Android. In this moment we are finishing with the app's texts and legends. The translations and testing will be solved consecutively.

The application is available on Google Play: https://play.google.com/store/apps/details?id=com.enveros.enverosgame2.

We have created the map for testing purposes also – a tester can check the records on this page: https://SaveGREEN.cdvgis.cz.

Graphic user interface of the mobile application

The graphic user interface and basic functionality is described in this chapter. The components of the application are called as "screens".

Screen 0

This screen is visible just for few seconds. It shows the SaveGREEN logo and the Interreg logo.

Screen 1

There are icons for all collected feature types on the Screen 1 (Figure 27). Taping on an icon will record current date, time and location and will forward to the Screen 2. If the GPS signal of the mobile phone is not sufficient, the warning announcement will be shown. If the application is opened for the first time and the permission of the GPS using was not granted yet, the request of this permission will be shown.

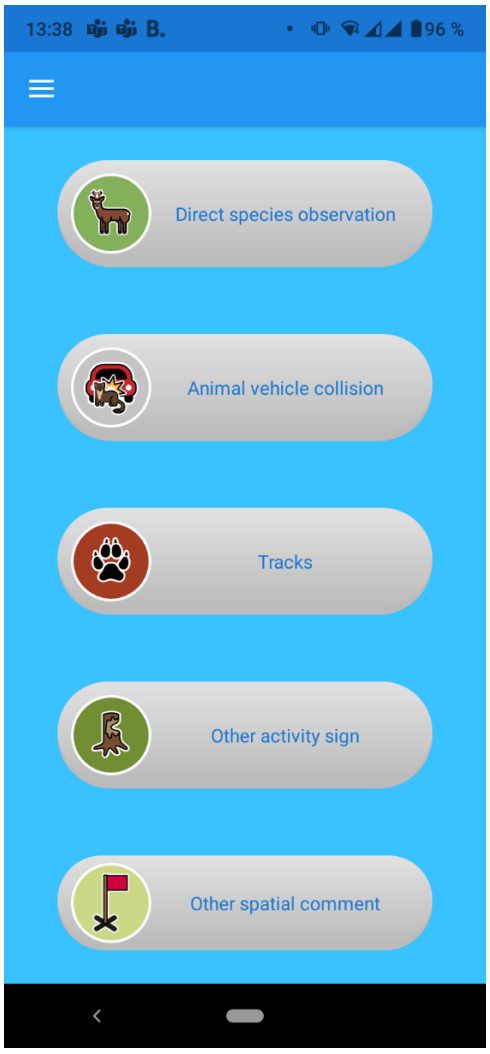


Figure 27: FT Screen 1 – icons for all collected feature types

Screen 2

User will enter information about the selected feature type. Each feature type will have its own version of Screen 2. Not all properties will be filled by user – some of them will be added automatically by the Server layer. When inserting a photo, the user can decide whether he/she wants to take photo by the mobile phone camera or add photo from the phone gallery. In the Settings screen user can choose option, whether he/she wants to keep photos from the camera also in his/her gallery. "Click the Save for later" button will lead to saving the data in the mobile phone memory, clearing the Screen 2 and forwarding user back to the Screen 1. The not-finished record can be found in the List of unsent records in the Menu.

In the following proposals of the Screen 2 graphic user interface just those not obvious properties will be described.

Direct species observation

Select species combobox will offer the species from the cl_Species code list. If this code list will be updated later the Server layer ensures that the list will be updated in the mobile app also.

Select degree of validity combobox will offer the validities from the cl_DegreeOfValidity code list. The updates will be handled as in the case of the list of species.

Note and Photo is not mandatory.

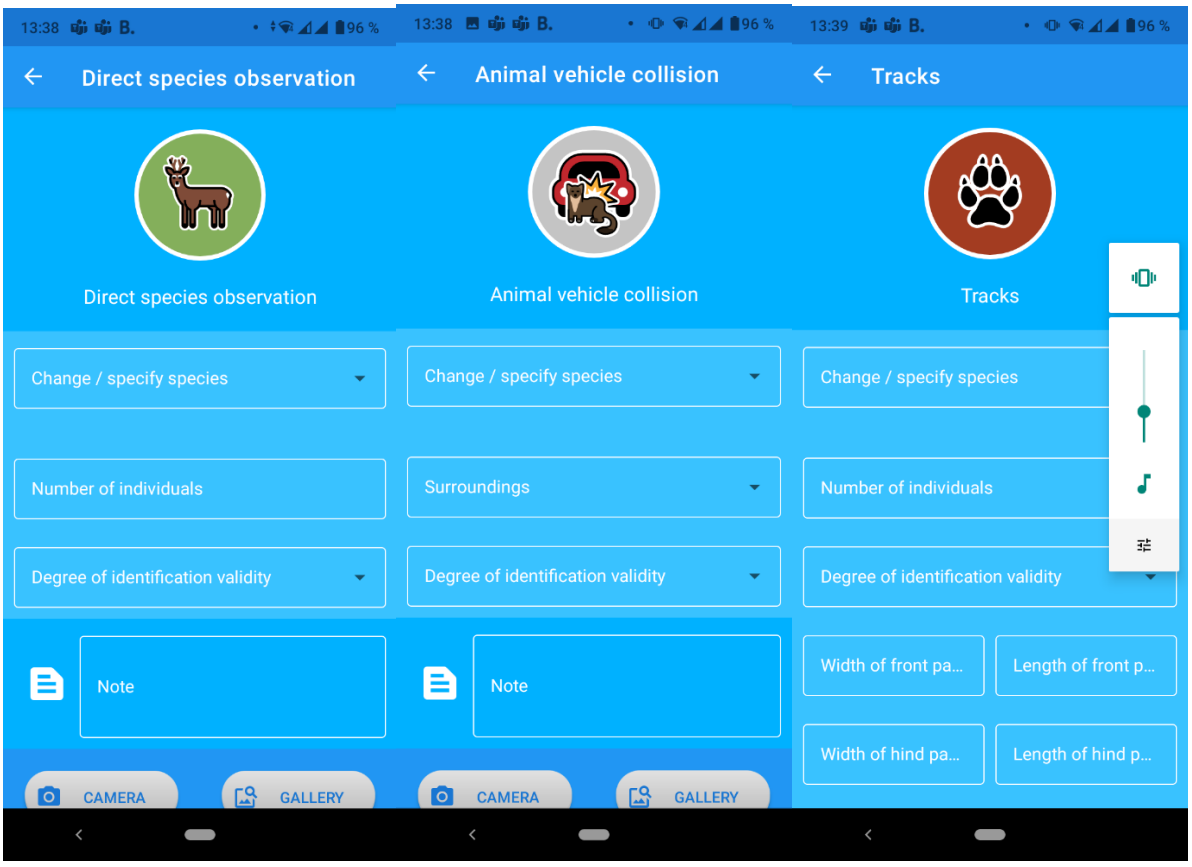


Figure 28: FT Screen 1 – icons for all collected feature types

Animal vehicle collision (Roadkill)

As we are interested not only in the collisions on roads but also on rails we have used the common term “animal vehicle collision” instead of “roadkill”.

Note is not mandatory.

Track

Note is not mandatory.

Other activity sign

Note is not mandatory.

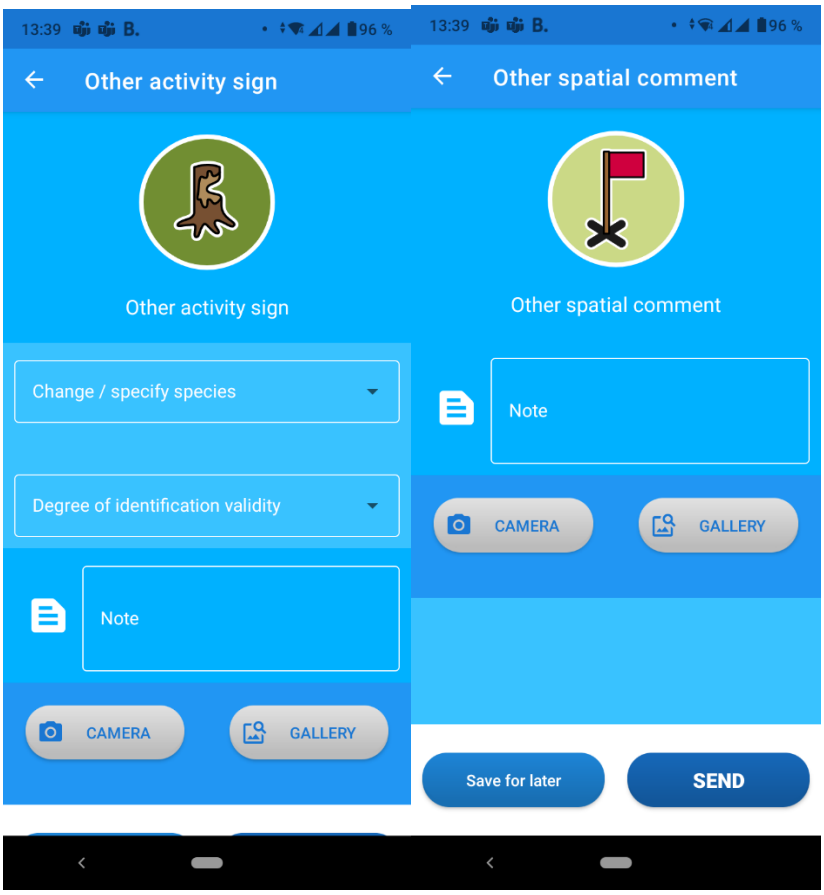


Figure 29: Screen 2 for Other activity sign and Other spatial comment feature type

Other spatial comment

Note is not mandatory.

Menu

In the top left corner there is the menu button. It has 4 items: User, Settings, About app and List of unsent records.

Screen user

This screen can be used for user registration and log in/out.

After registering, the confirmation email is sent to users email box. If the email is confirmed by the user, he/she can log in.

The logged user sees some basic statistics:

- Count of sent records
- Last data sending
- Count of non-sent records

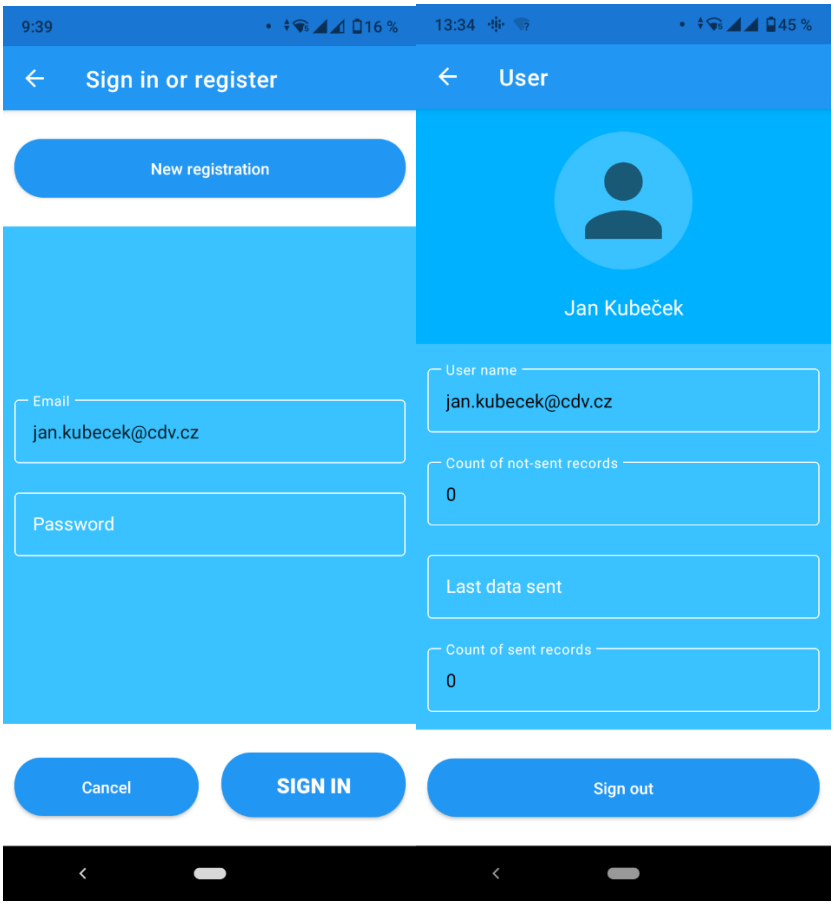


Figure 30: User screen in log out and log in state

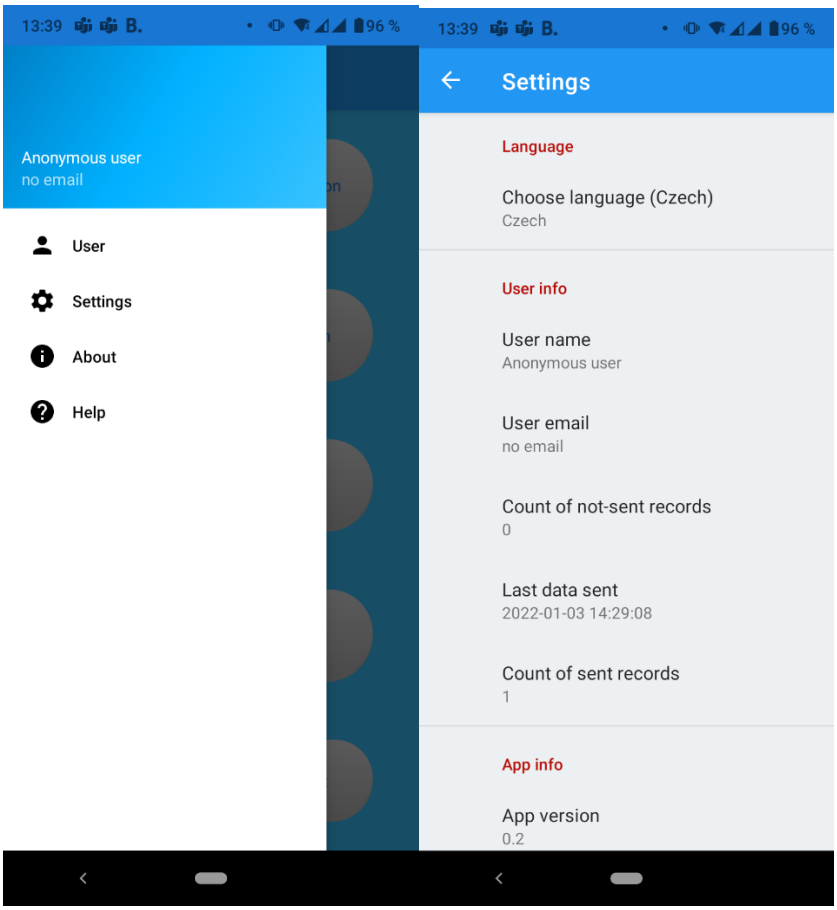


Figure 31: Menu and Settings

Screen Settings

On this screen user will be able to set application behavior.

- Language selection – we plan to localize the app to the languages of all SaveGREEN pilot areas. This will depend on help of project partners with translations.
- App version
- Keeping pictures in gallery – pictures taken through the application will be accessible in gallery of the mobile phone
- Data via WiFi only – receiving or sending data will be possible with WiFi connection only. No mobile data will be used.

Screen About app

This screen will contain basic information about the application, its functionality, the SaveGREEN project and there will be the contact to developers.

List of unsent records

User has the possibility to save the record for later. In that case the data is not send to the server but it is stored in the mobile phone memory. He/she can use this feature in case when he/she has not enough time for adding the record's details. By clicking the record user will be forwards to the Screen 2 which will be set up into the state when he/she click the Save for later button.

Server layer

Server layer serves as an interface between the mobile app and the PostgreSQL field work database. It provides following services:

- Connection with the PostgreSQL field work database
- Processing data from the mobile app and sending them to the database and in the case of photos to the file storage
- Checking if the new record is situated inside a pilot area based on its position
- Transformation of the default GPS coordinate system (EPSG 4326) into the EPSG 3035 used by the data model
- Monitoring changes of the code lists on the database side and code lists updating in the mobile app
- Logging the warnings and errors
- Blocking of the users abusing the citizen science data collection system and providing intentionally false data

The server layer will be physically situated on the Transport Research Center (CDV) servers. The Nginx[10] as a web server and Nette[11] as a php framework will be used.

Interface

The interface ensures the data transfer between the mobile app and the CDV's server layer and between the CDV's server layer and the SaveGREEN's data storage.

There are eight type of services ensuring the data transfer from the mobile app:

[10] https://www.nginx.com/
[11] https://nette.org/en/

- User login
- User registration
- User account activation
- Records sending
- Species list
- Validity list
- Surroundings list
- Direction list

Testing and translations

Three rounds of testing of the mobile app were done – two internal and one with our project partners. The bugs were fixed and the comments and suggestions were included or answered. For sharing with project partners the Google sheets were used.

We put together all texts in the mobile app and asked our project partners to help us with translations. Then we add these translations to the app. In this moment the app is localized in eight languages.

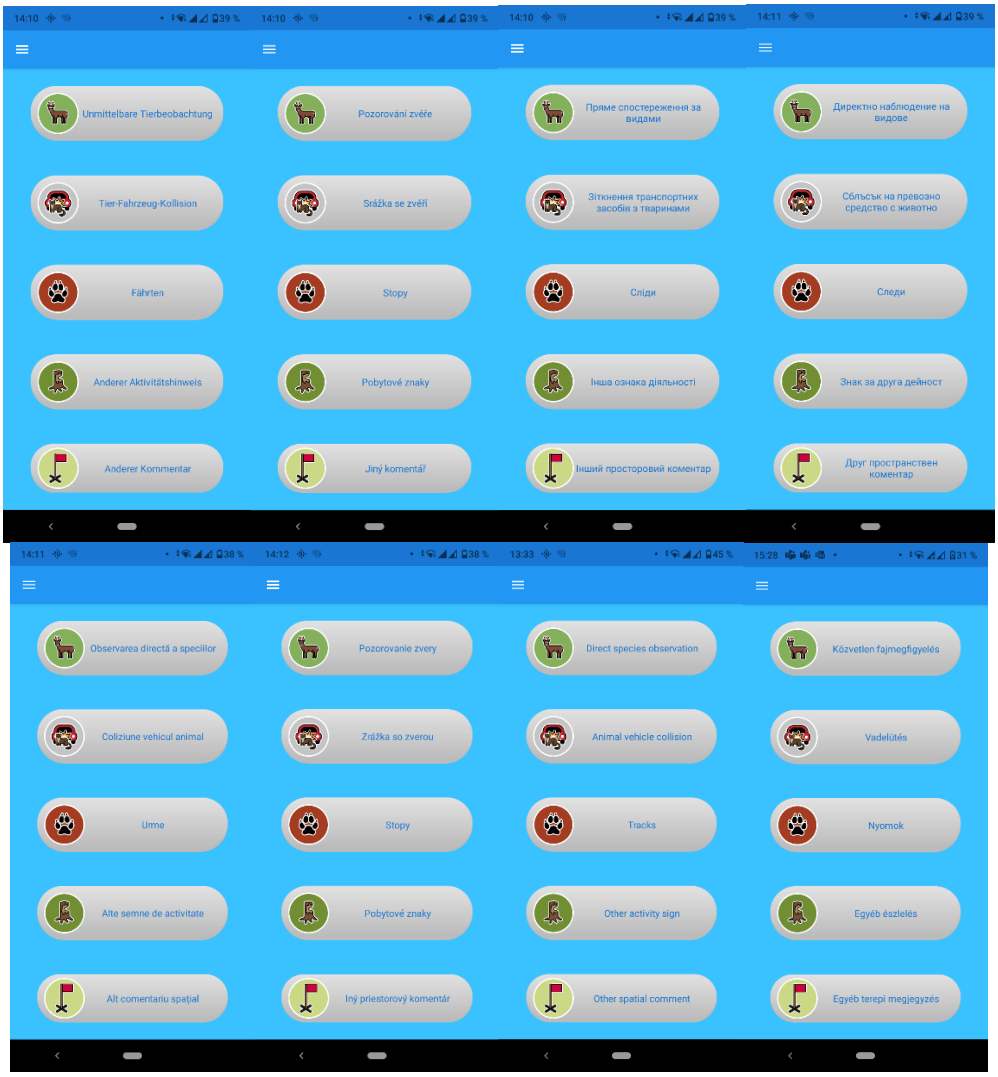


Figure 32: Input form in eight languages

5. Data distribution platforms

All within the SaveGREEN project generated data are distributed by the so-called *SaveGREEN-Distribution Platform* (SaveGREEN-DP). The platform consists of the following software components, which provide seamless access to all SaveGREEN results for both humans and machines.

SaveGREEN-DP:Geodata-Catalogue

https://metadata.SaveGREEN.at/

The central access point to all geodata and results of SaveGREEN is the geodata catalogue, which is implemented with the open source software Geonetwork (https://geonetwork-opensource.org/). The catalogue describe and documents the data sets and results in the form of metadata (data about data). The data catalogue also documents the different access capabilities and data formats in which the data sets and results are offered. The geodata catalogue represents the central entry point to all the results produced in the context of the project.

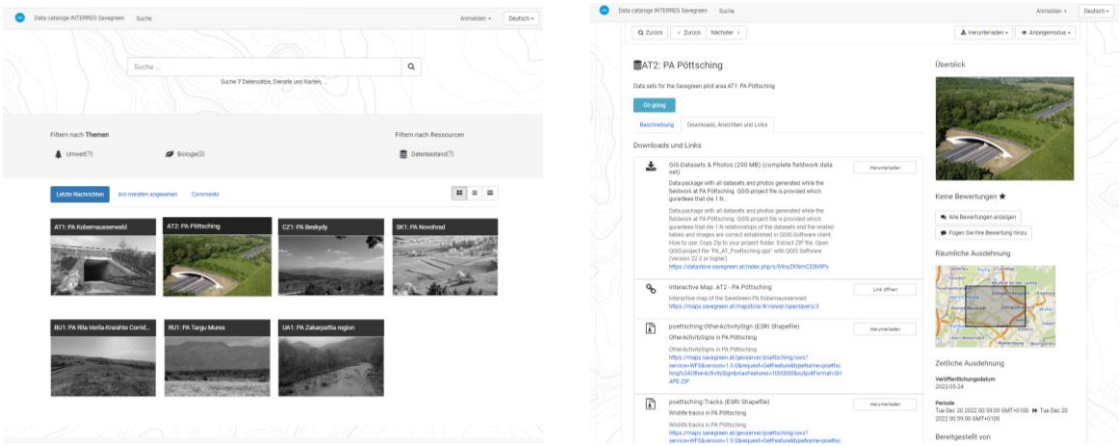


Figure 30: SaveGREEN Geodata catalogue – central access point to all geodata and results of SaveGREEN project

SaveGREEN-DP: Cloud-Datastore

https://datastore.SaveGREEN.at

Via the SaveGREEN cloud data store which is implemented based on the open source software nextcloud (https://github.com/nextcloud), the quality-checked data from structural and functional monitoring are provided according the harmonized data model as a file-based database in geopackage format. In addition to the geopackage, all photos of the recorded objects and a QGIS project file are made available in the download package, which allows the direct and easy use of the data and photos in the open source software GIS client QGIS (Figure 31).

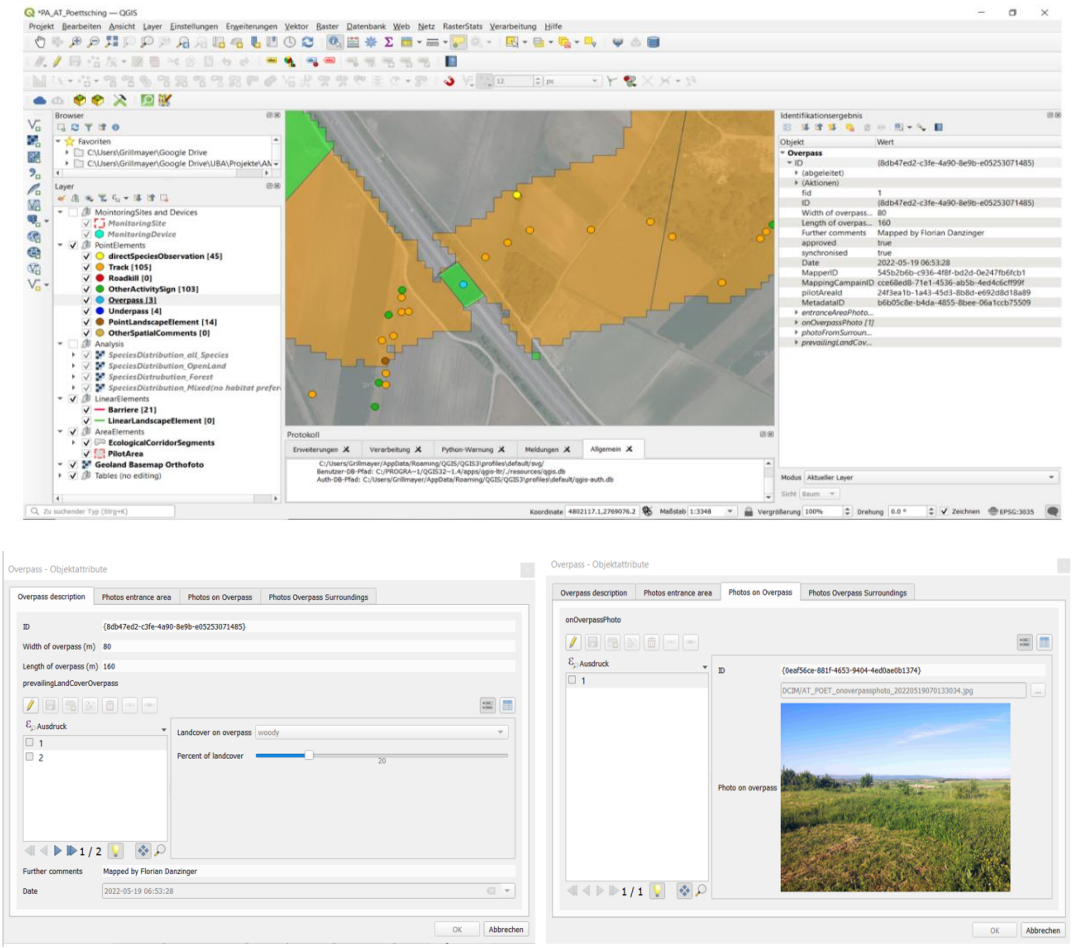


Figure 31: Example of the provided Geopackage for the PA Pöttsching in QGIS-Client

In addition to the provision of the finished data sets, the cloud storage serves as a backup system for all data sets created as part of the SaveGREEN project (Figure 32).

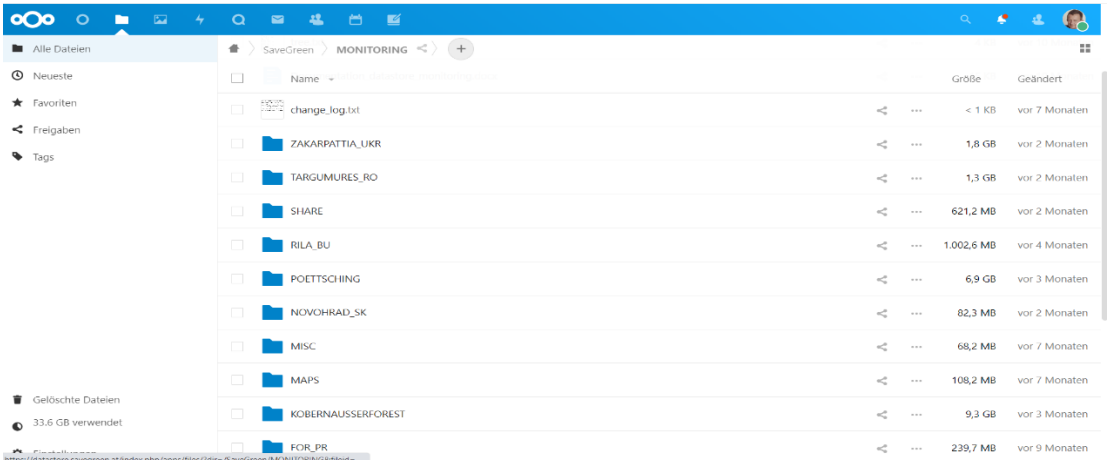


Figure 32: NextCloud User Interface – central backup store for all results of the SaveGREEN project

SaveGREEN-DP: OGC-Webserver

https://maps.SaveGREEN.at/

All geodata of the structural and functional monitoring are provided via OGC web service based on the open source technology Geoserver (Figure 33 - https://geoserver.org/). Through this standardized OGC web services, the results can be directly used in GIS client software and easy integrated in other geodata portals like CCIBIS or ENE.

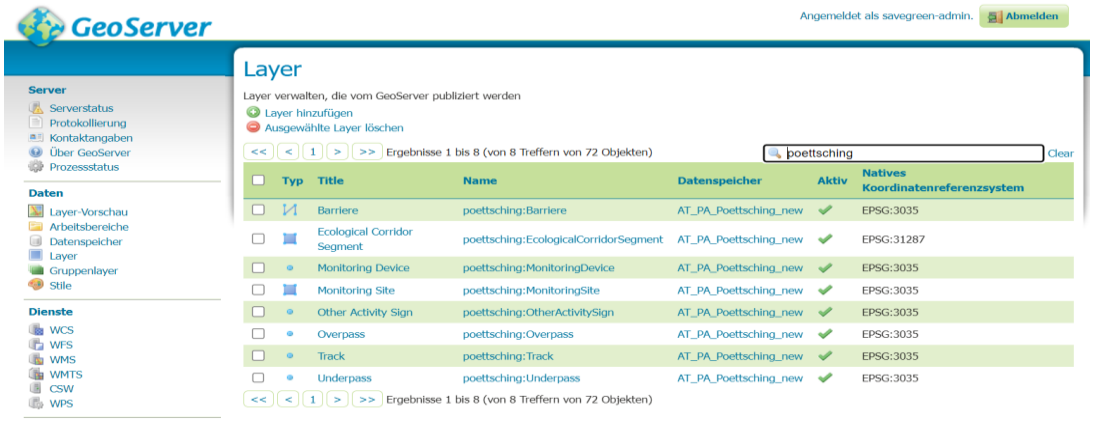


Figure 33: Admininstartion interface ofthe open source technology Geoserver which is used for the provision of the OGC web services

Furthermore, the OGC web services allows the publication of the results in interactive web-maps, which are provided by the software components MapStore (SaveGREEN-DP:MapStore)

SaveGREEN-DP: MapStore

https://maps.SaveGREEN.at/geoserver

The MapStore software component enables easy configuration and provision of the data in the form of interactive web maps (Figure 34). The results of the pilot regions are made available as interactive maps via this software component.

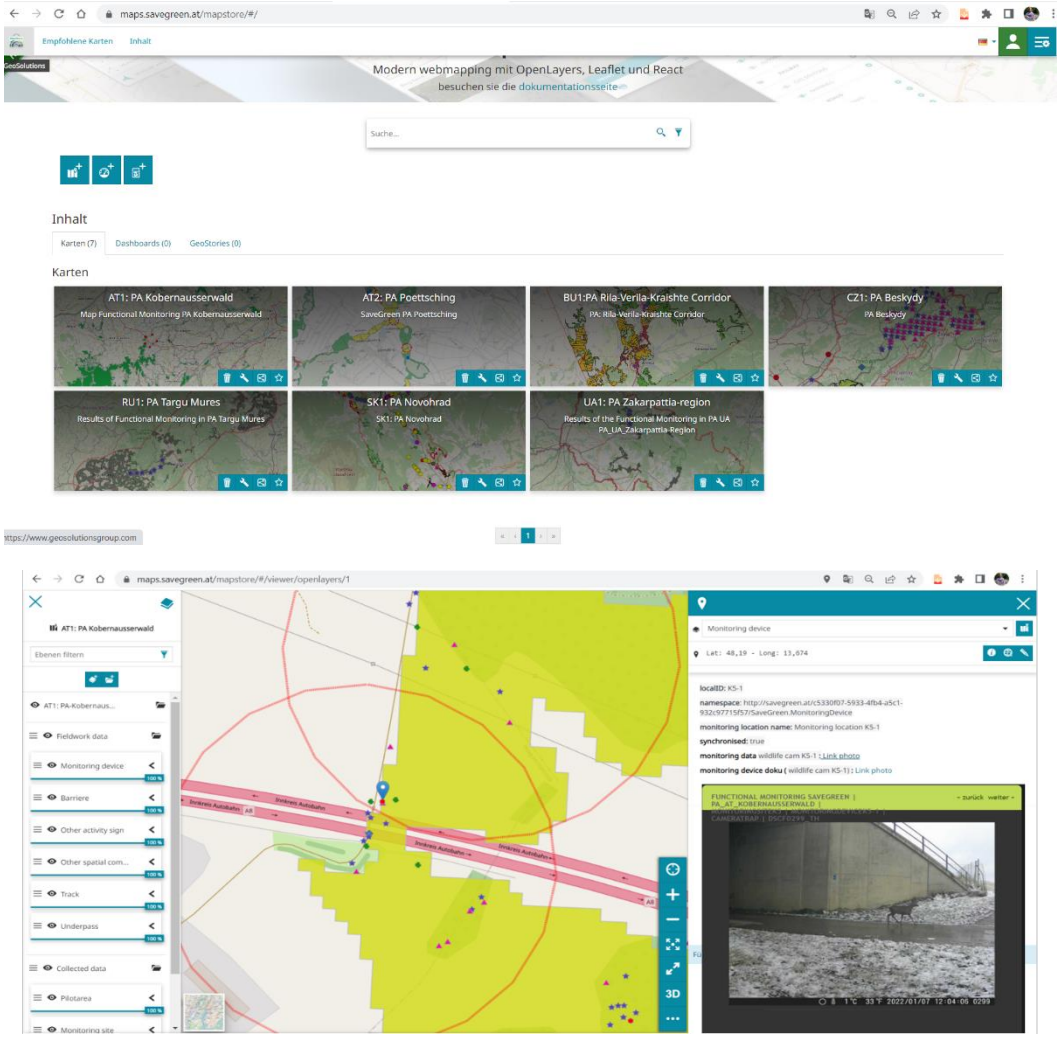


Figure 34: Open Source Software MapStore which is used for the provision of interactiv maps of results from the structural and functional monitoring of the pilot areas

The interactive maps of the pilot areas can be easily embedded in web pages by the MapStore provides iframe technology and MapStore API. Through these technologies, the provided maps are integrated into the thematic portals CCIBIS and ENE. This two established thematic platforms represents the open data access points to all the results of the SaveGREEN project especially after project completion.

Ecological Corridors Europe: http://ecological-corridors.eu

The Federal Ministry of Agriculture, Regions and Tourism established the platform Ecological Corridors Europe in 2016 (figure 27). The aim of this platform is to create a single point of access for quality-controlled information about ecological corridors especially in Austria but also in EC countries. All geodata are registered and documented using standardised metadata (ISO 19115) within a catalogue, which allows discovering datasets and estimating their fitness of use for own purpose. Furthermore, all datasets are made available providing download services to access the whole dataset and so called direct download services (OGC Web Services), which allows a direct integration of the data and provided maps in all common GIS clients.

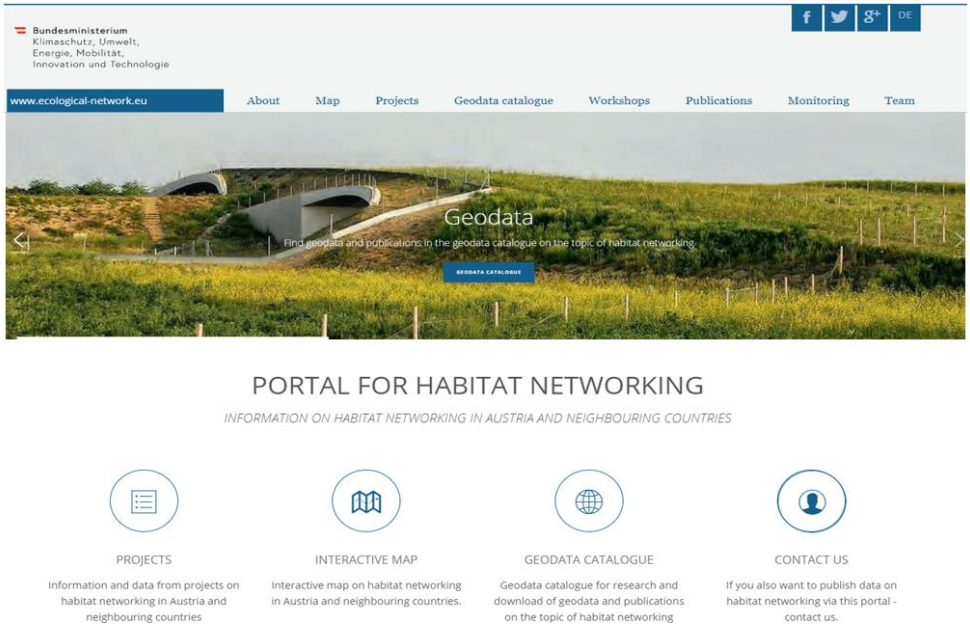


Figure 35: Webportal Ecological Corridors Europe (http://ecological-corridors.eu)

CCIBIS Geoportal: https://geoportal.ccibis.org/

The Carpathian Countries Integrated Biodiversity Information System (CCIBIS) is an information portal for spatial data and notable publications related to environmental conservation in the Carpathian Ecoregion. It serves the needs for information exchange within the area of protected areas and biodiversity. Identified by the Convention on Biological Diversity, under the Program of Work on Protected Areas, information exchange is a main priority. The dissemination of information, experience and knowledge is not only practical, but improves the discourse in providing effective and improved protected area and project work. The CCIBIS serves partners within the Carpathian Convention sharing information and building a set of data that is useful for project planning and implementation. It is an open-source website, thus any organization, institution or private person is welcome to share its data. It was developed in response to a need for increased information exchange on biodiversity conservation and related issues in the Carpathian region.

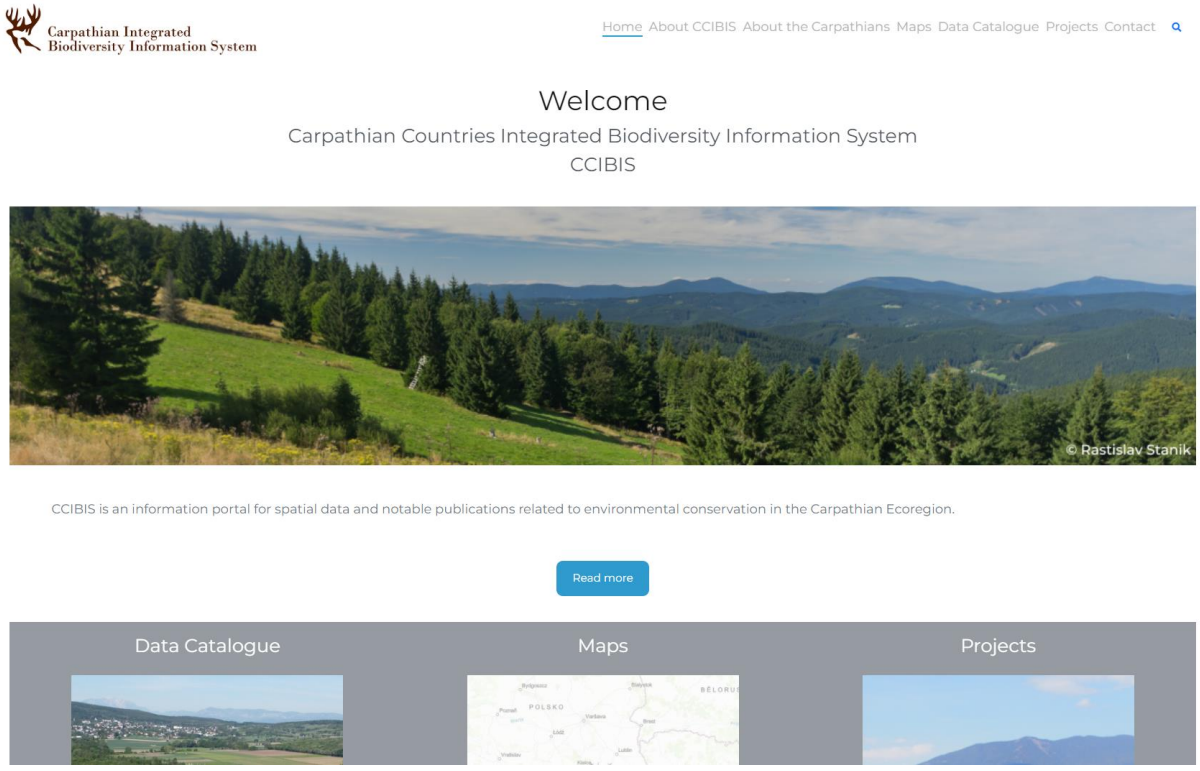


Figure 36: Landing page of the CCIBIS website https://ccibis.org/

The active and collaborative dissemination of information, experience, and knowledge directly contributes to the quality and effectiveness of nature

conservation work. CCIBIS works to provide both a scientific network for professionals and a platform for increasing awareness about nature conservation in central and eastern Europe, aimed not only at relevant stakeholders working on the topic, but members of civil society as well as anyone who has an interest in the Carpathian region.

Under the auspices of the Carpathian Convention, CCIBIS aims to be a collaborative platform for information exchange, meaning that any organisation, institution or private person is welcome to share their data and thereby support others in the planning and implementation of their projects.

A number of international and EU projects have contributed to the creation of the CCIBIS portal. To find out more about the projects and how they have contributed, see https://ccibis.org/partners/

CCIBIS offers two types of datasets:

1. Data covering the whole Carpathians
    a. Carpathian region border
    b. Natura 2000 sites
    c. Protected areas (WDPA)
    d. Old growth forests
    e. Wetlands
    f. Orographical units
    g. Modelled ecological corridors as developed by VUKOZ during the ConnectGREEN Project
    h. Map of barriers for the ecological connectivity as developed by VUKOZ during the ConnectGREEN Project
    i. Species occurrence data as developed by VUKOZ during the ConnectGREEN Project

2. Data from pilot areas from TRANSGREEN Project
    a. Arad-Deva pilot area
    b. Beskydy-Kysuce pilot area, and
    c. Miskolc-Kosice-Uzhgorod pilot area)

    And from ConnectGREEN Project

    d. Western Carpathians pilot area

e. Apuseni Mountains pilot area
f. Piatra Craiului National Park and Bucegi Nature Park National Park pilot area, and
g. Bükk National Park in Hungary and Cerová vrchovina Protected Landscape Area pilot area).

It contains information about species occurrence, transportation, barriers and corridors in the respective pilot areas. The data from ConnectGREEN Project (Modelled ecological corridors - "Map of core areas and ecological corridors for large carnivores in the Carpathians") as well as the data for ConnectGREEN Project pilot areas were collected in accordance with the "Methodology for identification of ecological corridors in the Carpathian countries by using large carnivores as umbrella species" (Okanikova et. al., 2021) developed within the ConnectGREEN Project.

CCIBIS will also include data collected in the SaveGREEN Project collected by partners responsible for the pilot areas in accordance with the Technical Application Toolbox developed by Environment Agency Austria.

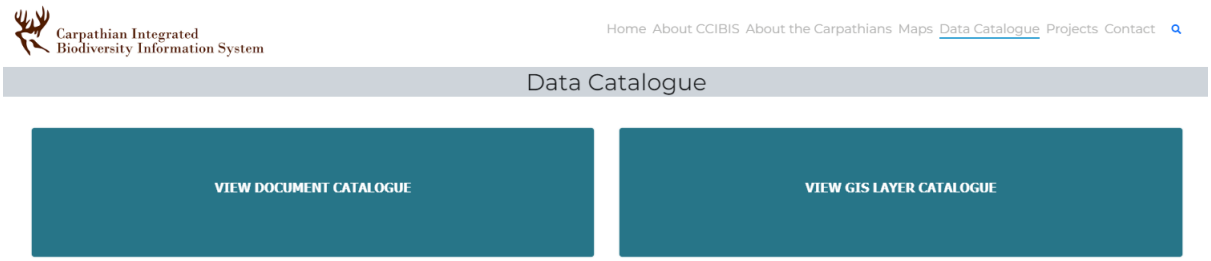


Figure 37: Graphical user interface when entering the data catalogue

CCIBIS features two main interrelated components:

- A Data Catalogue, which serves as a searchable repository for spatial data and publications on the Carpathian region;
- A Geoportal, which allows the user to navigate through specialised thematic maps that combine particular datasets stored in the Data Catalogue.

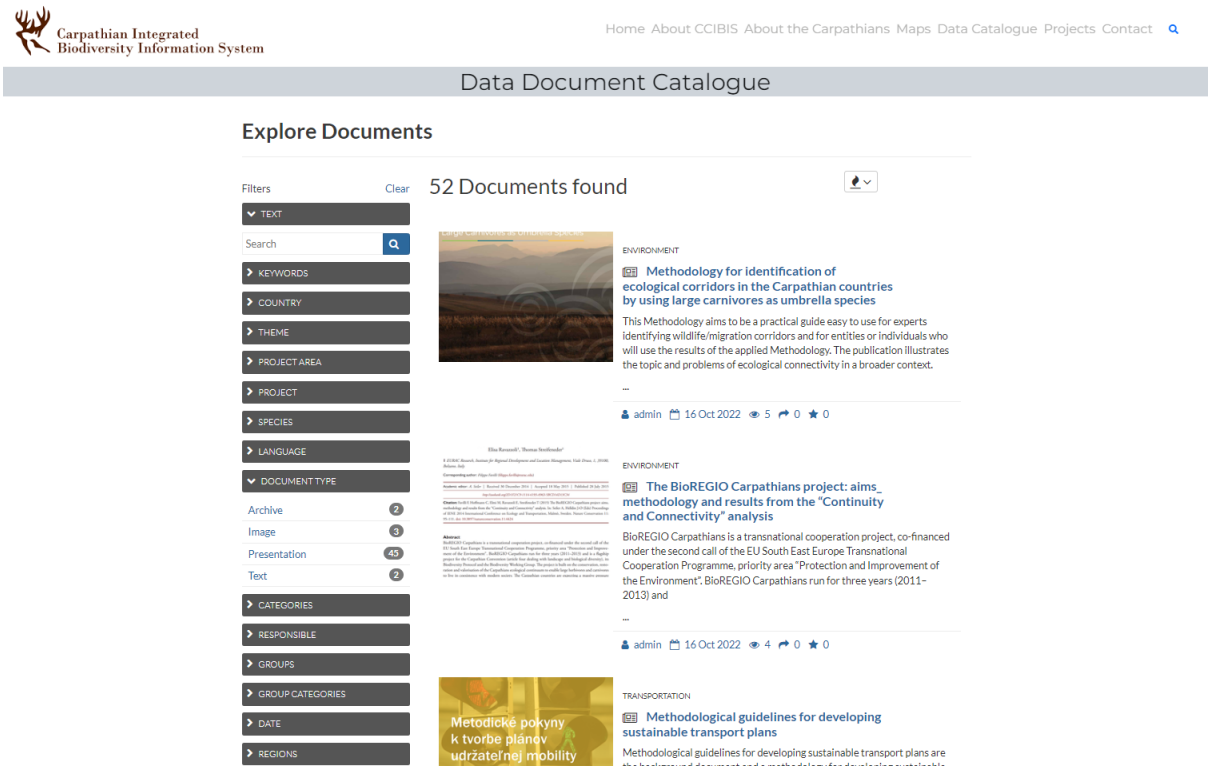


Figure 38: Data document catalogue user interface

CCIBIS portal is built upon open-source software GeoNode - a geospatial content management system, a platform for the management and publication of geospatial data, bringing together mature and stable open-source software projects under a consistent and easy-to-use interface allowing non-specialized users to share data and create interactive maps. CCIBIS portal website is also secured by SSL certificate.

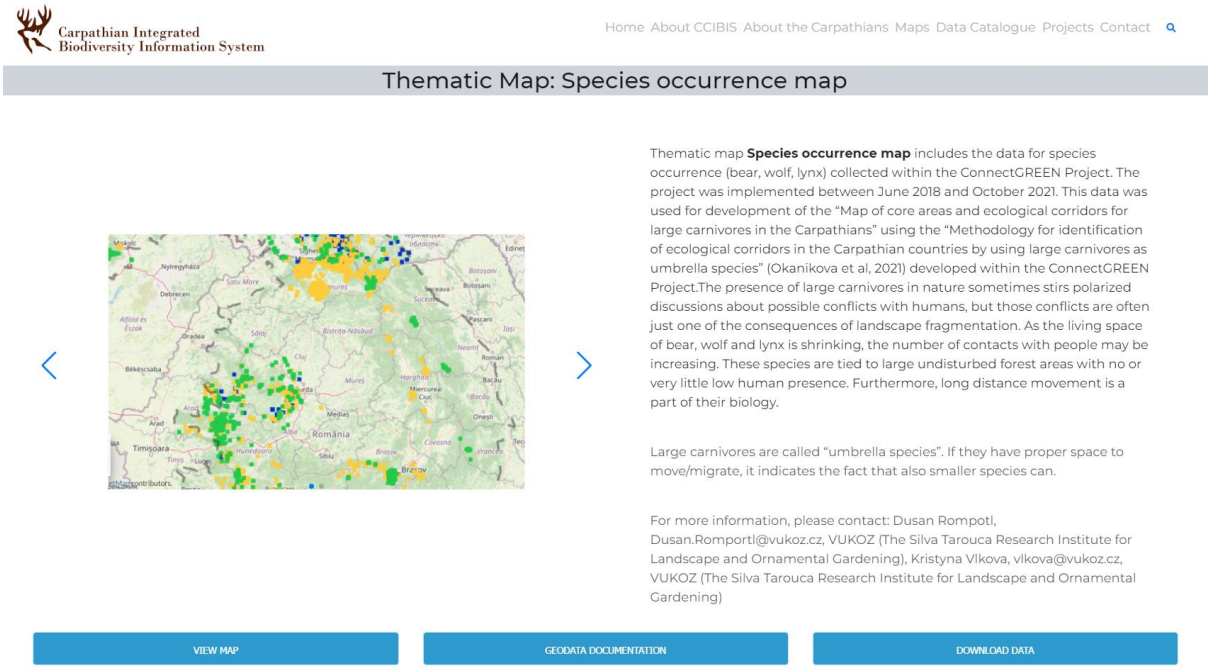


Figure 39: Example of thematic map view

CCIBIS makes it possible to explore the Carpathian region and discover information about protected areas, biodiversity conservation, results from relevant past and on-going projects, and much more. The interactive platform allows users to:

- Visualise and navigate thematic maps of the Carpathians;
- Search for publications and GIS data according to their specific needs;
- Export datasets/publications for use in their own work;
- Contribute to the platform by submitting data of their own.