Recovery of degraded and transformed ecosystems in coal mining-affected areas

847205-RECOVERY-RFCS-2018

Deliverable 2.3

Baseline mapping of relevant ecosystems of Ema-Terezie Mine dumps complex

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Table of contents

List of Figures

Executive summary

The complex includes dumps of Ema, Terezie (the oldest part of the complex, thermally active in the past) and Bezruč coal mines in Ostrava city. The spoil deposition was started in the middle of 19th century and ended in the 1980s (Terezie, Bezruč) or in 1976 (Ema). The complex consists of three different units: the conical, thermally active mine dump of the Ema mine, the tableland dump of the Terezie mine and the tableland ring dump of the Bezruč mine, which surrounds the whole complex.

Ema-Terezie Mine dumps complex covers an area of 7 hectares, reaching 116 m of height. The complex is very diverse in terms of habitats, it contains thermophilous vegetation of thermally active parts of the Ema dump and hygrophilous vegetation on foots of slopes. It is also widely used as a tourist destination.

Ema-Terezie Mine dumps complex wider territorial relations covers an area of 1356 ha.

Baseline mapping of ecosystems of Ema-Terezie Mine dumps complex was processed by CORINE Land Cover 2018, OpenStreetMap, Pan-European High Resolution Layer from COPERNICUS programme, Digital Terrain Model of the Czech Republic of the 5th generation (DMR 5G), Ortophotos. These sources were complement via expert knowledge about dumps and terrain survey focused on present landuse. Base ortophoto and terrain survey helped to supplement missing object in OSM.

Mapping of relevant ecosystems was classified by CLC classes: 1. Artificial surfaces; 2. Agricultural areas; 3. Forests and seminatural areas; 4. Wetlands; 5. Water bodies.

Discountinuous urban fabric (112) 44,5%; Forests and seminatural greenery 26,8 % (311 Broad-leaved forest, 312 Coniferous forest, 321 Natural grassland, 324 Transitional woodland-scrub) and 141 Green urban area 7,7 % represent the highest proportion of different types of ecosystems (Corine CLC).

1 Introduction

Work Package No 2 focuses on mapping and assessing the ecosystems and their services of the project's case-studies.

Specific objectives are:

1. To identify the adequate boundaries of the different case-studies based on existing spatial connectivity and functional cohesion for each coal mining-affected area.
2. To delineate, categorize and map the different ecosystems types of land covers in the study areas, according to CORINE Land Cover classes (Bossard, Feranec, & Otahel, 2000; Barbara, György, Gerard, & Stephan, 2017), although doing detailed field mapping at a higher resolution.
3. To assess the ecosystem services according to the Common International Classification of Ecosystem Services V5.1 (Haines-Young & Potschin, 2018), in order to achieve standardization and to avoid any overlapping or redundancy within the different categories.
4. To implement a geographic information system (GIS) web interface for each-case study, allowing constructing user desired information thematic maps for viewing purposes.

As the typology of ecosystems and ecosystem services will provide the analytical frame for the project, in order to operationalize this work package, in first place Task 2.1 will focus on the baseline mapping of relevant ecosystems.

Under the coordination of UBER, with a lot of experience in this field, for each case-study the surrounding limits of the different coal mining-affected areas will be defined on the basis of existing spatial connectivity and functional cohesion.

It is critical for establishing an ecosystem services context to determine with accuracy the adequate boundaries of the areas where the impact of the planned activities may produce changes in forms of land use, monetary value of properties, and potential of ecosystem services.

In second place, CORINE Land Cover classes will be used to delineate, categorize and map the different ecosystems types of land cover in the study areas, although doing detailed field mapping at a higher resolution than in the CORINE programme.

In 1985 the CORINE programme was initiated in the European Union. CORINE means 'coordination of information on the environment' and it was a prototype project working on many different environmental issues.

The CORINE databases and several of its programmes have been taken over by the European Environment Agency (EEA). One of these is an inventory of land cover in 44 classes, and presented as a cartographic product, at a scale of 1:100 000. This database is operationally available for most areas of Europe.

Deliverable 2.3 will undergo the baseline mapping of the relevant ecosystems from Ema-Terezie Mine dumps complex, property of RPG RE Land, Ltd. Ostrava (Czech Republic).

2 Ema-Terezie Mine dumps complex

The complex includes dumps of Ema, Terezie (the oldest part of the complex, thermally active in the past) and Bezruč coal mines in Ostrava city. The spoil deposition was started in the middle of 19th century and ended in the 1980s (Terezie, Bezruč) or in 1976 (Ema). The complex consists of three different units: the conical, thermally active mine dump of the Ema mine, the tableland dump of the Terezie mine and the tableland ring dump of the Bezruč mine, which surrounds the whole complex.

Figure 2-1 presents the whole dumps complex and Figure 2-2 presents its morphology.

Figure 2-1. Ema-Terezie Mine dumps complex

Ema-Terezie Mine dumps complex covers an area of 7 hectares, reaching 116 m of height. The dump Ema is the largest cone dump in the Ostrava city and forms a significant landmark of the city (with a peak at 324 m above sea level) at the same time. The dump is classified as a cultural monument.

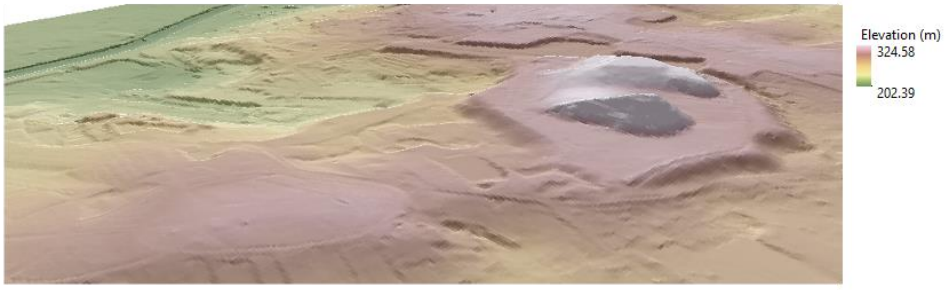

Figure 2-2. Hypsography of Ema-Terezie Mine dumps complex

Between 1979 and 1995, almost the entire complex was reclaimed for forestry, with the exception of the dump Ema cone, the northern part of dump Terezie and part of the

area in the west of the complex. At present 80% of the area is created by forest vegetation.

The complex is very diverse in terms of habitats, it contains thermophilous vegetation of thermally active parts of the Ema dump and hygrophilous vegetation on foots of slopes. It is also widely used as a tourist destination. Figure 2-3 presents the view from Ema dump.

Figure 2-3. View from Ema dump

Figure 2-4 presents which parts of Ema-Terezie Mine dumps complex were recultivated.

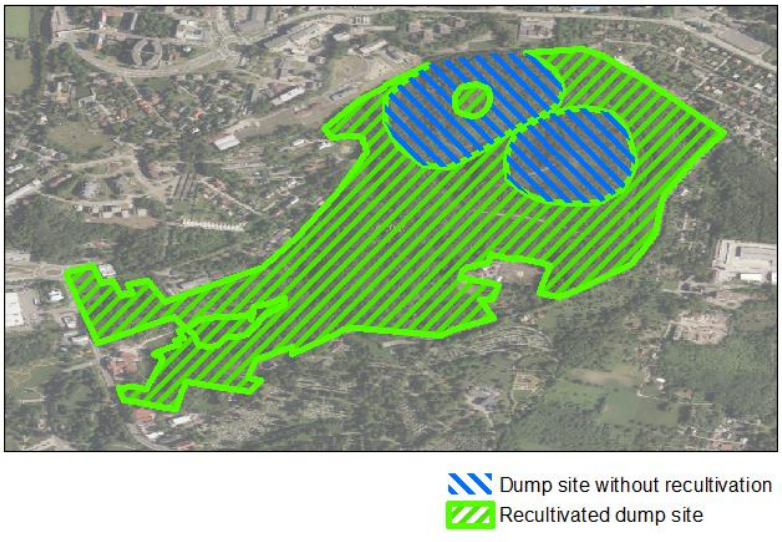

Figure 2-4. Recultivation of Ema-Terezie Mine dumps complex

3 Identifying the adequate boundaries for the case-study area

The surrounding limits of the different coal mining-affected areas will be defined on the basis of existing spatial connectivity and functional cohesion. It is critical for establishing an ecosystem services context to determine with accuracy the adequate but flexible boundaries of the area where the impact of the planned activities may produce changes in forms of land use, monetary value of properties, and potential of ecosystem services.

The area that was selected for the Ema-Terezie Mine dumps complex is presented in Figure 3-1, and it covers an area of 1356 ha.

Figure 3-1. Boundaries of the Ema-Terezie Mine dumps complex case-study

All the limits (north, south, west and east) were selected according to main streets in the location. The settlement structure of the impact area is made up of family buildings, urban buildings, postmining elements, as old mine spoil dumps (Michal I and Michal II, Jan Maria dumps -naturally reforested by birch), Coal Mines with discontinued mining (Petr Bezruč, Mine and coke-oven plant Trojice, Michal – today Mining museum and National Cultural Monument, Jan Maria, Heřmanice Mine), old mining colonies with typical single-storey houses intended for miners. Part of city district Ostrava – Slezská Ostrava (Silesian Ostrava) - ie. local parts Slezská Ostrava, Michálkovice and Heřmanice is defined as case-study area. The streets, which represent the limits are:

- for the west limit: streets Frýdecká – Bohumínská
- for the north limit: streets Orlovská – Vrbická
- for the east limit: streets Fišerova – Radvanická. Part of the boundary case-study area create railway between streets Fišerova and Radvanická

- for the south limit: boundary of case-study continues to west from street Radvanická at Chotěbuz. The area is enclosed (between Chotěbuz and starting point at Frýdecká) via local streets and by part of railway Vítkovice.

So near surrounding of dumps complex with possible spatial connectivity is included.

The position of Ema-Terezie Mine dumps complex in context of all case-study area is presented in Figure 3-2.

Extensive area (104 ha) occupies the Ostrava Zoo, which lies northeast part of case-study area (Figure 4-5).

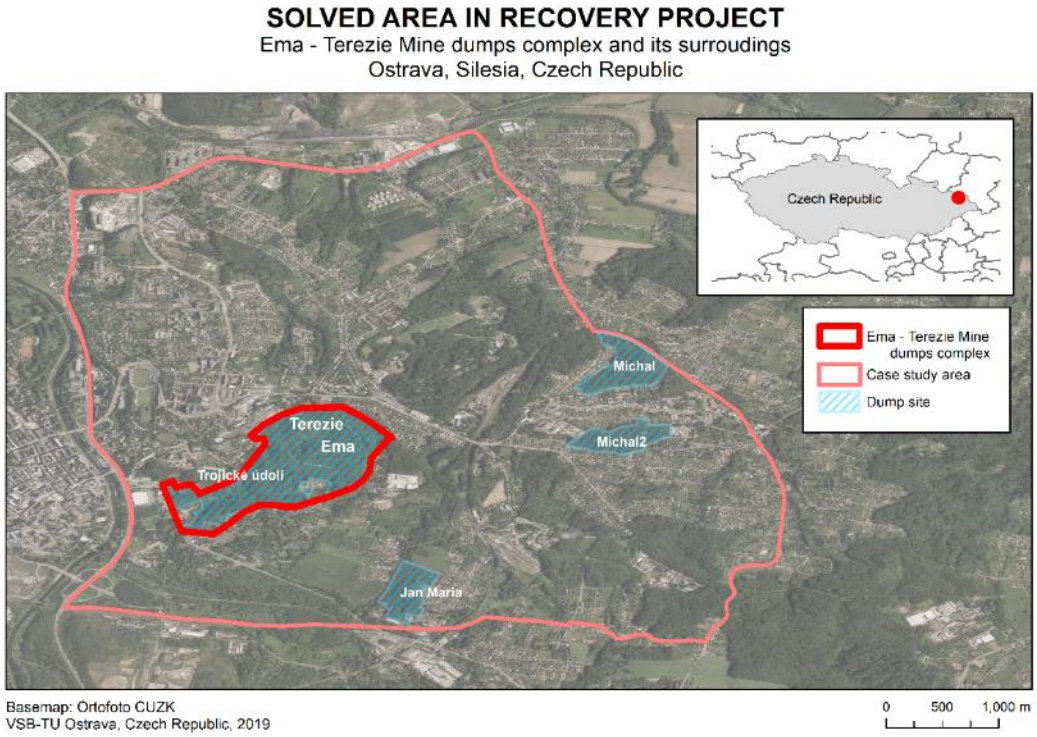

Figure 3-2. Boundaries of the Ema-Terezie Mine dumps complex case-study with highlighted dumps complex

4 Geospatial Data Available

A revision of the European and Czech online geospatial data that was available for Ema-Terezie Mine dumps complex area was developed. There were selected following sources of geospatial data:

- CORINE Land Cover 2018
- OpenStreetMap
- Pan-European High Resolution Layer from COPERNICUS programme
- Digital Terrain Model of the Czech Republic of the 5th generation (DMR 5G)
- Ortophotos

These sources were complement via expert knowledge about dumps and terrain survey focused on present landuse. Base ortophoto and terrain survey helped to supplement missing object in OSM.

4.1 CORINE Land Cover 2018

The information was obtained from the following sites:

- Czech site: geoportal.gov.cz/web/guest/home/ as WMS (web map server) for visualization (http://geoportal.gov.cz/ArcGIS/services/CENIA/cenia_corine_2018/MapServer/WMSServer)

- https://land.copernicus.eu/pan-european/corine-land-cover, a downloading centre from the European Environment Agency.

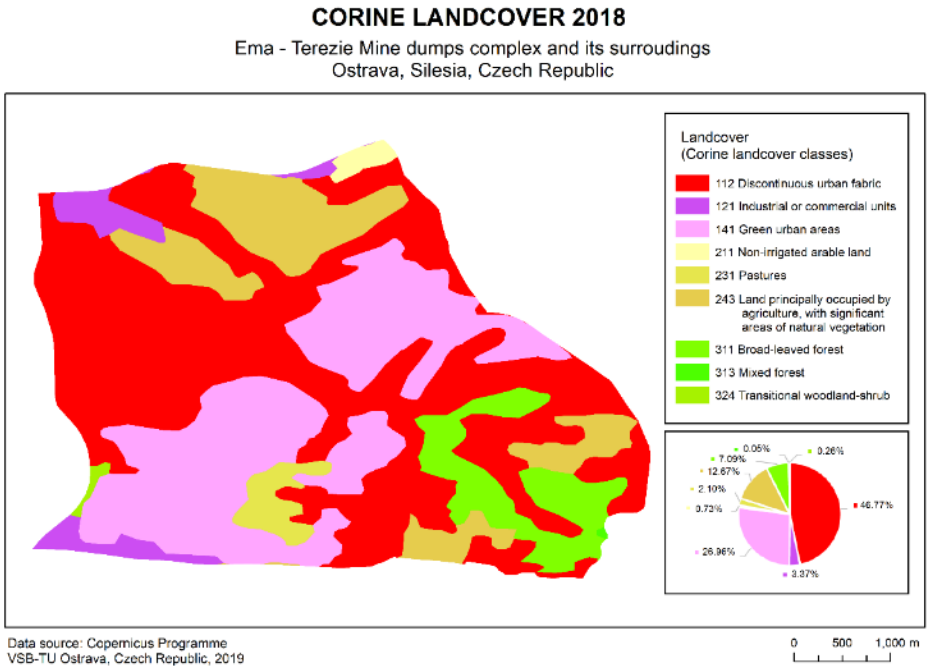

Figure 4-1 presents the map of land cover in 2018. The Geodetic Reference datum used is WGS 84 (EPSG:4326). Figure 4-2 presents the same data with ortophoto basemap.

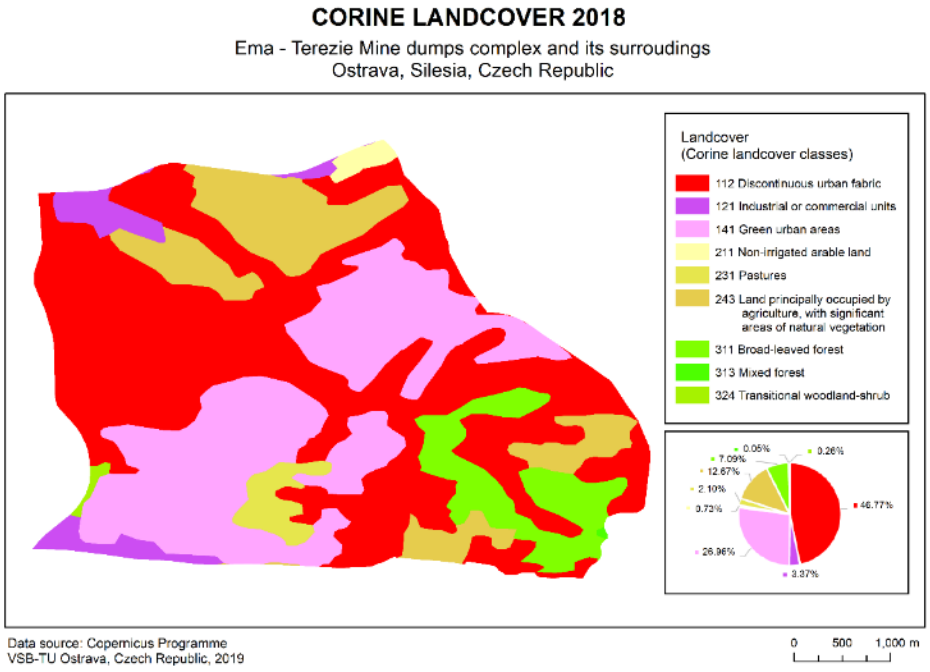

Figure 4-1. CORINE Land Cover 2018 (land cover)

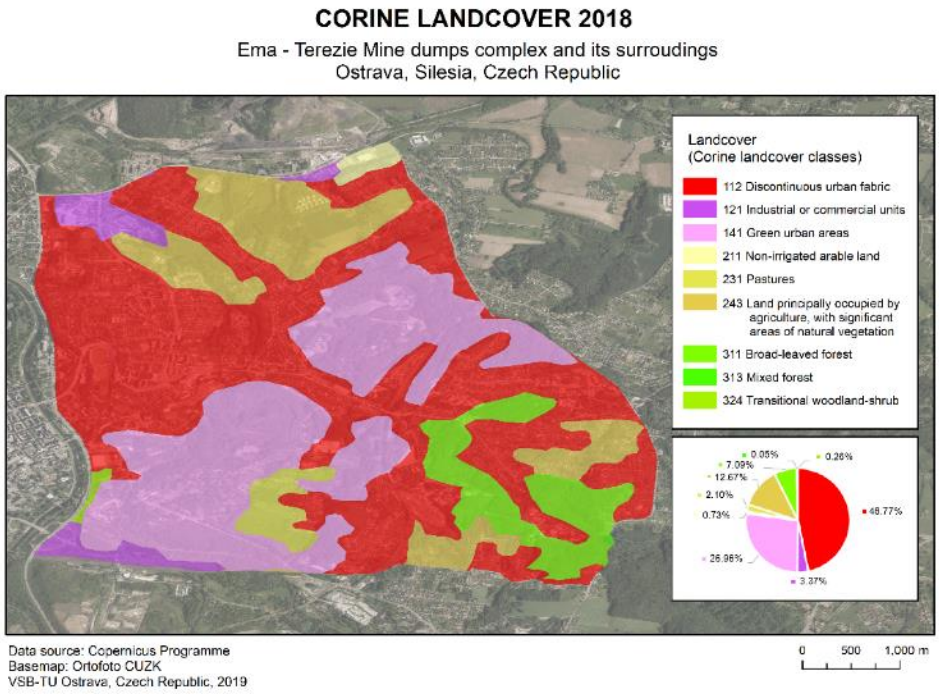

Figure 4-2. CORINE Land Cover 2018 (land cover) with ortophoto basemap

The CORINE Land Cover (CLC) project has been the responsibility of the European Environment Agency since 1995 with the fundamental objective of obtaining a European database of land use at a scale of 1: 100 000, useful for territorial analysis and policy management.

This project is currently included in the COPERNICUS Program whose main objective is to establish an Earth Observation System under the mandate of the European Commission.

4.2 OpenStreetMap

The OpenStreetMap (OSM) is collaborative map project, which was created by Steve Coast in the UK in 2004. Contributors can collect data using manual survey, GPS devices, aerial photography, and other free sources. OSM represents physical features on the ground using tags. Each tag describes a geographic attribute of the feature. The tagging system is free to allow to include an unlimited number of attributes describing each feature. On the other hand, there are certain keys and value combinations for the most commonly used tags, which act as informal standards. Short

descriptions of tags that relate to particular topics or interests can be found using the feature pages (at page wiki.openstreetmap.org/wiki/Category:Features).

The scale of OSM data is not fixed, the dataset is scalable. The highest detail is 1:500.

OSM datasets can be used/upload via QGIS plugin QuickOSM.

Following figures (Figures 4-3. – 4-8.) present OSM datasets in case-study.

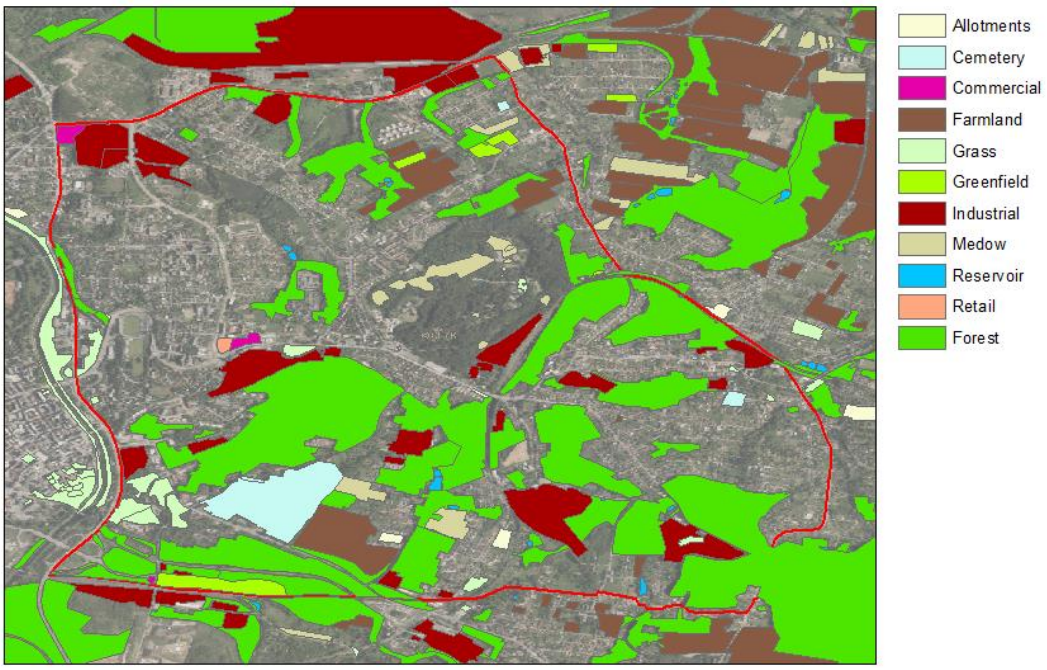

Figure 4-3. OSM – Landuse features

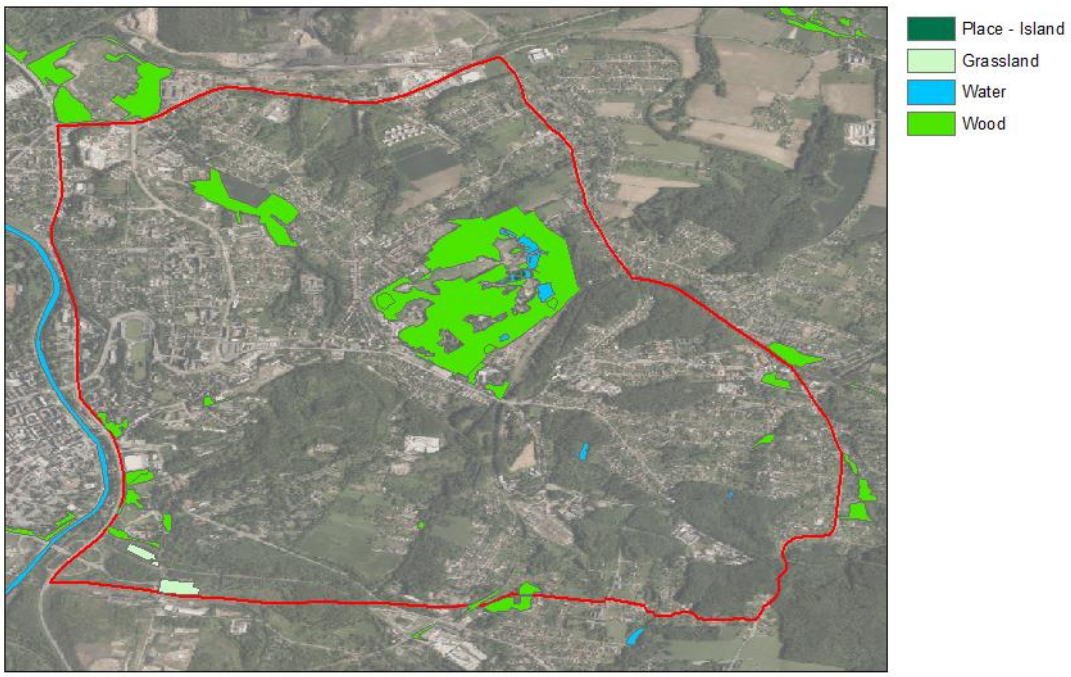

Figure 4-4. OSM – Natural and Place features

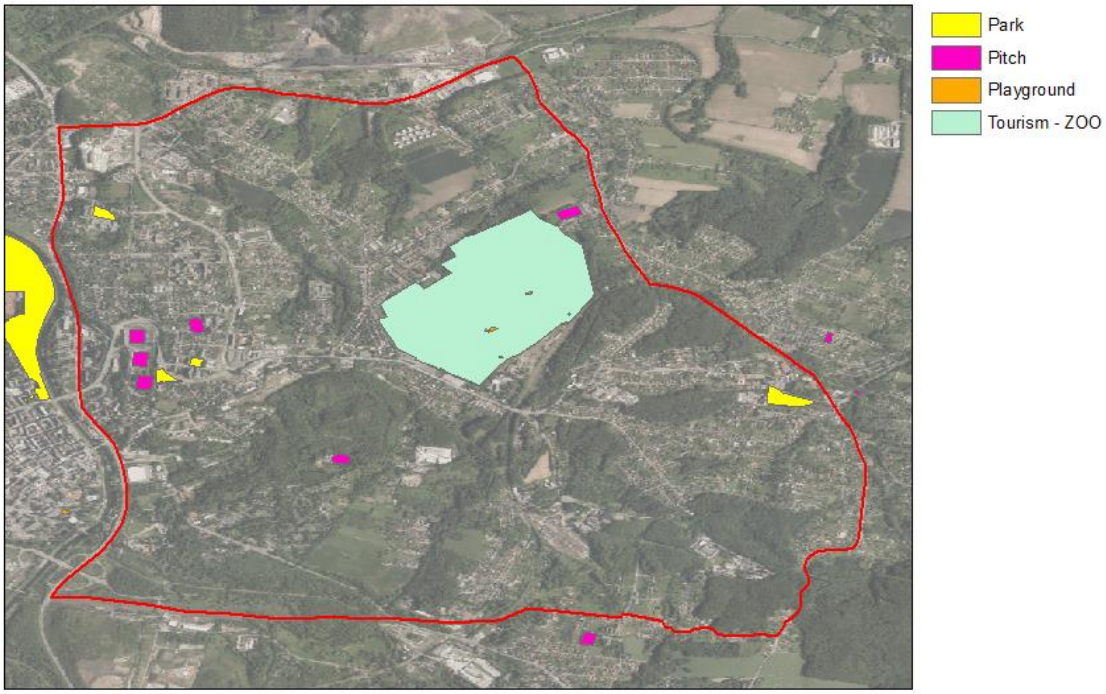

Figure 4-5. OSM – Leisure and Tourism features

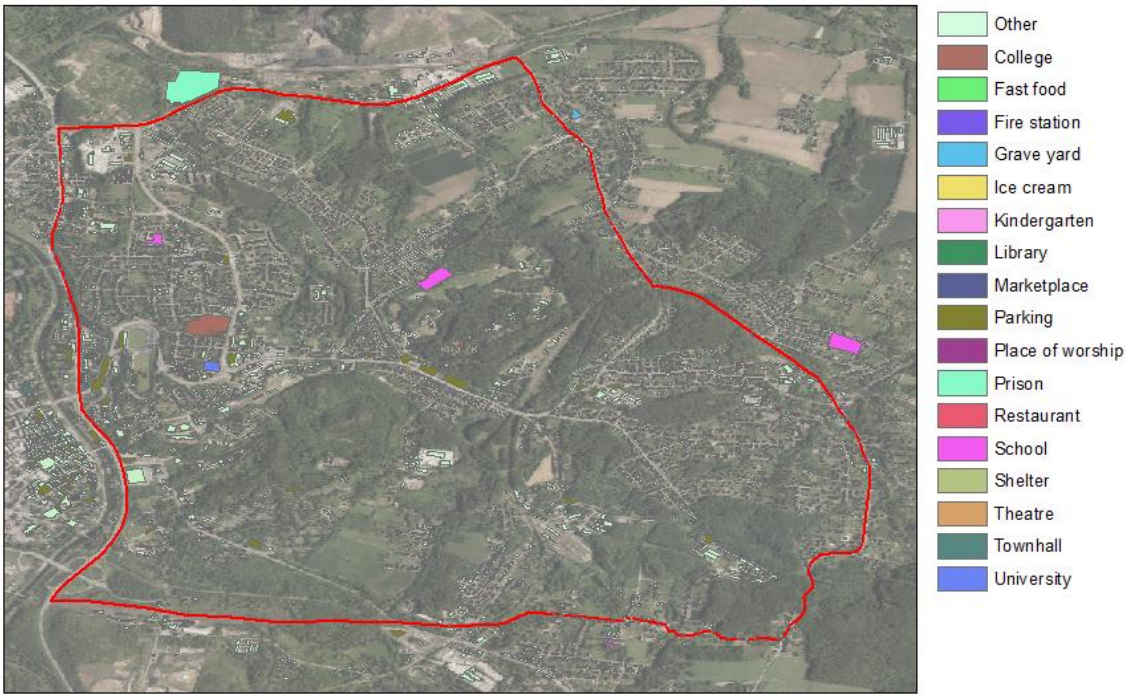

Figure 4-6. OSM – Amenity and Building features

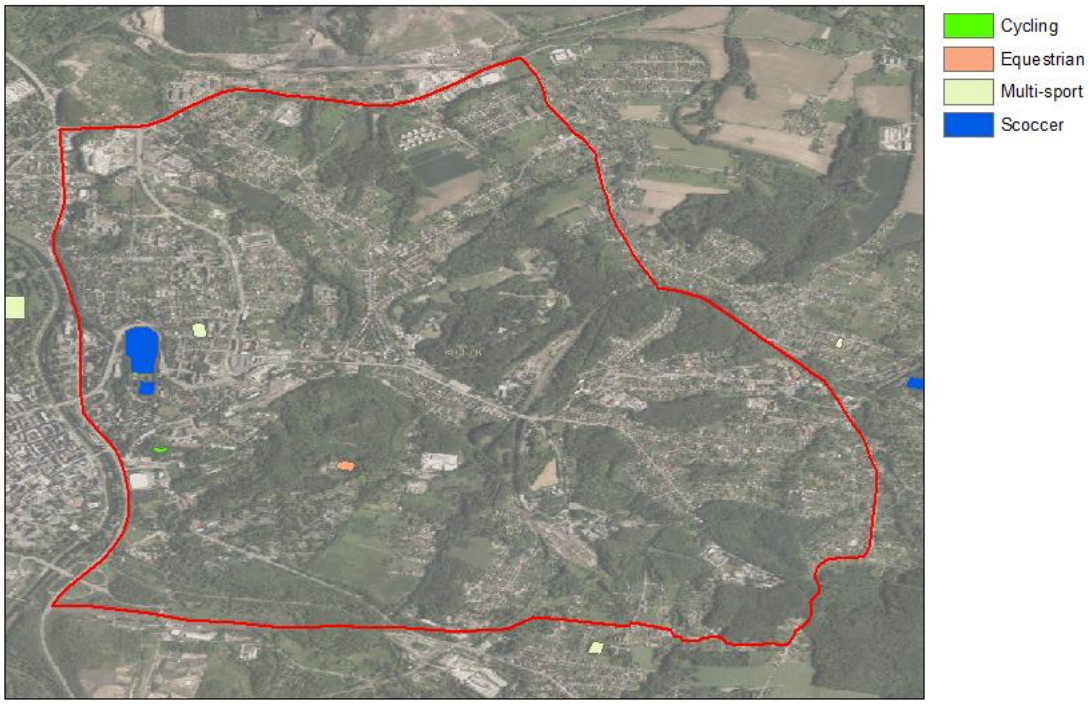

Figure 4-7. OSM – Sport features

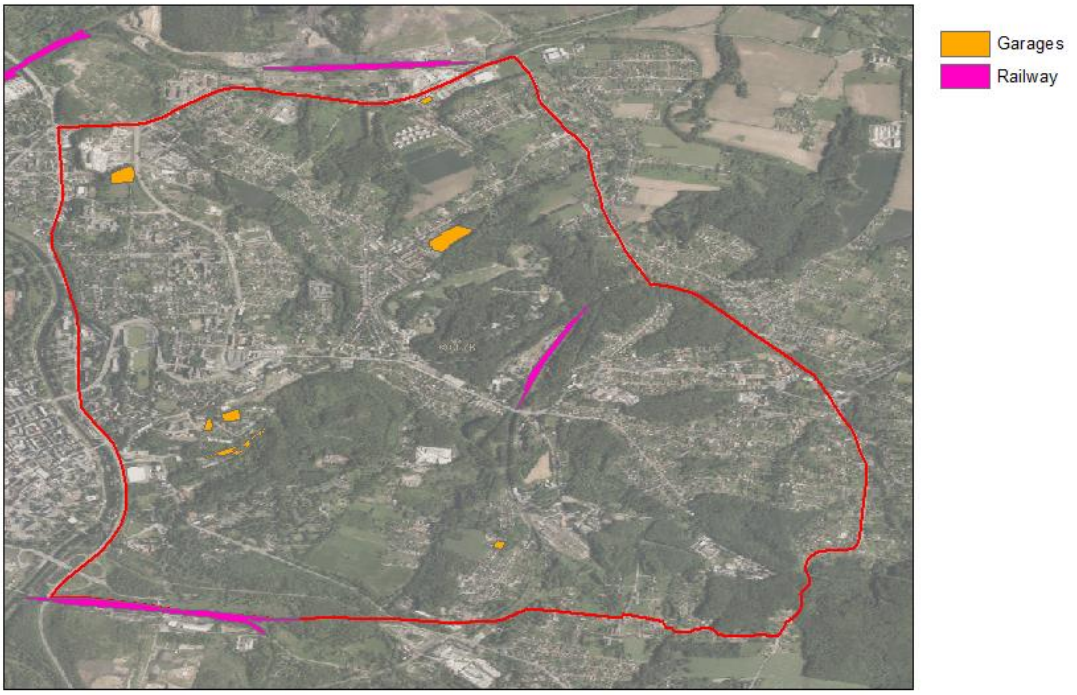

Figure 4-8. OSM – Transport features

4.3 COPERNICUS Land Monitoring System

Information was obtained from: https://land.copernicus.eu/pan-european/high-resolution-layers

Pan-European High Resolution Layers (HRL) provide information on specific land cover characteristics, and are complementary to land cover / land use mapping such as in the CORINE Land Cover (CLC) datasets.

The HRLs are produced from satellite imagery through a combination of automatic processing and interactive rule based classification. Since the production of the 2015 reference year the production is increasingly based on time series of satellite images from a number of different sensors, including the combination of optical and radar data.

The main sources are the Sentinel Satellites (in particular Sentinel-2 and Sentinel-1). In addition to high resolution (HR) data, since 2015, they also use very high resolution (VHR) imagery for some of the products.

Five themes have been identified so far, corresponding with the main themes from CLC, i.e. the level of sealed soil (imperviousness), tree cover density and forest type, grasslands, wetness and water, and small woody features.

Figure 4-9 presents the tree cover layer with two categories: broadleaved forest in light green and coniferous forest in dark green. White colour represents non-forest areas.

Figure 4-9. COPERNICUS Forest Type 2015

Some parts of forests, which Figure 4-9. presents, were classified as Green urban area or Dump sites according the CLC classification.

4.4 Czech Office for Surveying, Mapping and Cadastre imagery and reference data

Other intermediate products coming from Czech Office for Surveying, Mapping and Cadastre support the processing data and used as base maps:

- Digital Terrain Model of the Czech Republic of the 5th generation (DMR 5G), which is available as Web map service: http://ags.cuzk.cz/arcgis2/services/dmr5g/ImageServer/WMSServer?request=GetCapabilities&service=WMS
- Ortophoto images as on-line web map service at link: https://geoportal.cuzk.cz/WMS_ORTOFOTO_PUB/WMService.aspx

Hillshaded digital Terrain Model is presented in Figure 4 9.

Figure 4-10. Hillshaded Digital Terrain Model (DMR 5G)

5 Mapping of relevant ecosystems

CORINE Land Cover classes (Bossard et al., 2000) were used to delineate, categorize and map the different ecosystems types of land cover in the study areas (Figure 5-1).

CLC Level 1	CLC Level 2	CLC Level 3	Ecosystem types level 2
1. Artificial surfaces	1.1. Urban fabric	1.1.1. Continuous urban fabric	Urban
		1.1.2. Discontinuous urban fabric	
	1.2. Industrial, commercial and transport units	1.2.1. Industrial or commercial units	
		1.2.2. Road and rail networks and associated land	
		1.2.3. Port areas	
		1.2.4. Airports	
	1.3. Mine, dump and construction sites	1.3.1. Mineral extraction sites	
		1.3.2. Dump sites	
		1.3.3. Construction sites	
	1.4. Artificial non-agricultural vegetated areas	1.4.1. Green urban areas	
		1.4.2. Sport and leisure facilities	
2. Agricultural areas	2.1.Arable land	2.1.1. Non-irrigated arable land	Cropland
		2.1.2. Permanently irrigated land	
		2.1.3. Rice fields	
	2.2. Permanent crops	2.2.1. Vineyards	
		2.2.2. Fruit trees and berry plantations	
		2.2.3. Olive groves	
	2.3. Pastures	2.3.1. Pastures	Grassland
	2.4. Heterogeneous agricultural areas	2.4.1. Annual crops associated with permanent crops	Cropland
		2.4.2. Complex cultivation patterns	
		2.4.3. Land principally occupied by agriculture, with significant areas of natural vegetation	
		2.4.4. Agro-forestry areas	
3. Forests and semi-natural areas	3.1. Forests	3.1.1. Broad-leaved forest	Woodland and forest
		3.1.2. Coniferous forest	
		3.1.3. Mixed forest	
	3.2. Shrub and/or herbaceous vegetation association	3.2.1. Natural grassland	Grassland
		3.2.2. Moors and heathland	Heathland and shrub
		3.2.3. Sclerophyllous vegetation	
		3.2.4. Transitional woodland shrub	Woodland and forest
	3.3. Open spaces with little or no vegetation	3.3.1. Beaches, dunes, and sand plains	Sparsely vegetated land
		3.3.2. Bare rock	
		3.3.3. Sparsely vegetated areas	
		3.3.4. Burnt areas	
		3.3.5. Glaciers and perpetual snow	
4. Wetlands	4.1. Inland wetlands	4.1.1. Inland marshes	Wetlands
		4.1.2. Peatbogs	
	4.2. Coastal wetlands	4.2.1. Salt marshes	Marine inlets and transitional waters
		4.2.2. Salines	
		4.2.3. Intertidal flats	
5. Water bodies	5.1 Inland waters	5.1.1 Water courses	Rivers and lakes
		5.1.2 Water bodies	
	5.2 Marine waters	5.2.1 Coastal lagoons	Marine inlets and transitional waters
		5.2.2 Estuaries	
		5.2.3 Sea and ocean	Marine

Figure 5-1. Correspondence between CLC Classes and ecosystem types

As resented in Figure 5-1, the number of ecosystem types level 2 is much lower than CLC level 3 (Maes et al., 2013), but as the area that is going to be studied is small, CLC level 3 seems to be much more appropriate in order to analyse future changes in the land cover classes and, subsequently, in their ecosystem services provision.

Moreover, Figure 5-2 presents the specific colours of CLC were used in order to develop the mapping of relevant ecosystems (Source: http://www.gisandbeers.com/descarga-corine-land-cover-2018/).

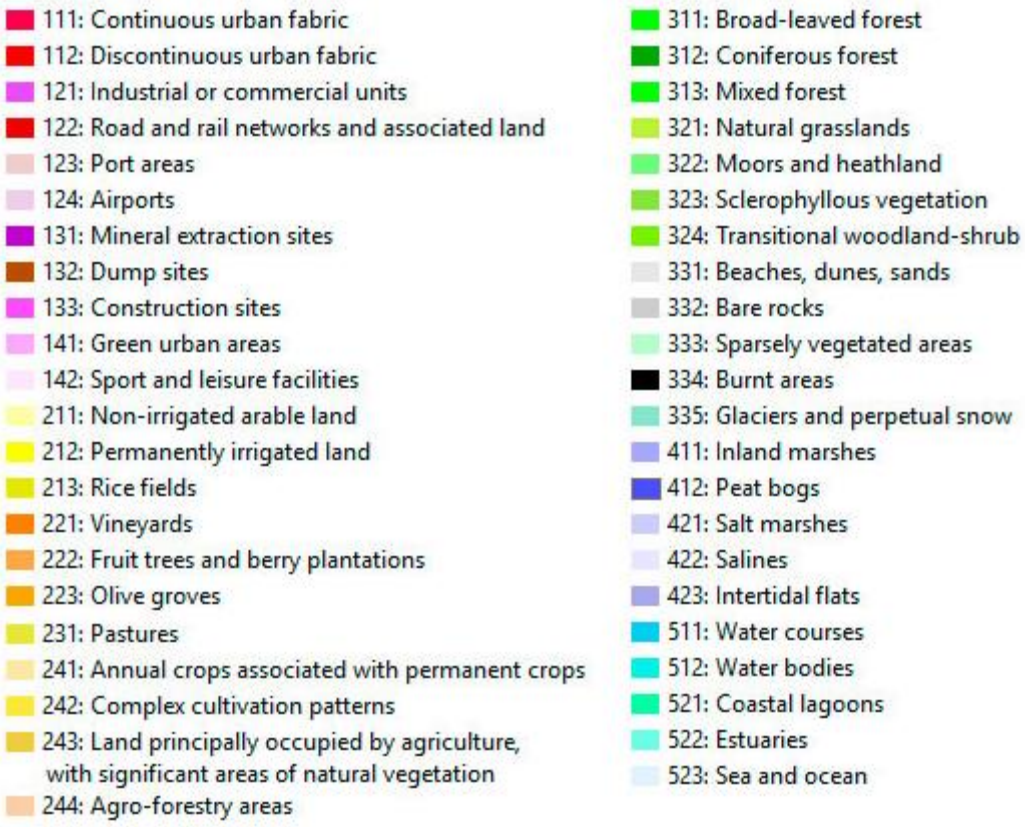

Figure 5-2. CORINE Land Cover pantone

Linking the CLC classes to OSM feature attributes presents following table:

Code	CLC name	Used OSM data/category	Note
112	Discountinuous urban babric		Complement to next data
121	Industrial or commercial units, public services and military installations	Landuse (retail, commercial, industrial)	
		Amenity (college, marketplace, university)	
		Building (university, school)	Selected-big areas

122	Road and rail networks and associated land	Landuse (railway, garages)	
		Amenity (parking)	
		Public transport (railway, garages, stop_area)	
141	Green urban area	Landuse (cemetery)	
		Place (islet)	Mainly in zoo
		Natural (wood)	
		Landuse (forest)	
		Tourism (zoo)	
142	Sport and leisure facilities	Leisure (park, pitch, playground)	
		Sport (scoccer, cycling, equestrian, multi)	
231	Pastures	Landuse (medow)	
242	Complex cultivation patterns	Landuse (allotments)	
243	Land principally occupied by agriculture, with significant areas of natural vegetation	Landuse (farmland)	
		Landuse (greenfield)	Selected parts
311	Broad-leaved forest	Natural (wood)	
		Landuse (forest)	
312	Coniferous forest	Natural (wood)	
		Landuse (forest)	
321	Natural grassland	Natural (grassland)	
		Landuse (grass)	
512	Water bodies	Natural (water)	
		Landuse (reservoir)	

Figure 5-3 presents the GIS aspect of CLC classes in Ema-Terezie Mine dumps complex that was developed with ArcMap 10.6. Also open-source QGIS 3.8 Zanzibar was used. This software is desktop GIS applications that supports viewing, editing, and analysis of geospatial data. Figure 5-5 presents the same image but over imposed to the ortophoto of the area.

Figure 5-6 presents web interface GIS presentation. There must be set projection of coordinate system for 3D viewing, so the system WGS 84 (EPSG:4326) was changed to ETRS89 (EPSG:3035). It caused stretching case-study area in direction of meridians. But it was suitable also for calculation of areas, which can be biased without projection.

Finally, Figure 5-6 presents an example of the polygon information that is available within the GIS: area (ha), perimeter (km), CLC class level 2 and level 3, and total surface of this specific CLC class level 3 in the whole case-study.

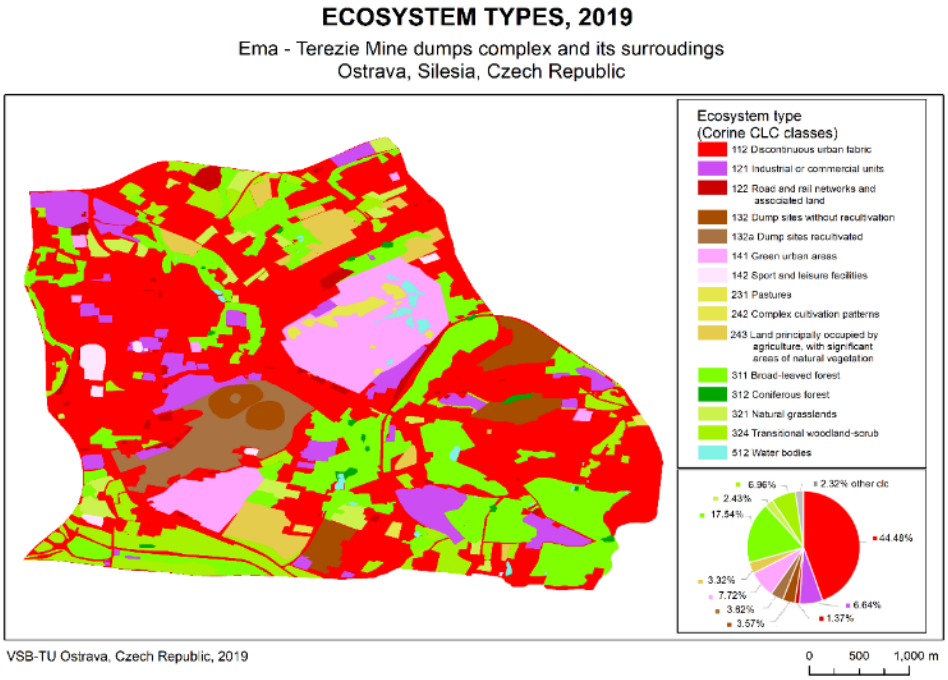

Figure 5-3. GIS presentation of CLC classes in Ema-Terezie Mine dumps complex

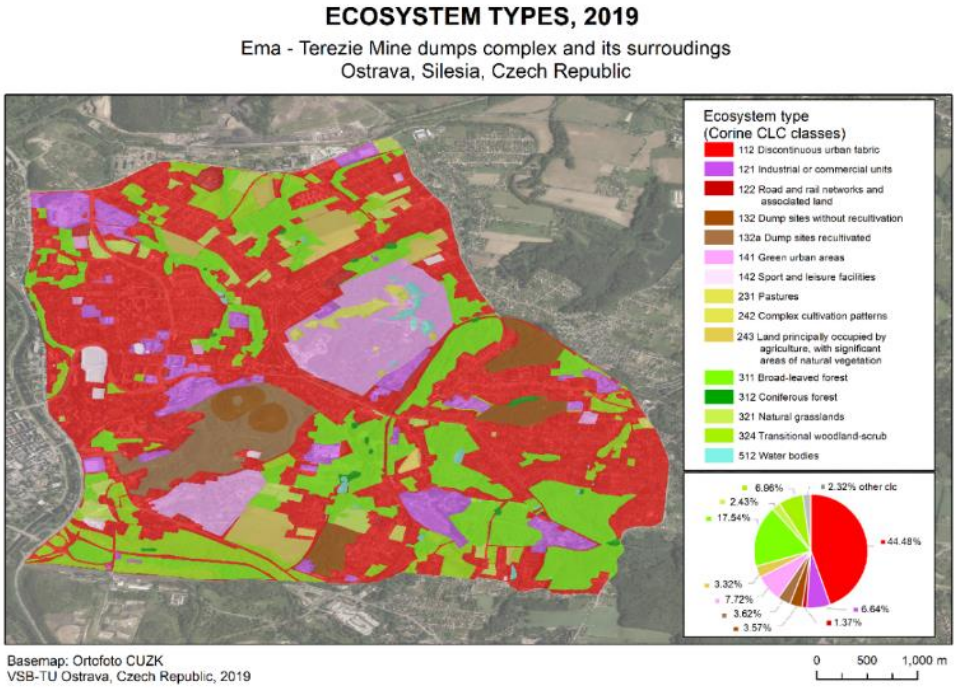

Figure 5-4. GIS presentation of CLC classes in Ema-Terezie Mine dumps complex over the ortophoto of the area

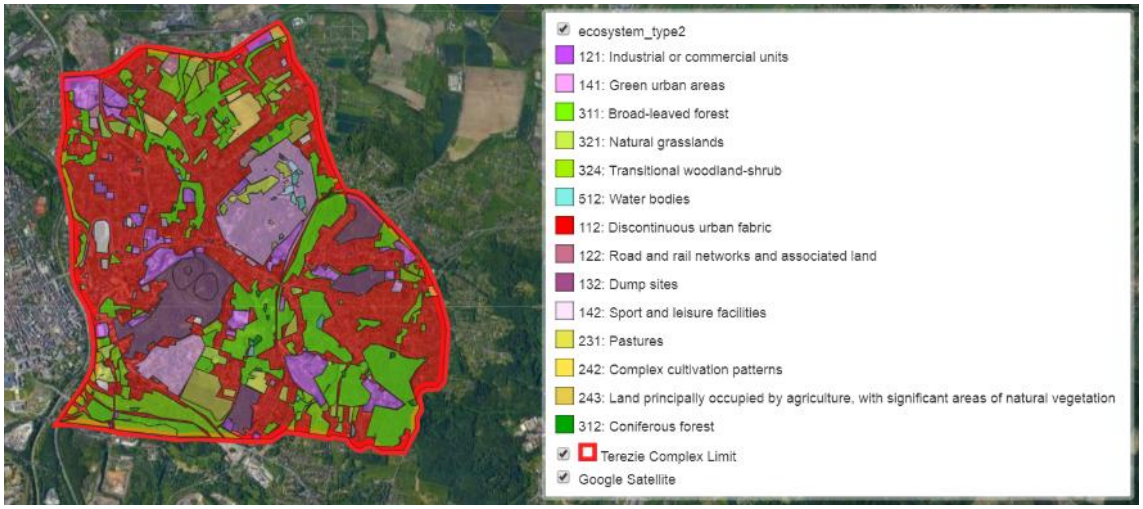

Figure 5-5. Web interface GIS presentation of CLC classes in Ema-Terezie Mine dumps complex

Figure 5-6. Web interface - Polygon description in the GIS

This information will be used afterwards to develop the calculations concerning the ecosystem services valuation.

The explanation of the different CLC classes used in Ema-Terezie Mine dumps complex is the following (Bossard et al., 2000):

5.1 Artificial areas (Main Class 1)

In case of cultivated areas inter-mixed with built-up areas within a patchwork system, the minimum threshold to be considered to classify in discontinuous urban fabric is 30 % (at least 30 % of the small parcels are urban fabric). Otherwise, the area should be classified as complex cultivation patterns.

5.1.1 Discontinuous urban fabric (112)

Most of the land is covered by structures. Building, roads and artificially surfaced areas associated with vegetated areas and bare soil, which occupy discontinuous but significant surfaces. Between 30 to 80 % of the total surface should be impermeable.

The discrimination between continuous and discontinuous urban fabric is set from the presence of vegetation visible illustrating either single houses with gardens or scattered apartment blocks with green areas between them.

The density of houses is the main criteria to attribute a land cover class to the built-up areas or to the agricultural area (242). In case of patchwork of small agricultural parcels and scattered houses, the cut-off-point to be applied for discontinuous urban fabric is 30 % at least of urban fabric within the patchwork area.

5.1.2 Industry or commercial units, public services and military installations (121)

Artificially surfaced areas (with concrete, asphalt, tarmacadam, or stabilised, e.g. beaten earth) without vegetation occupy most of the area, which also contains buildings and/or vegetation.

5.1.3 Road and rail networks and associated land (122)

Motorways and railways, including associated installations (stations, platforms), parking areas.

5.1.4 Dump sites (132)

Public, industrial or mine dump sites. This class includes dump sites of raw materials or liquid wastes.

5.1.5 Green urban areas (141)

Areas with vegetation within or partly embraced by urban fabric. This class is assigned for urban greenery, which usually has recreational or ornamental character and is usually accessible for the public.

5.1.6 Sport and leisure facilities (142)

This class is assigned for areas used for sports, leisure and recreation purposes. Camping grounds, sports grounds, leisure parks, golf courses, racecourses etc. belong to this class, as well as formal parks not surrounded by urban areas.

5.2 Agricultural areas (Main class 2)

5.2.1 Pastures (231)

Dense grass cover, of floral composition, dominated by graminacea, not under a rotation system. Mainly for grazing, but the fodder may be harvested mechanically. Includes areas with hedges (bocage). Grazing used by cattle.

Pastures can be described as extensively used grasslands with presence of farm structure such as fences, shelters, enclosures, watering places, drinking trough, or regular agricultural works: mowing, drainage, hay making, agricultural practices, manuring.

5.2.2 Complex cultivation patterns (242)

Mosaic of small cultivated land parcels with different cultivation types - annual crops, pasture and/or permanent crops, eventually with scattered houses or gardens.

5.2.3 Land principally occupied by agriculture, with significant areas of natural vegetation (243)

Areas principally occupied by agriculture, interspersed with significant natural or semi-natural areas (including forests, shrubs, wetlands, water bodies, mineral outcrops) in a mosaic pattern.

5.3 Forest and semi-natural areas (Main class 3)

5.3.1 Broad-leaved forest (311)

Vegetation formation composed principally of trees, including shrub and bush understoreys, where broad-leaved species predominate.

This class includes areas with a crown cover of more than 30 % or a 500 subjects/ha density for plantation structure, broad-leaved trees represent more than 75 % of the planting pattern. In case of young plants or seedlings, the proportion of broad-leaved plants to be considered is at least 75 % of the total amount of plants.

5.3.2 Coniferous forest (312)

Vegetation formation composed principally of trees, including shrub and bush understorey, where coniferous species predominate.

5.3.3 Natural grassland (321)

Grasslands under no or moderate human influence. Low productivity grasslands. Often situated in areas of rough, uneven ground, steep slopes; frequently including rocky areas or patches of other (semi-)natural vegetation.

5.3.4 Transitional woodland/shrub (324)

Bushy or herbaceous vegetation with scattered trees. Can represent either woodland degradation or forest regeneration/recolonization.

Areas of natural developmental forest formations (young broad–leaved and coniferous wood species with herbaceous vegetation and dispersed solitary trees) for instance; in abandoned meadows and pastures or after calamities of various origin, part of this class may be also various degenerative stages of forest caused by industrial pollution, etc.

5.4 Water bodies (Main class 5)

5.4.1 Water bodies (512)

Natural or artificial water bodies with presence of standing water surface during most of the year.

6 Three-dimensional view

Finally, **¡Error! No se encuentra el origen de la referencia.** presents a 3D image of the study area and Figure 6-2 presents CLC classes over the terrain.

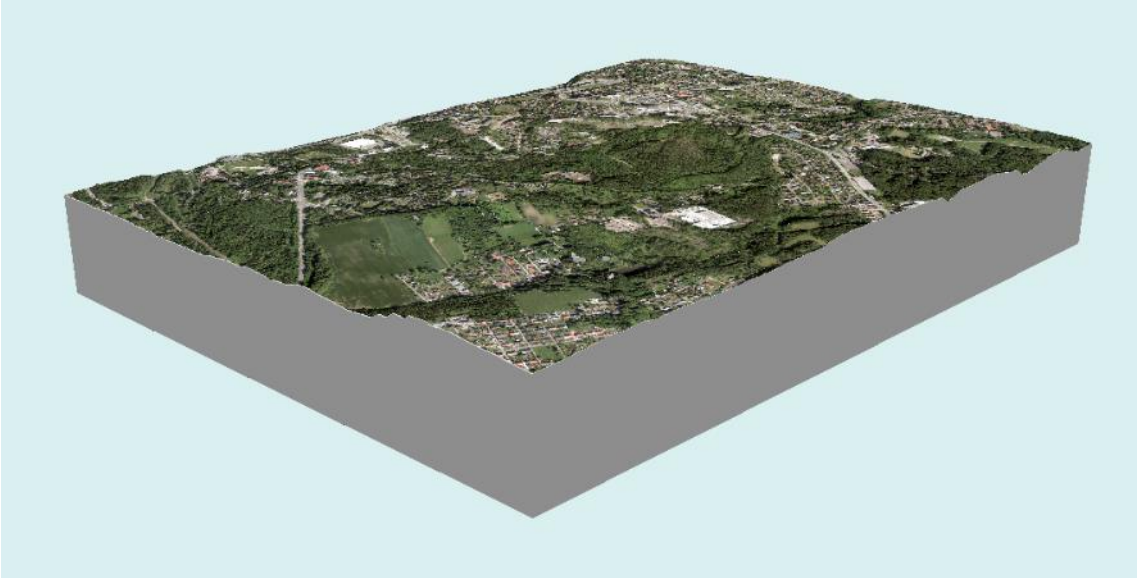

Figure 6-1. 3D image of case-study

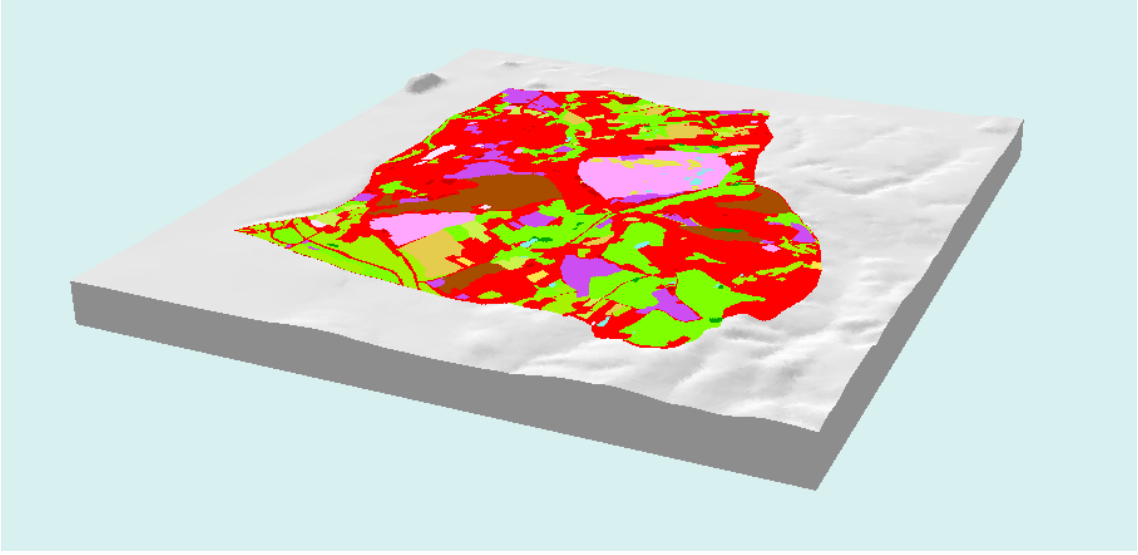

Figure 6-2. 3D view of the CLC classes

7 Conclusions and lessons learnt

In Case study Ema – Terezie Mine Dumps Complex the boundaries of a wider area were defined (it covers 1356 ha). In the frame of wider area, boundaries of core area, which contains the complex of mine dumps Ema - Terezie - Bezruč and the adjacent Trojice Valley with the former coke plant were determined. The surrounding limits of the different coal mining-affected areas will be defined on the basis of existing spatial connectivity and functional cohesion. It is critical for establishing an ecosystem services context to determine with accuracy the adequate but flexible boundaries of the area where the impact of the planned activities may produce changes in forms of land use, monetary value of properties, and potential of ecosystem services.

A revision of the European and Czech online geospatial data that was available for Ema-Terezie Mine dumps complex area was developed. There were selected following sources of geospatial data: CORINE Land Cover 2018, OpenStreetMap, Pan-European High Resolution Layer from COPERNICUS programme, Digital Terrain Model of the Czech Republic of the 5th generation (DMR 5G), Ortophotos.

The next different ecosystems types of land cover in the study areas were defined using CORINE Land Cover classes level 1: 1. Artificial surfaces; 2. Agricultural areas; 3. Forests and seminatural areas; 4. Wetlands; 5. Water bodies. For the core area CLC level 3 seems to be much more appropriate in order to analyse future changes in the land cover classes and, subsequently, in their ecosystem services provision. Most of the area (approx. 45%) belongs to CLC 3 Discontinuous urban fabric (112)**,** followed by Broad-leaved forest (311) with approx. 18%. Other types of ecosystems CLC level 3 do not cover more than about 8% of the area. In terms of ecosystem services, it should be noted that the core area - Ema Terezie Mine dumps complex is very diverse in terms of habitats, it contains thermophilous vegetation of thermally active parts of the Ema dump and hygrophilous vegetation on foots of slopes. It is also widely used as a tourist destination.

GIS aspect of CLC classes in Ema-Terezie Mine dumps complex was developed with ArcMap 10.6. Also open-source QGIS 3.8 Zanzibar was used. This software is desktop GIS applications that supports viewing, editing, and analysis of geospatial data.

Web interface GIS presentation was also created. There had to be set projection of coordinate system for 3D viewing, so the system WGS 84 (EPSG:4326) was changed to ETRS89 (EPSG:3035). It caused stretching case-study area in direction of meridians. But it was suitable also for calculation of areas, which can be biased without projection

This information will be used afterwards to develop the calculations concerning the ecosystem services valuation.

8 Glossary

CLC - CORINE Land Cover

CORINE - Coordination of information on the environment

CUZK - Czech Office for Surveying, Mapping and Cadastre

DMR 5G - Digital Terrain Model of the Czech Republic of the 5th generation

EEA - European Environment Agency

GIS - Geographic information system

OSM – OpenStreetMap

UNIOVI - University of Oviedo

VSB-TU Ostrava – Vysoká škola báňská – Technická universita Ostrava

References

Barbara, K., György, B., Gerard, H., & Stephan, A. (2017). Updated CLC illustrated nomenclature guidelines. *European Environment Agency*, (3436), 1–124. Retrieved from https://land.copernicus.eu/user-corner/technical-library/corine-land-cover-nomenclature-guidelines/docs/pdf/CLC2018_Nomenclature_illustrated_guide_20170930.pdf%0Ahttp://land.copernicus.eu/user-corner/technical-library/Addendum_finaldraft_v2_August_2014.pd

Bossard, M., Feranec, J., & Otahel, J. (2000). CORINE Land Cover technical guide - Addendum 2000 - Technical report No 40. *European Environmental Agency*, (40), 105. Retrieved from http://www.eea.eu.int

Wiki contributors. Map features (2019) https://wiki.openstreetmap.org/wiki/Category:Features

Haines-Young, R., & Potschin, M. B. (2018). Common International Classification of Ecosystem Services (CICES) V5.1 and Guidance on the Application of the Revised Structure. *European Environment Agency*, (January), 53. Retrieved from www.cices.eu

Maes, J., Teller, A., Erhard, M., Liquete, C., Braat, L. C., Berry, P., … Bidoglio, G. (2013). *Mapping and Assessment of Ecosystems and their Services. An analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020*. *Publications office of the European Union*. Publications office of the European Union, Luxembourg. https://doi.org/10.2779/12398