Recovery

RFCS RESEARCH PROJECT

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

847205-RECOVERY-RFCS-2018

Deliverable 2.4

Baseline mapping of relevant ecosystems of Chabařovice Mine and Most-Ležáky Mine

European Commission

Research Fund for Coal & Steel

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EXECUTIVE SUMMARY

Within the Deliverable 2.4, the baseline mapping of relevant ecosystems of Chabařovice Mine and Most-Ležáky Mine is developed.

In the first place, and after a description of Chabařovice Mine and Most-Ležáky Mine, the adequate boundaries for the study areas were defined, based on the existing spatial connectivity and functional cohesion. Chabařovice Mine covers an area of 1457 ha. The boundaries were determine as all the area of the mine and spoil heaps, Northern Slopes as the north limit, Eastern Slopes as the east limit, Western Slopes as the west limit and heap Žichlice as the south limit.

Most-Ležáky Mine covers an area of 1 234 ha. The boundaries were determine as all the area of the mine and spoil heaps, Northern spoil heap slopes as the north limit, Střimice spoil heap as the east limit, Western spoil heap slopes as the west limit, South spoil heap slopes and the Assumption of Virgin Mary Church area as the south limit.

In the second place, a revision of the European and Czech online geospatial data that was available for Chabařovice Mine and Most-Ležáky Mine areas was developed.

The information was obtained from the Czech National Geoportal INSPIRE, provider of the map is CENIA and imagineries were viewed with QGIS 3.10 Coruña and Google Earth Pro.

The obtained information for Chabařovice Mine and Most-Ležáky Mine areas was: The CORINE Land Cover 2018 (land cover), COPERNICUS Land Monitoring System - the level of sealed soil (imperviousness), the tree cover density, and forest type, grasslands, wetness and water, and small woody features, COPERNICUS NATURA 2000, 2018, and COPERNICUS CORINE Land Cover 2018. Also other intermediate products coming from COPERNICUS were the European Digital Elevation Model (EU-DEM), version 1.1. EPSG: 4326 (ETRS89, LAEA) grid width: 25m, the EU-Hydro EPSG: 4326 (ETRS89, LAEA) grid width: 25m and High Resolution Imagery False Colour 2015. EPSG: 4326. GSD: 20m.

In the third place, CORINE Land Cover classes (level 3) were used to delineate, categorize and map the different ecosystem types of land cover in the study areas, although doing detailed field mapping at a higher resolution than in the CORINE programme.

Finally, the information was introduced in the QGIS 3.8 Zanzibar. QGIS (previously known as Quantum GIS), a free and open-source cross-platform desktop GIS application that supports viewing, editing, and analysis of geospatial data.

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

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 2.4 will undergo the baseline mapping of the relevant ecosystems from Chabařovice Mine and Most-Ležáky Mine, property of PKÚ (Czech Republic).

2 Chabařovice Mine

The former Chabařovice Mine, now lake Milada, is the property of Palivový kombinát Ústí, s.p. (PKÚ), industrial partner of RECOVERY, which is phasing out its restoration (Figure 2-1).

Figure 2-1. Chabařovice mine (Lake Milada)

The mining activities at Chabařovice mine began in 1977, and the mining of brown coal was completed in 1997. Coal from Chabařovice mine was characterized for its absolute lowest sulfur content in the Czech Republic (0.35%), as well as other carcinogens, thus minimizing the environmental burden at the time of inversion conditions.

The locality of the former brown coal quarry Chabařovice is located in the easternmost part of the North Bohemian brown coal basin near the towns of Ústí nad Labem, Chabařovice and Trmice.

Since 1996, reclamation activities have been carried out for the restoration of the landscape in order to smooth out the consequences of mining activities. In the framework of the Disposal Plan, it was decided to implement a hydric method of reclamation, which means flooding the residual pit with water and creating a lake of approximately 250 ha.

Reclamation is currently in a phase of phasing out.

The total revitalization and reclamation work is carried out on an area of 1457 ha and includes landscaping, construction of drainage ditches, construction of access roads, biological reclamation - forestry, agricultural, other (grassing), hydric reclamation - reservoirs (Lake Milada).

The eastern, western and northern part of the slopes adjacent to the lake is forested and will also provide a scattered recreation. The southern part of the territory will primarily fulfill the ecological function.

3 Identifying the adequate boundaries of Chabařovice Mine

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 Chabařovice Mine is presented in Figure 3-1, and it covers an area of 1457 ha.

Figure 3-1. Boundaries of the Chabařovice Mine case-study

The boundaries were selected according to the following aspects:

1. All the area of the mine and spoil heaps were included in the polygon.
2. The north limit was selected according to the border of the reclaimed area, this part is called Northern Slopes.
3. The east limit was selected according to the main road and also the border of the reclaimed area, this part is called Eastern Slopes.
4. The west limit was selected according to the border of the reclaimed area, this part is called Western Slopes.
5. The south limit was selected according to the border of the spoil heap Žichlice.

4 Geospatial Data Available for Chabařovice Mine

A revision of the European and Czech online geospatial data that was available for Chabařovice mine area was developed. Imagineries were viewed with QGIS 3.10 Coruña and Google Earth Pro. QGIS is a user friendly Open Source Geographic Information System (GIS) licensed under the GNU General Public License. QGIS is an official project of the Open Source Geospatial Foundation (OSGeo). Google Earth Pro on desktop is free for users with advanced feature needs. Import and export GIS data, and go back in time with historical imagery.

4.1 CORINE Land Cover 2018

The information was obtained from the following Czech sites:

- https://geoportal.gov.cz/web/guest/eshop/gallery;jsessionid=AE6D745CBF8929EE8EFB8A7CB8C79A9A/#mainProductPanelId:productDetailPanelId, a downloading centre from the Czech National Geoportal INSPIRE, provider of the map is CENIA.

Figure 4-1 presents the map of land cover in 2018. The Geodetic Reference datum used is ETRS89 and the UTM projection spindle 30.

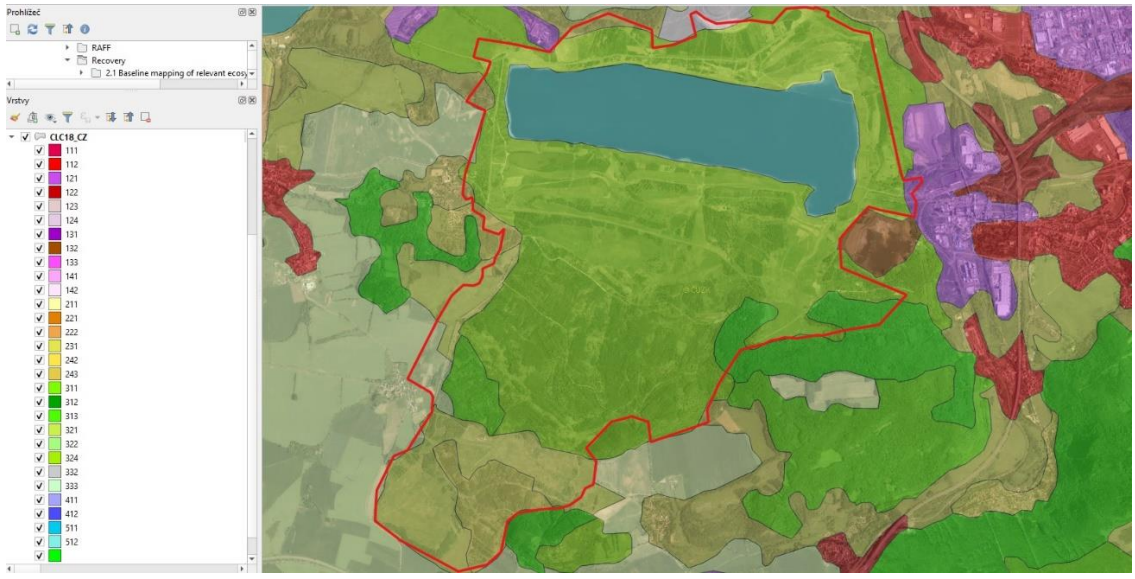

Figure 4-1. CORINE Land Cover 2018 (land cover) Chabařovice mine

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 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, water and wetness, and small woody features.

Figure 4-2 presents the imperviousness density in 2015, capturing the percentage and change of soil sealing. Built-up areas are characterized by the substitution of the original (semi-) natural land cover or water surface with an artificial, often impervious cover.

Figure 4-2. COPERNICUS Imperviousness 2015 Chabařovice mine

Figure 4-3 presents the tree cover density in 2015, being the 'vertical projection of tree crowns to a horizontal earth's surface', providing information on the proportional crown coverage per pixel. This information is derived from multispectral High Resolution (HR) satellite data using Very High Resolution (VHR) satellite data and/or aerial ortho-imagery as reference data. Tree cover density is assessed on VHR sources by visual interpretation following a point grid approach and subsequently transferred to the HR data by a linear function.

Figure 4-3. COPERNICUS Tree Cover Density 2015 Chabařovice mine

Figure 4-4 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 4-4. COPERNICUS Forest Type 2015 Chabařovice mine

Figure 4-5 presents the grassland layer, a binary status layer. This grassy and non-woody vegetation baseline product includes all kinds of grasslands: managed grassland, semi-natural grassland and natural grassy vegetation.

Figure 4-5. COPERNICUS Grassland 2015 Chabařovice mine

Figure 4-6 presents the water and wetness layer, showing the occurrence of water and wet surfaces over the period from 2009 to 2015.

This layer has defined classes of (1) permanent water, (2) temporary water, (3) permanent wetness and (4) temporary wetness.

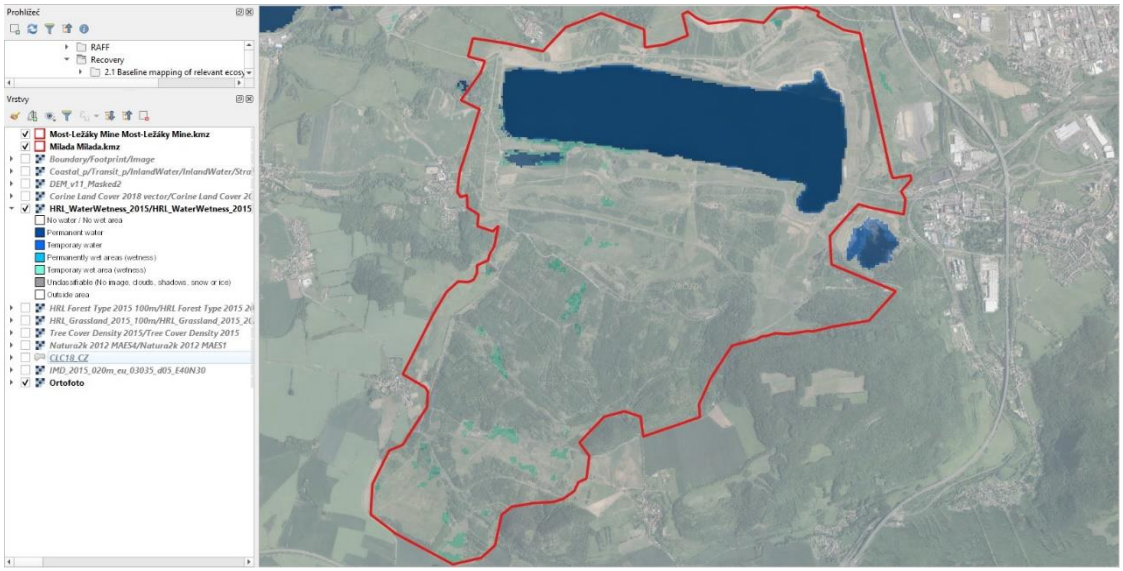

Figure 4-6. COPERNICUS Water and Wetness 2015 Chabařovice mine

On the other hand, Natura 2000 is a network of core breeding and resting sites for rare and threatened species, as well as for some rare natural habitat types which are protected in their own right. The aim of the network is to ensure the long-term survival of Europe's most valuable and threatened species and habitats that are listed under the Birds Directive and the Habitats Directive.

The mapping product offers a detailed LC/LU product applying a hierarchical nomenclature with 55 thematic LC/LU classes. Figure 4-7 presents the NATURA 2000 mapping in the study area, obtained from https://land.copernicus.eu/news/natura-2000-lc-lu-product-now-updated.

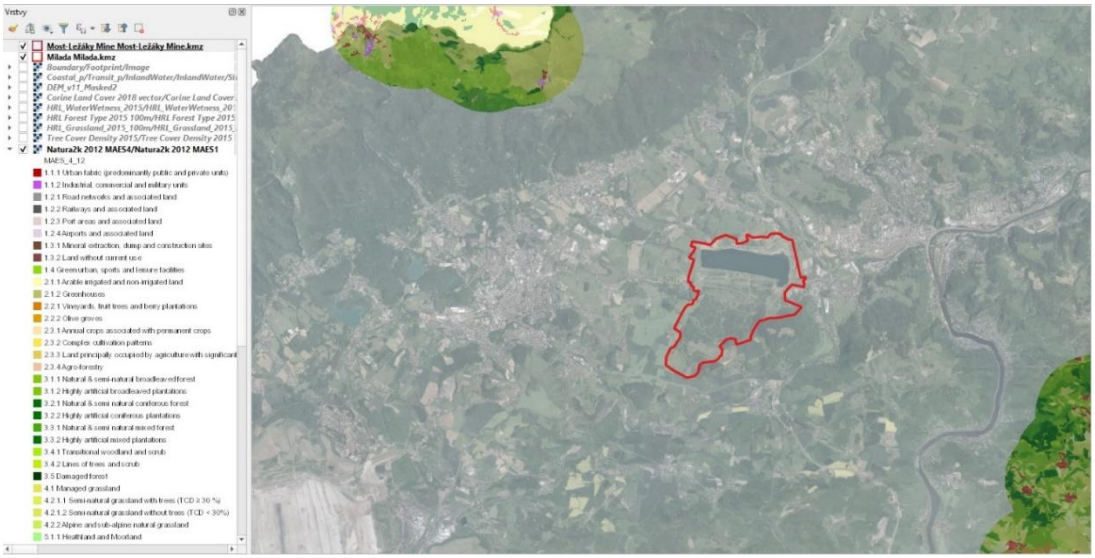

Figure 4-7. COPERNICUS NATURA 2000, 2018 Chabařovice mine

Finally, as CORINE Land Cover (CLC) is also a part of the COPERNICUS Land Monitoring Service, developed with a minimum mapping unit (MMU) for status layers is 25 hectares - minimum width of linear elements is 100 meters - minimum mapping unit (MMU) for Land Cover Changes (LCC) for change layers is 5 hectares (Figure 4-8).

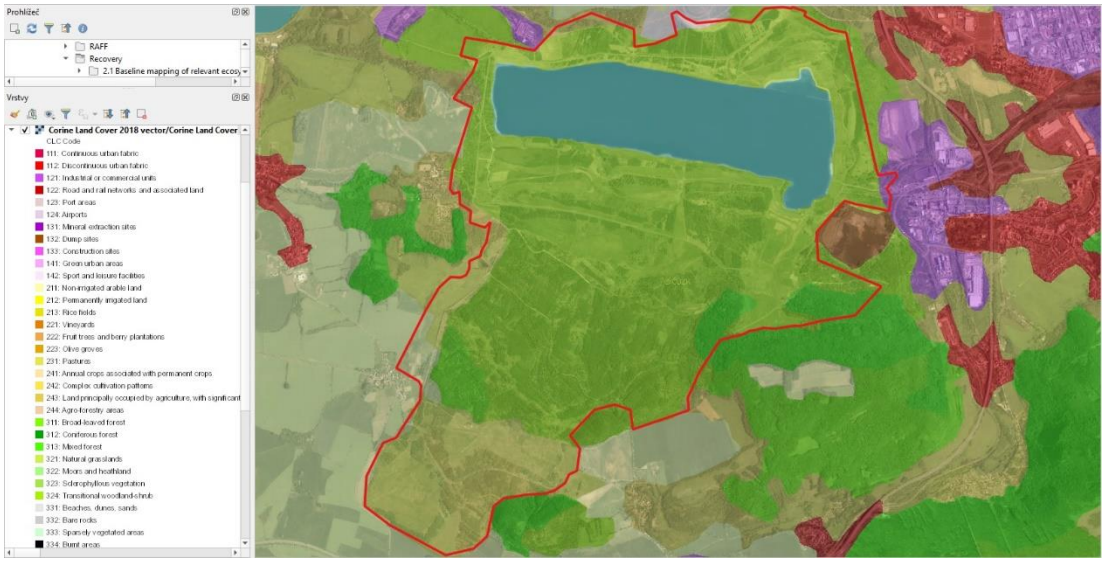

Figure 4-8. COPERNICUS CORINE Land Cover 2018 Chabařovice mine

4.3 COPERNICUS imagery and reference data

Other intermediate products coming from COPERNICUS are the European Digital Elevation Model that is presented in Figure 4-9.

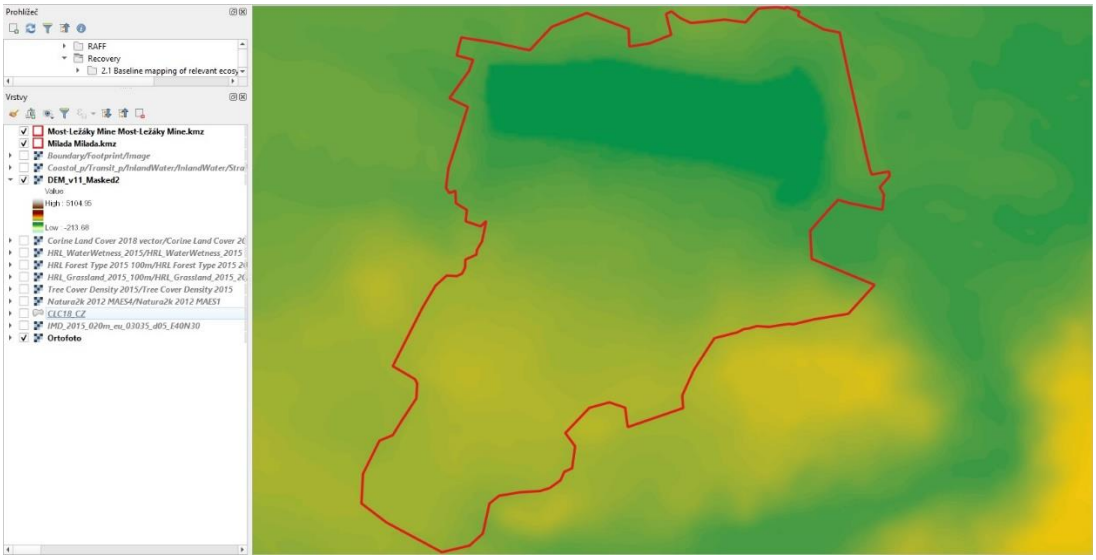

Figure 4-9. European Digital Elevation Model (EU-DEM), version 1.1. EPSG: 4326 (ETRS89, LAEA) grid width: 25m Chabařovice mine

Also the EU-Hydro, a dataset for all EEA39 countries providing photo-interpreted river network, consistent of surface interpretation of water bodies (lakes and wide rivers), and a drainage model (also called Drainage Network), derived from EU-DEM, with catchments and drainage lines and nodes (Figure 4-10).

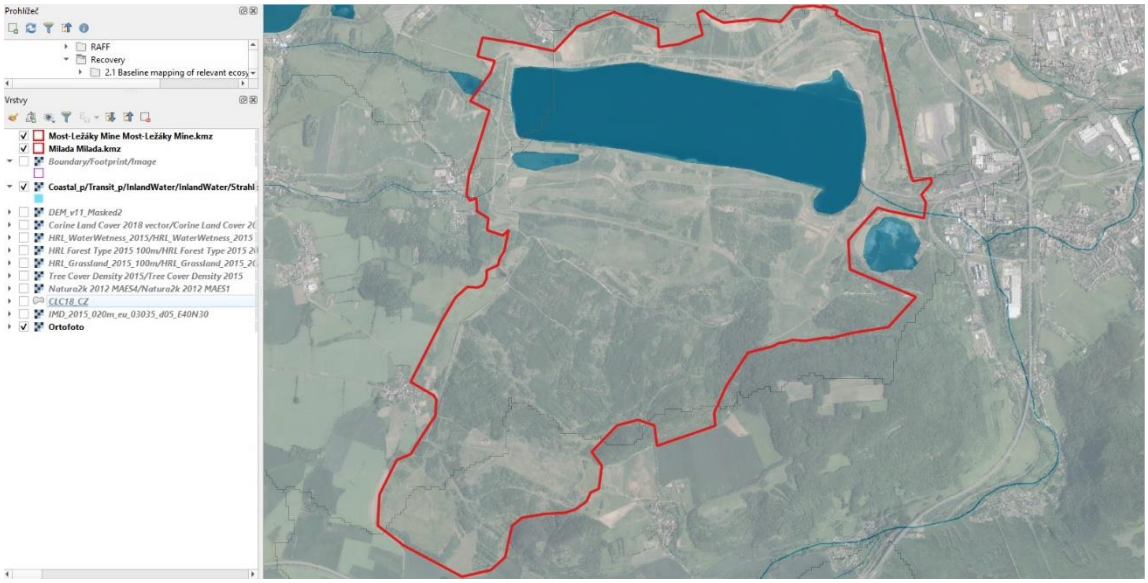

Figure 4-10. EU-Hydro EPSG: 4326 (ETRS89, LAEA) grid width: 25m Chabařovice mine

Finally, a cloud-free HR corresponding to the vegetation season in 2014-2015, representing in false colour the vegetative zone (Figure 4-11).

Figure 4-11. High Resolution Imagery False Colour 2015. EPSG: 4326. GSD: 20m Chabařovice mine

5 Mapping of relevant ecosystems of Chabařovice Mine

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 presented 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/).

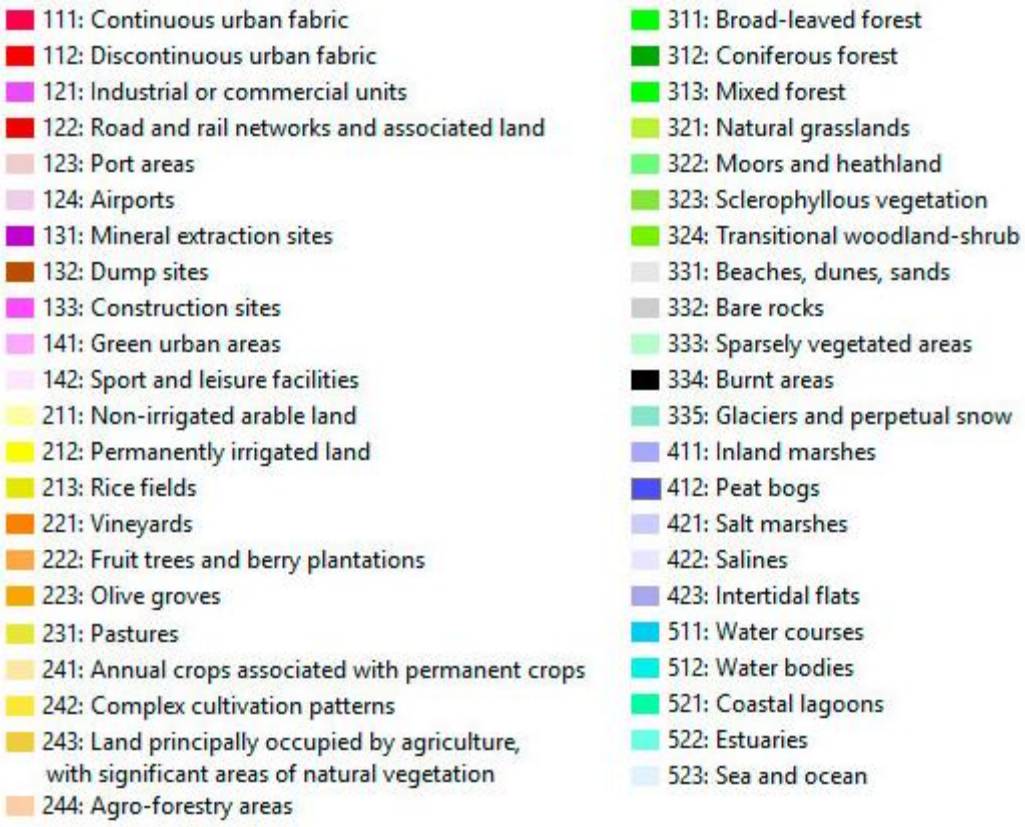

Figure 5-2. CORINE Land Cover pantone

Figure 5-3 presents the GIS aspect of CLC classes in Chabařovice that was developed with QGIS 3.8 Zanzibar. QGIS (previously known as Quantum GIS) is a free and open-source cross-platform desktop GIS application that supports viewing, editing, and analysis of geospatial data. On the other hand, Figure 5-4 presents the same image but over imposed to the orthoimage of the area.

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

Figure 5-3. GIS presentation of CLC classes in Chabařovice mine

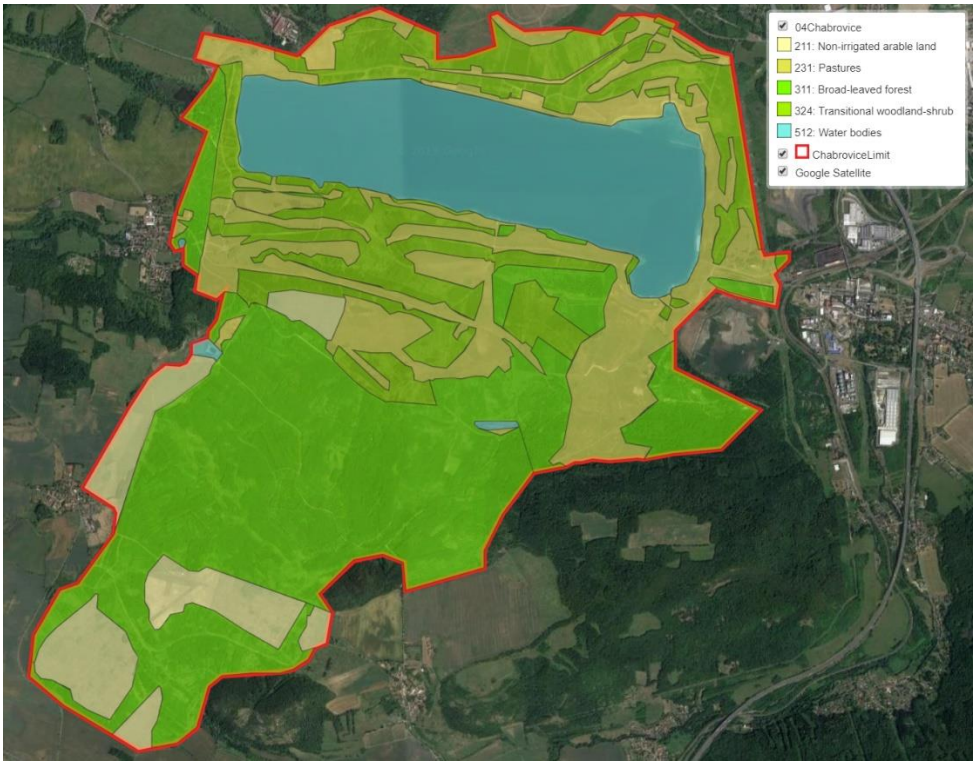

Figure 5-4. GIS presentation of CLC classes in Chabařovice over the orthoimage of the area

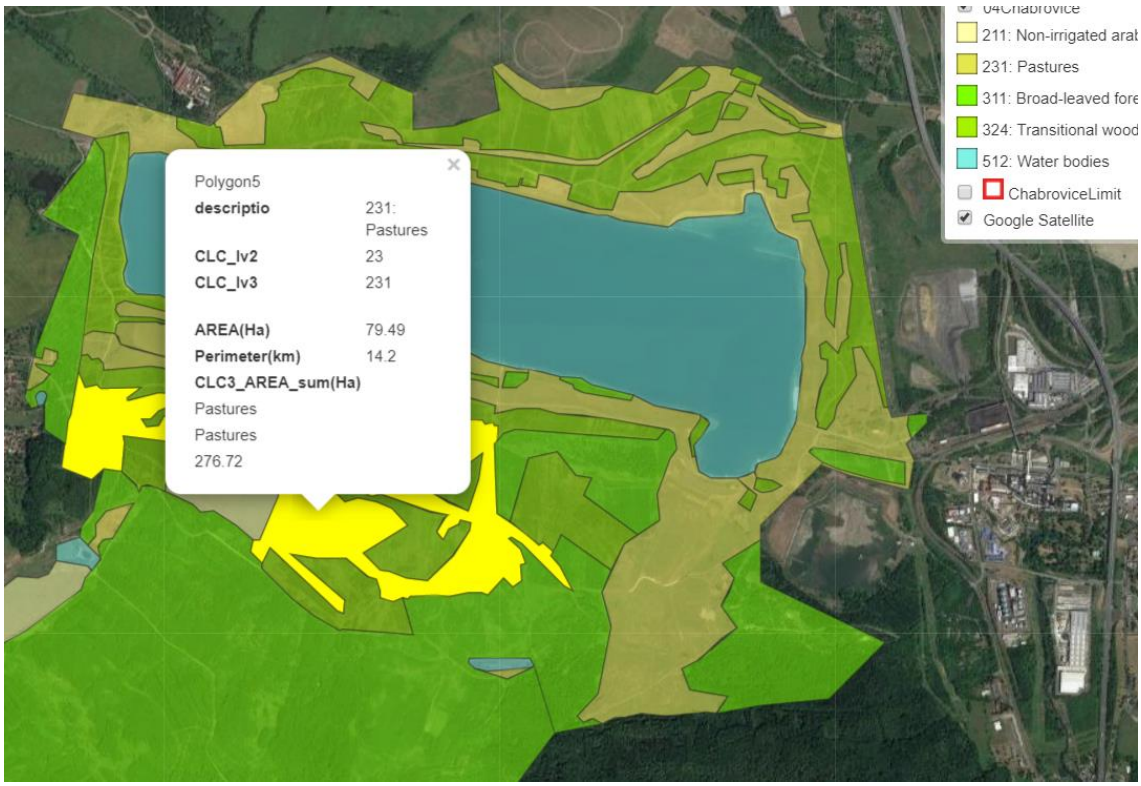

Figure 5-5. Polygon description in the GIS

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

The explanation of the different CLC classes used in Chabařovice Mine is the following (Bossard et al., 2000):

5.1 Agricultural areas (Main class 2)

5.1.1 Non-irrigated arable land (211)

Cereals, legumes, fodder crops, root crops and fallow land. Includes flowers and fruit trees (nurseries cultivation) and vegetables, whether open field, under plastic or glass (includes market gardening). Includes aromatic, medicinal and culinary plants. Does not include permanent pastures.

This class includes flower, fruit trees (nurseries) and vegetable cultivation. Includes other annually harvested plants with more than 75 % of the area under a rotation system. Part of this class are the plots of arable land with area of several hectares reaching tens (hundreds) of ha.

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

5.2.1 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.

5.2.2 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.

5.3 Water bodies (Main class 5)

5.3.1 Water bodies (512)

Natural or artificial stretches of water.

6 Most-Ležáky Mine

Most-Ležáky Mine is property of Palivový kombinát, s.p. (PKÚ), industrial partner of RECOVERY, which is undertaking nowadays its restoration (Figure 6-1).

Figure 6-1. Most-Ležáky mine

The quarry mining activities began in 1945 and ended in 1999. The original meadows, forests and fields were destroyed during intensive coal mining. Due to Most-Lezaky mine there was seven municipalities destroyed, including old city of Most.

Center of restoration is Lake Most, which has 315 ha. Nowadays, it is possible to see mostly areas created by reclamation or natural succession around the lake. Reclamated areas are divided into North slopes, Western slopes, South slopes, Střimice on East, Rudolice spoil heap, Pařidla spoil heap and inner spoil heap of moved Assumption of Virgin Mary Church. There is around 1 200 ha of reclamated areas and around 200 ha are in progress.

7 Identifying the adequate boundaries of Most-Ležáky Mine

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 Most-Ležáky Mine is presented in Figure 7-1, and it covers an area of 1 234 ha.

Figure 7-1. Boundaries of the Most-Ležáky Mine case-study

The boundaries were selected according to the following aspects:

1. All the area of the mine and spoil heaps were included in the polygon.
2. The north limit was selected according to Northern spoil heap slopes.
3. The east limit was selected according to Střimice spoil heap.
4. The west limit was selected according to Western spoil heap slopes.
5. The south limit was selected according to South spoil heap slopes and the Assumption of Virgin Mary Church area.

8 Geospatial Data Available for Most-Ležáky Mine

A revision of the European and Czech online geospatial data that was available for Most-Ležáky mine area was developed. Imagineries were viewed with QGIS 3.10 Coruña and Google Earth Pro. QGIS is a user friendly Open Source Geographic Information System (GIS) licensed under the GNU General Public License. QGIS is an official project of the Open Source Geospatial Foundation (OSGeo). Google Earth Pro on desktop is free for users with advanced feature needs. Import and export GIS data, and go back in time with historical imagery.

8.1 CORINE Land Cover 2018

The information was obtained from the following Czech site:

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Figure 8-1 presents the map of land cover in 2018. The Geodetic Reference datum used is ETRS89 and the UTM projection spindle 30.

Figure 8-1. CORINE Land Cover 2018 (land cover) Most-Ležáky Mine

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.

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8.2 COPERNICUS Land Monitoring System

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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, water and wetness, and small woody features.

Figure 8-2 presents the imperviousness density in 2015, capturing the percentage and change of soil sealing. Built-up areas are characterized by the substitution of the original (semi-) natural land cover or water surface with an artificial, often impervious cover.

Figure 8-2. COPERNICUS Imperviousness 2015 Most-Ležáky Mine

Figure 8-3 presents the tree cover density in 2015, being the 'vertical projection of tree crowns to a horizontal earth's surface', providing information on the proportional crown coverage per pixel. This information is derived from multispectral High Resolution (HR) satellite data using Very High Resolution (VHR) satellite data and/or aerial ortho-imagery as reference data. Tree cover density is assessed on VHR sources by visual interpretation following a point grid approach and subsequently transferred to the HR data by a linear function.

Figure 8-3. COPERNICUS Tree Cover Density 2015 Most-Ležáky Mine

Figure 8-4 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 8-4. COPERNICUS Forest Type 2015 Most-Ležáky Mine

Figure 8-5 presents the grassland layer, a binary status layer. This grassy and non-woody vegetation baseline product includes all kinds of grasslands: managed grassland, semi-natural grassland and natural grassy vegetation.

Figure 8-5. COPERNICUS Grassland 2015 Most-Ležáky Mine

Figure 8-6 presents the water and wetness layer, showing the occurrence of water and wet surfaces over the period from 2009 to 2015.

This layer has defined classes of (1) permanent water, (2) temporary water, (3) permanent wetness and (4) temporary wetness.

Figure 8-6. COPERNICUS Water and Wetness 2015 Most-Ležáky Mine

On the other hand, Natura 2000 is a network of core breeding and resting sites for rare and threatened species, as well as for some rare natural habitat types which are protected in their own right. The aim of the network is to ensure the long-term survival of Europe's most valuable and threatened species and habitats that are listed under the Birds Directive and the Habitats Directive.

The mapping product offers a detailed LC/LU product applying a hierarchical nomenclature with 55 thematic LC/LU classes. Figure 8-7 presents the NATURA 2000 mapping in the study area, obtained from https://land.copernicus.eu/news/natura-2000-lc-lu-product-now-updated.

Figure 8-7. COPERNICUS NATURA 2000, 2018 Most-Ležáky Mine

Finally, as CORINE Land Cover (CLC) is also a part of the COPERNICUS Land Monitoring Service, developed with a minimum mapping unit (MMU) for status layers is 25 hectares - minimum width of linear elements is 100 meters - minimum mapping unit (MMU) for Land Cover Changes (LCC) for change layers is 5 hectares (Figure 8-8).

Figure 8-8. COPERNICUS CORINE Land Cover 2018 Most-Ležáky Mine

8.3 COPERNICUS imagery and reference data

Other intermediate products coming from COPERNICUS are the European Digital Elevation Model that is presented in Figure 8-9.

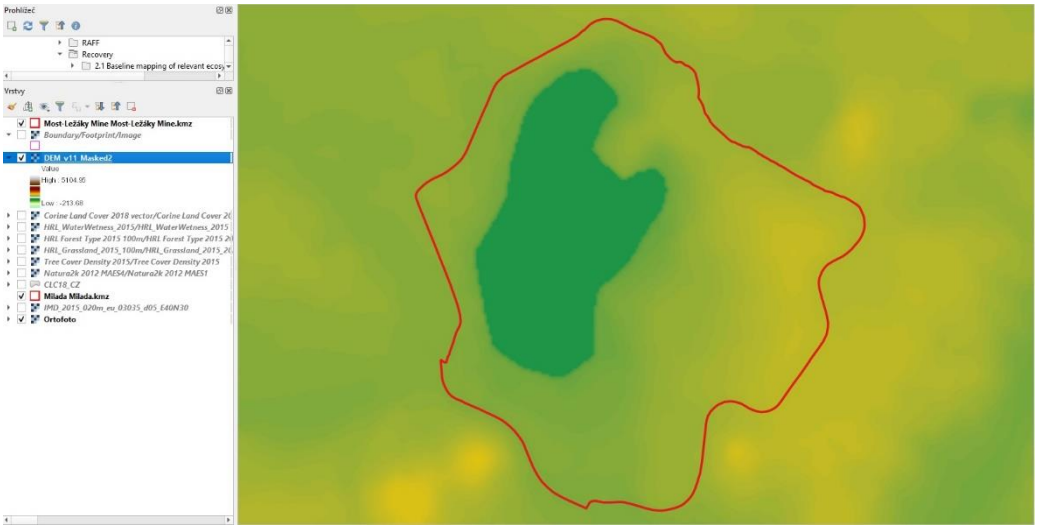

Figure 8-9. European Digital Elevation Model (EU-DEM), version 1.1. EPSG: 4326 (ETRS89, LAEA) grid width: 25m Most-Ležáky Mine

Also the EU-Hydro, a dataset for all EEA39 countries providing photo-interpreted river network, consistent of surface interpretation of water bodies (lakes and wide rivers), and a drainage model (also called Drainage Network), derived from EU-DEM, with catchments and drainage lines and nodes (Figure 8-10).

Figure 8-10. EU-Hydro EPSG: 4326 (ETRS89, LAEA) grid width: 25m Most-Ležáky Mine

Finally, a cloud-free HR corresponding to the vegetation season in 2014-2015, representing in false colour the vegetative zone (Figure 8-11).

Figure 8-11. High Resolution Imagery False Colour 2015. EPSG: 4326. GSD: 20m Most-Ležáky Mine

9 Mapping of relevant ecosystems of Most-Ležáky Mine

Figure 9-1 presents the GIS aspect of CLC classes in Most-Ležáky that was developed with QGIS 3.8 Zanzibar. QGIS (previously known as Quantum GIS) is a free and open-source cross-platform desktop GIS application that supports viewing, editing, and analysis of geospatial data. On the other hand, Figure 9-2 presents the same image but over imposed to the orthoimage of the area.

Finally, Figure 9-3 presents an example of the polygon information that is available within the GIS: description, CLC class level 2 and level 3, area (ha), the perimeter (km) and the total surface of this specfc CLC class level 3 in the whole case-study.

Figure 9-1. GIS presentation of CLC classes in Most-Ležáky Mine

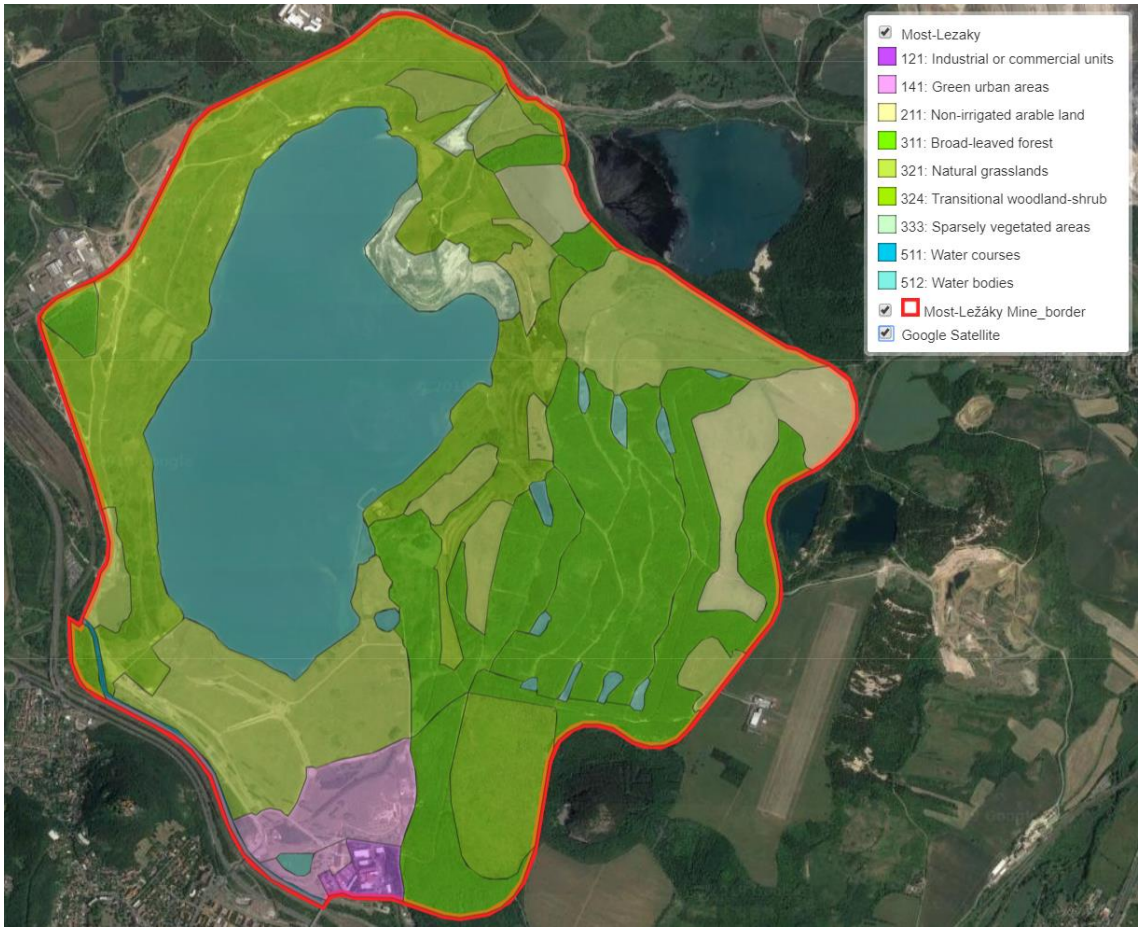

Figure 9-2. GIS presentation of CLC classes in Most-Ležáky over the orthoimage of the area

Figure 9-3. 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 Most-Ležáky Mine is the following (Bossard et al., 2000):

9.1 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.

9.1.1 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.

9.1.2 Green urban areas (141)

Areas with vegetation within urban fabric, includes parks and cemeteries with vegetation, and mansions and their grounds. This class includes cemeteries with important vegetation coverage.

Green urban areas concern all vegetated areas greater than 25 ha which are either situated within or in contact with urban fabrics. Greenery with strips of lanes and paths may be found within these areas created for recreational use.

9.2 Agricultural areas (Main class 2)

9.2.1 Non-irrigated arable land (211)

Cereals, legumes, fodder crops, root crops and fallow land. Includes flowers and fruit trees (nurseries cultivation) and vegetables, whether open field, under plastic or glass (includes market gardening). Includes aromatic, medicinal and culinary plants. Does not include permanent pastures.

This class includes flower, fruit trees (nurseries) and vegetable cultivation. Includes other annually harvested plants with more than 75 % of the area under a rotation system. Part of this class are the plots of arable land with area of several hectares reaching tens (hundreds) of ha.

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

9.3.1 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.

9.3.2 Natural grassland (321)

Low productivity grassland. Often situated in areas of rough, uneven ground. Frequently includes rocky areas, briars and heathland.

Natural grasslands are areas with herbaceous vegetation (maximum height is 150 cm and gramineous species are prevailing) which cover at least 75 % of the surface covered by vegetation which developed under a minimum human interference (not mowed, fertilized or stimulated by chemicals which might influence production of biomass); here belong for instance grass formations of protected areas, karstic areas, military training fields, etc. (even though the human interference cannot be altogether discarded in quoted areas, it does not suppress the natural development or species composition of the meadows), areas of shrub formations of scattered trees.

9.3.3 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.

9.3.4 Sparsely vegetated areas (333)

Includes steppes, tundra and badlands. Scattered high-altitude vegetation.

Scattered vegetation is composed of gramineous and/or ligneous and semi-ligneous

9.4 Water bodies (Main class 5)

9.4.1 Water courses (511)

Natural or artificial water-courses serving as water drainage channels. Includes canals. Minimum width for inclusion: 100 m.

9.4.2 Water bodies (512)

Natural or artificial stretches of water.

Conclussions and lessons learnt

In case-study areas Lake Most and Lake Milada, the boundaries of the areas on which the project activities will take place have been determined. Due to the fact that the localities have historically been mined by opencast mining and the surrounding area is well delimited by various spatial elements, it was relatively easy to define this area.

The area of Lake Milada covers an area of 1 457 ha and is bordered by the Northern, Eastern and Western slopes and in the south by the Žichlice dump. The territory of Lake Most covers an area of 1 234 ha and is bordered by Northern, Western, Střimice and South spoil heap slopes and the Assumption of Virgin Mary Church area.

On Lake Milada Maps of CORINE Land Cover 2018 show that the area is covered mainly by transitional woodland shrub, deciduous and mixed forests of water bodies, in the south by pastures and a complex cultivation pattern. On Lake Most they show that the area consists mainly of water bodies and pastures with small areas of broad-leaved forest and road and rail networks and associated land.

Subsequently, the results were obtained using the COPERNICUS Land Monitoring System (data from 2015). Sealed soil (imperviousness), tree cover density and forest type, grasslands, water and wetness, and NATURA 2000 were determined. On the territory of Lake Milada these data showed that the area is of natural character, without urban area, where a significant element in the landscape is itself Lake Milada. In addition to the retention reservoir, which is in close proximity to the lake, and to the lake, the area is covered with vegetation. The lake itself is located at the lowest point and to the south of the lake the altitude rises due to the dump. Data from Lake Most show that the area is on the one hand very similar to the area of Lake Milada, where the main element in the area is the lake itself and the surrounding slopes are covered with pastures and forests, with the difference that there is an urban area.

These data provided an overview and a lot of information about the area that will be used in mapping the ecosystems of areas of interest.

Manual mapping using QGIS 3.8 Zanzibar, Google Earth Pro and the CLC classification in Lake Milada found that it was relatively similar to data from the CORINE Land Cover 2018 map, but manual vectorization provided a more detailed and therefore more fragmented overview of the area. Especially in transition areas, this method was more precise. The territory of Lake Most differs quite significantly from the map CORINE Land Cover 2018 (Figure). Vectorization of the area revealed many discrepancies, but thanks to this method, a map was created that provides us with the necessary source of information.

The data obtained by means of CORINE Land Cover and COPERNICUS Land Monitoring and subsequent refinement by means of vectorization provided the necessary

information for the subsequent evaluation of the mapped land covers of areas of interest using ecosystem services.

10 Glossary

CLC - CORINE Land Cover

CORINE - Coordination of information on the environment

EEA - European Environment Agency

GIS - Geographic information system

PKÚ - Palivový kombinát Ústí, státní podnik

11 References

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