RFCS RESEARCH PROJECT

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

847205-RECOVERY-RFCS-2018

Deliverable 2.2

Baseline mapping of relevant ecosystems of Janina Mine Waste Heap

European Commission

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EXECUTIVE SUMMARY

Within this Deliverable, the baseline mapping of relevant ecosystems of Janina Heap was developed. The appropriate boundaries on existing spatial connectivity and functional cohesion of the coal mining-affected areas were base on administrative that correlated with extension of the negative impact of mining activity. In the case of Jania Mine the spatial range on air, water contamination, and landscape impact were analyzed. Base on these range of administrative units was set. The deliminated area of Libiąż district covers 5708 ha. The open sources of data were used for achieving high resolution maps of ecosystem types without time-consuming field research. It was possible thanks to the developing Copernicus Earth and OpenStreetMap. Spatial information provided by this program was assigned to appropriate CLC categories and used to refine CLC map. In compere with information base on CLC 2018 map, a refined map allow to identify of more ecosystem types, and a better estimation of each ecosystem type area was obtained. For underground mining activities map development high-resolution ecosystem types map is recommended for ecosystem services assessment.

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 desplying 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 2.2 will undergo the baseline mapping of the relevant ecosystems from Janina Mine Waste Heap, Poland (Tauron Wydobycie Janina Mine).

2 Janina Mine Waste Heap

The project goals focus on waste heap located on the south of the Janina Mine in Libiąż city, Southern Poland. Mine waste heap is an active underground coal mine property of Tauron Wydobycie S.A. (TWD). Waste heap covers an area of 75 hectares, reaching 35 m of height.

The Janina Mine Waste Heap is an example of significant pressure on the environment. Steep and high slope heaps, especially those formed recently and unsecured, are exposed to strong erosion, caused by runoff of rainwater and snowmelt. This processes are leading to the deterioration of strength parameters of both soil-forming and the subsoil itself, which led to plasticization of soils and displacement of clays in the foreground of the heap in its western part, entailing high financial costs and social problems which occurred in larger scale in 2016.

Practically all coal mining wastes, both disposed and reused, are being exposed to the atmospheric conditions. Thus, the safe waste management requires evaluation of their long-term environmental pollution potential pertain to the content of constituents susceptible to mobilization and leaching, and in particular to occurrence in the waste rock of geochemically instable sulfides (mostly FeS_2 – pyrite, marcasite) resulting in Acid Rock Drainage (ARD) generation. Acid leachate is formed when rainwater contacts a surface layer of mining waste rich in sulphide minerals, mainly pyrite. This pose a potential threat to the natural environment, especially the surface and groundwater environment. The resultant ARD generation potential depends on the neutralizing potential of waste rock materials due to presence of sufficient amounts of carbonates that is often expressed as the Neutralization Potential Ratio NPR =NP/AP, where NP is the Neutralization Potential and AP is the Acid Potential. Leachate from mining waste that is close to neutral or alkaline Neutral Rock Drainage (NRD) may also have high pollution potential e.g. due to the elevated salinity. European extractive industries, including Polish mining, are now legally obliged to prevent or minimize any adverse effects on the environment and health risks resulting from the waste management. The physicochemical properties of the stored waste do not favour the spontaneous succession of vegetation, as well as water purification processes. Dust arising on the green area of the mining waste heap, generates another pressure on the environment. It is particularly burdensome for the local community during dry periods. There are currently no works related to landfilling at the facility (Figure 2-1). In the future, the next stage related to the development of the facility by the Janina Mining Plant will be its reclamation resulting from the provisions contained in the construction design and the Mining Waste Act.

Figure 2-1. Janina Mine Waste Heap – drone photo

3 Identifying the appropriate boundaries for the case-study area

Janina Mine Waste Heap is located in the area of lowland with rare altitudes. Topography and relief limit the baseline boundaries and for setting them appropriate in the mine affected areas, where the impact of the planned activities may produce changes in forms of land use, is very challengeable. Moreover, many aspects of mining activity, social and environmental factors were taken into consideration to set the boundaries of case study area to define further potential of ecosystem services, monetary values of this services as well as aspects of spatial planning. In result the following aspects were considered:

- Air protection – zone contaminated by suspended dust (particulate matter PM10) from site.
- Water protection – zone affected by acid drainage waters.
- Landscape - visibility of waste heap and it impact on landscape.
- Cultural services–recreation function for local community

The area selected for ecosystem services assessment of the Janina Mine Waste Heap revitalization is presented in Figure 3-1, and it covers an area of 5707 ha.

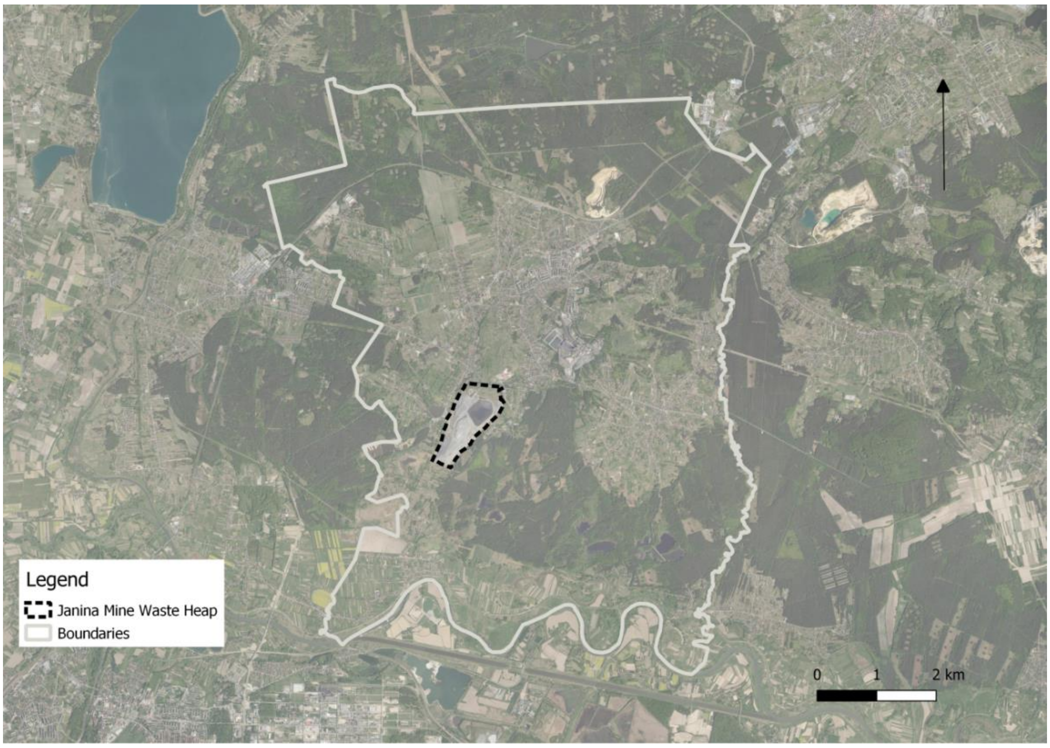

Figure 3-1. Boundaries of the Janina mine waste heap case-study

Air protection

During gusts of wind and dry periods, spreading of suspended dust results in VOC concentrations which was identified in the air (by PM10 detector on UAV) (Figure 3-2). Air contaminants reach only the houses located in near vicinity of the study site (Figure 3-3).

Figure 3-2. Devices for of air pollution measurement

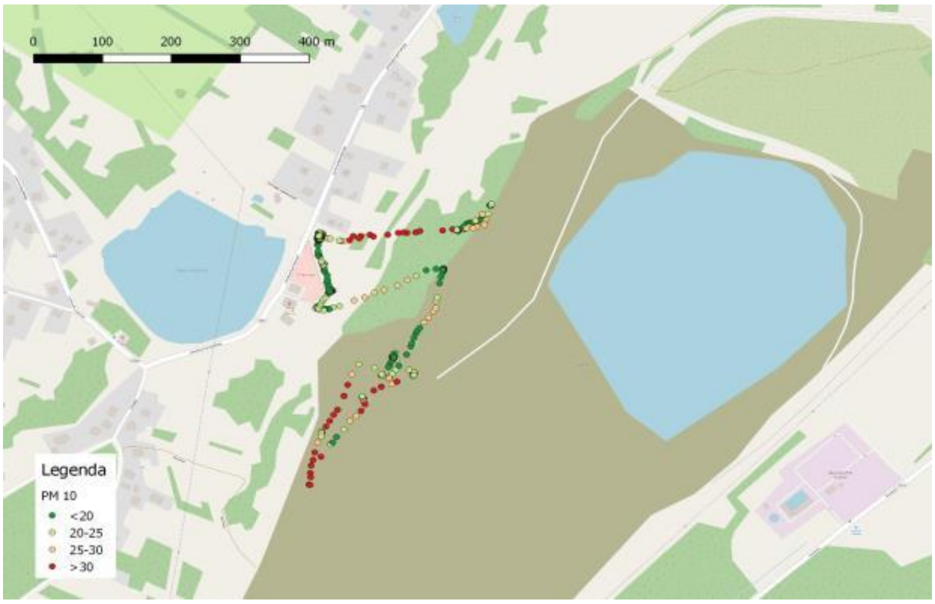

Figure 3-3. Measurement of air pollution spreading from Janina Mine Waste Heap

Water protection

Rock drainage from waste heap in general impact underground and surface waters. In coal mining waste management practice, the major source of a water deterioration appears to be the high sulfate salinity accompanied with high Mn and (under anoxic conditions) also high Fe release, independently on the susceptibility of a material to acidification (Figure 3-4). Therefore, groundwater protection measures should be undertaken both with respect to ARD and NRD generating waste, in case of their disposal and bulk reuse in engineering constructions. In Janina mine waste heap occurring of Al is also noted in the monitoring of groundwater status.

Figure 3-4. Janina Mine Waste Heap – acid rock drainage generation

Bulk coal mining waste re-use for residual coal extraction and as a common fill in engineering constructions results in the disturbance of primary formed hydrogeochemical conditions in re-deposited wastes. Due to the increase of the exposed surface, and application of the additional portions of water in the residual coal extraction process, an intensification of contaminant generation and leaching both: at waste re-disposal after coal extraction, and at its re-use for engineering constructions, has been observed.

An underwater disposal of coal mining wastes, although considered environmentally safe, causes temporary adverse impact on the groundwater chemical status pertain to release of contaminant loads occurring in the material at the moment of waterlogging. The water level decline below the waste surface also should be strictly controlled to avoid groundwater deterioration.

The presented examples confirm the need for efficient "cradle-to-grave" protection measures in any case of sulfidic coal mining waste disposal and re-use.

Acid rock drainage is observed in the process of formulation of surface runoff in the *first flush* phenomena during atmospheric precipitation especially heavy rains. The surface acidify water outflows to the ditches and is directed to the treatment system PAAPS (periodically acting alkanity producing system). This system is an effective solution for acid water buffering and reduction of heavy metal concentration. However, treated surface runoff waters are still saline which is further observed in local reservoir in mine subsidence area and Gromiecki stream – which is the recipient of the pumping system from local depression. Increased salinity below the discharge point in Gromnicki stream is observed, which is the local impact defined within the borders in case study of concern.

Observed changes of near surface underground water chemistry (physico-chemical status) mostly relate to pH, sulphates and metals. Underground waters connection with ecosystems (flora and fauna) in mine impacted area is defined only in the direct vicinity of case study area. Regional direction of groundwater flow is mostly related to drainage basin of large Wisla river. Long lasting mine drainage due to underground coal exploitation caused regional cone of depression and deterioration of groundwater resources. Impact of waste heap of Janina mine is limited only to local scale and no significant pressure to groundwater bodies are observed.

Borderline of waste heap impact on groundwater and surface water was included into formerly identified boundaries of high resolution map of ecosystem services (Figure 3-6).

Landscape - visibility zone for people.

The impact of Waste Heap on local landscape was evaluated on the basis of field observation. High percentage of tree cover area and rather flat relief results that the spoil heap of Janina mine is visible from near vicinity and from hills located in the north of the site (Figure 3-5).

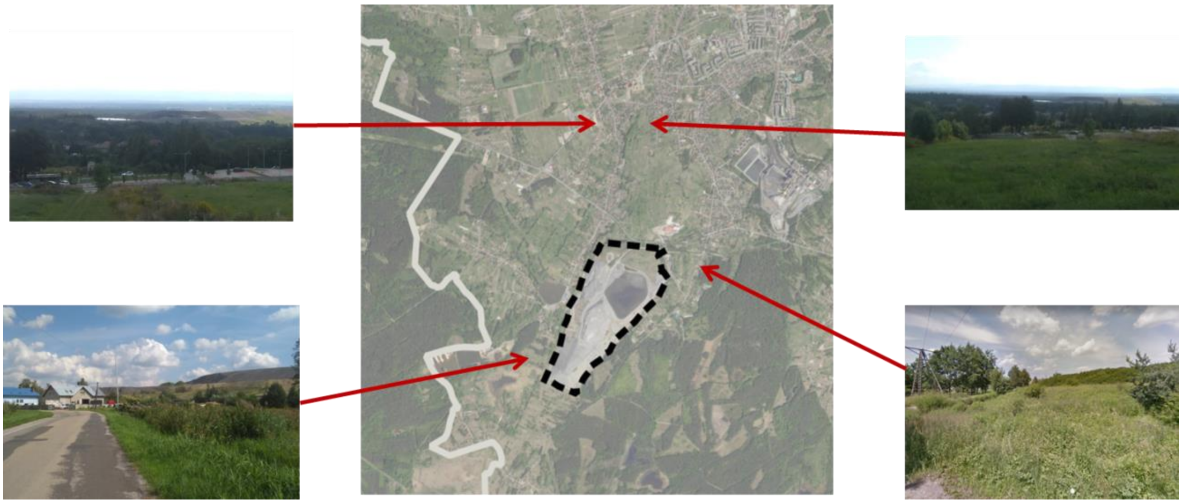

Figure 3-5. Visibility of Janina Mine Waste Heap

Cultural services–recreation function for local community

The boundaries of administrative units are most often used for cultural ecosystem services assessment. Collecting socio-economic data for administrative units is much easier. These approach allows to use results by decision-makers (urban planning, environmental protection offices). The adopted assumptions correspond with the methods used by other researchers in the process of assessing the ecosystem services provided by the covered areas. The main conclusions of the "*desk-research*" analysis, as well as relevant issues covered in the process of determining the boundaries of areas are presented in the table below.

Table 1. Selection of study area boundaries – "desk research"

References	Area boundaries for which ecosystem services were estimated	Conclusions and findings
Rodríquez-Rodríquez, D., Kain, J.H., Haase, D., Baró F. & Kaczorowska A., (2015). Urban self-sufficiency through optimised ecosystem service demand. An utopian perspective from	city-scale/ urban-scale	Providing city-scale statistics on ecosystem services demand provides a meaningful spatial scale for policy making and urban ecosystem management.
		Compact urban settings may make it possible to reduce the ecological footprint through environmental economies of scale reduced per

References	Area boundaries for which ecosystem services were estimated	Conclusions and findings
European cities. Futures, 70, 13-25.		head resource requirements, easier accessibility and communication, and collaboration.
Haase, D., Haase, A., Rink, D. & Quanz, J. (2019). Shrinking Cities and Ecosystem Services: opportunities, Planning, Challenges, and Risks. M. Schröter et al. (eds.),,Atlas of Ecosystem Services., 271-277	city-scale / „re-use „of degraded areas	Urban shrinkage implies dramatic land-use impacts, including under-utilization, vacancy, demolition, emerging brownfield sites, and de-densification.
		„Shrinkage also offers great potential to "re-create" —that is, to enhance and implement — urban green space, including the ecosystem services it provides (Local climate and air quality regulation by trees that grow on abandoned land, carbon sequestration and storage by vegetation on vacant lots, preservation or enhancement of urban biodiversity, and recreational facilities that support the mental and physical health of the inhabitants through the enlargement of parks and woodlands)"
Boćkowski, M. & Rogowski, W. (2018). Valuation of ecosystem services and their application in economic calculation: Practical examples of managing natural resources. Studia i Prace Kolegium Zarządzania i Finansów/SGH Warsaw School of Economics, 167, 37-64 [in Polish].	---	Valuation of ecosystem services is a process that requires many stakeholders between different administrative levels and scales: spatial, temporal and ecological.
Larondelle, N., Haase, D. & Kabisch, N. (2014). Mapping the diversity of regulating ecosystem services in European cities. Global Environmental Changes, 26, 119-129.	City scale	Cities are more than their administrative boundaries as they are ecologically, economically and socially connected to their hinterland, and urban dwellers often use the green and blue spaces in their surroundings. Cities are connected to their hinterland through flows of people (commuting and transport),

References	Area boundaries for which ecosystem services were estimated	Conclusions and findings
		materials (food and water), energy and other goods.

The arguments presented in the table above confirm the correctness of the adopted assumptions, according to which designating the boundaries of the study area along the administrative boundaries of the city enables to proceed the ecosystem services evaluation taking into account all factors and interactions between the analyzed and directly adjacent areas.

Finally the adequate boundaries was set on the administrative units that include all identified negative environmental impacts of Janina mine waste heap. The extent of ecosystem type map are defined by the border of Libiąż district, including rural and urban area (Figure 3-6).

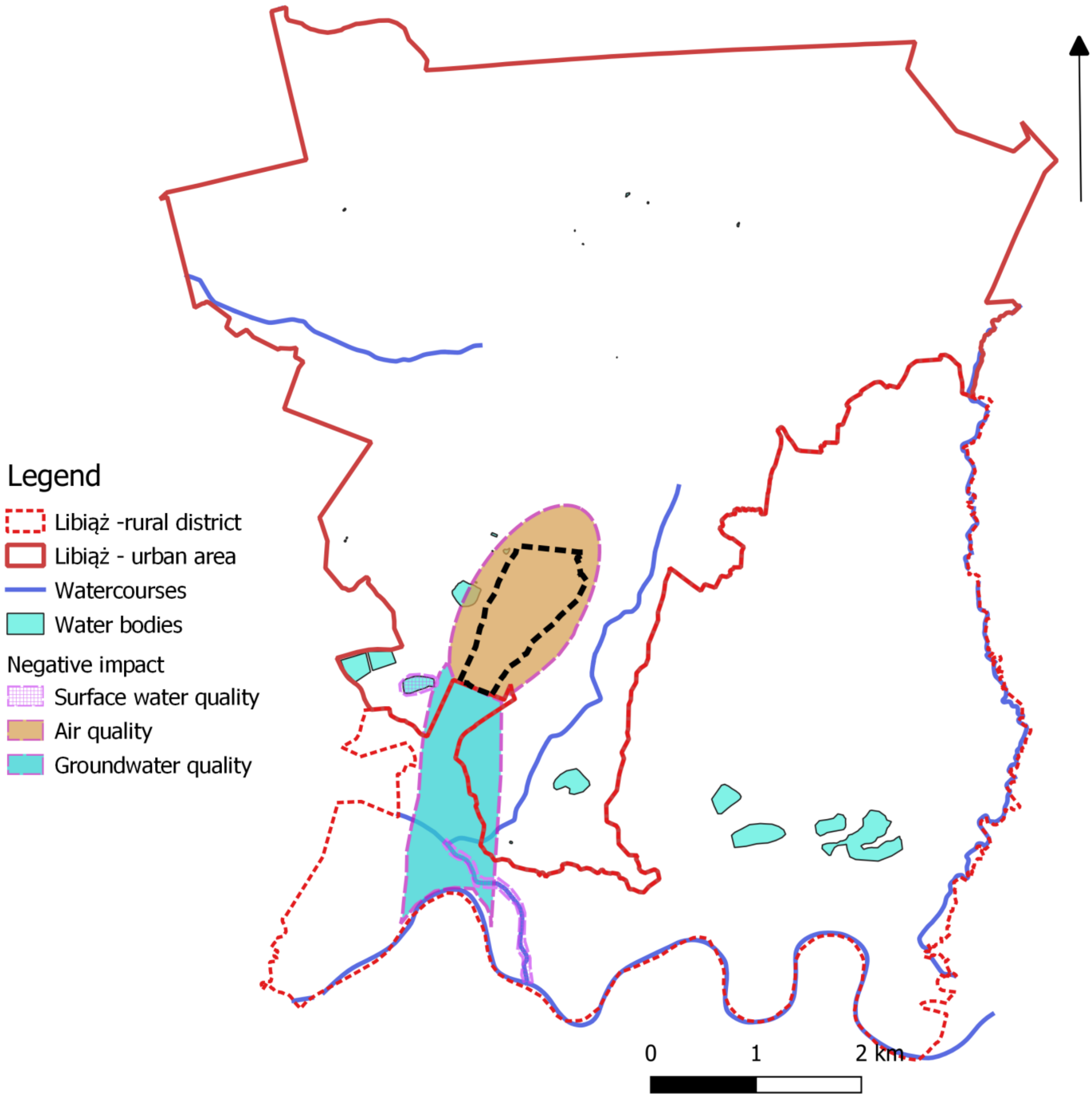

Figure 3-6. Boundaries of the Janina mine waste heap case-study in relation to them negative environmental impact

4 Geospatial Data Available

A revision of the European and Polish online geospatial data that was available for Janina Mine area was developed.

4.1 CORINE Land Cover 2018

The information was obtained from the following Polish sites:

- http://clc.gios.gov.pl/index.php/geoportal, a WPS (web map server) for visualization.
- http://clc.gios.gov.pl/index.php/clc-2018/udostepnianie, a downloading centre from the Chief Inspectorate Of Environmental Protection

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

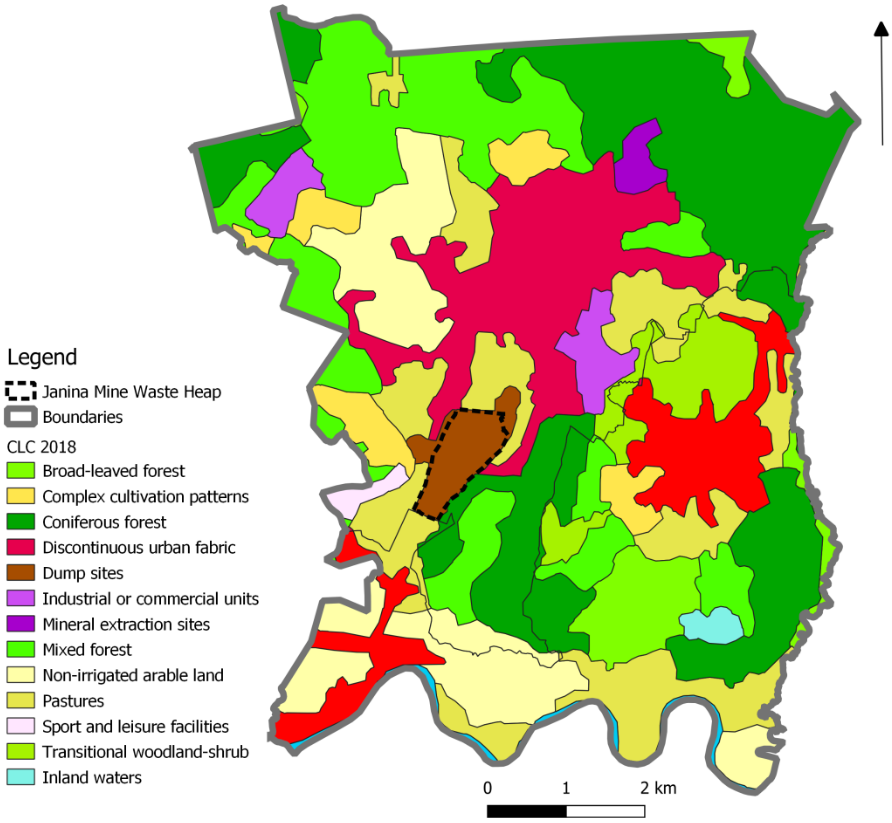

Figure 4-1. CORINE Land Cover 2018

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.

Corine Land Cover map is in too low resolution for Recovery project goals. Conducting field reaserch for refinement CLC map will require much effort and enourmous time. The open sources of high resolution land cover date for refinement CLC map :

- Copernicus Land Monitoring Service – High Resolution Layers 2015 (Tree cover area, Grassland, Water and Wetness);
- OpenStreetMap Landcover (plugin QuickOSM for QGIS).

4.2 COPERNICUS Land Monitoring System

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

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 4-2 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. The information was used to refinement of discontinuous urban fabric CLC layer (cover classes)

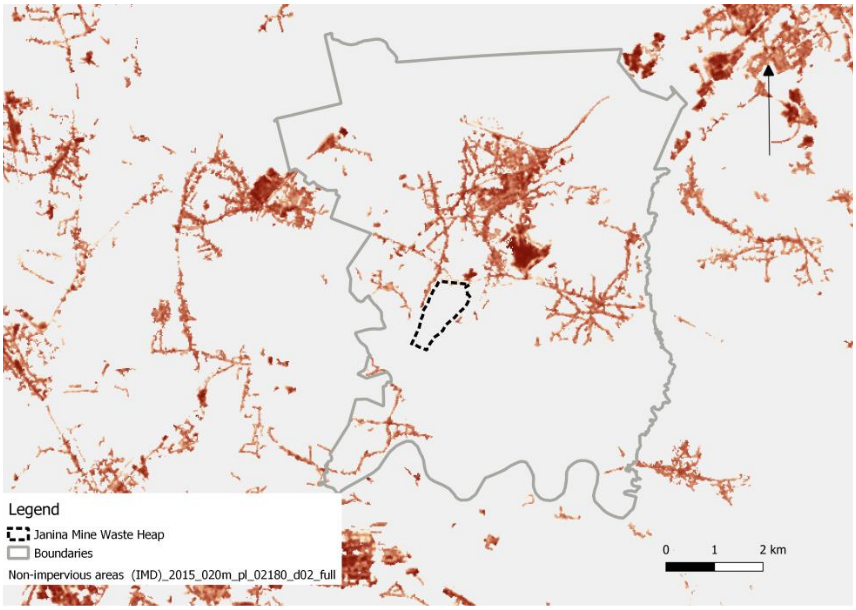

Figure 4-2. COPERNICUS Imperviousness 2015

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.

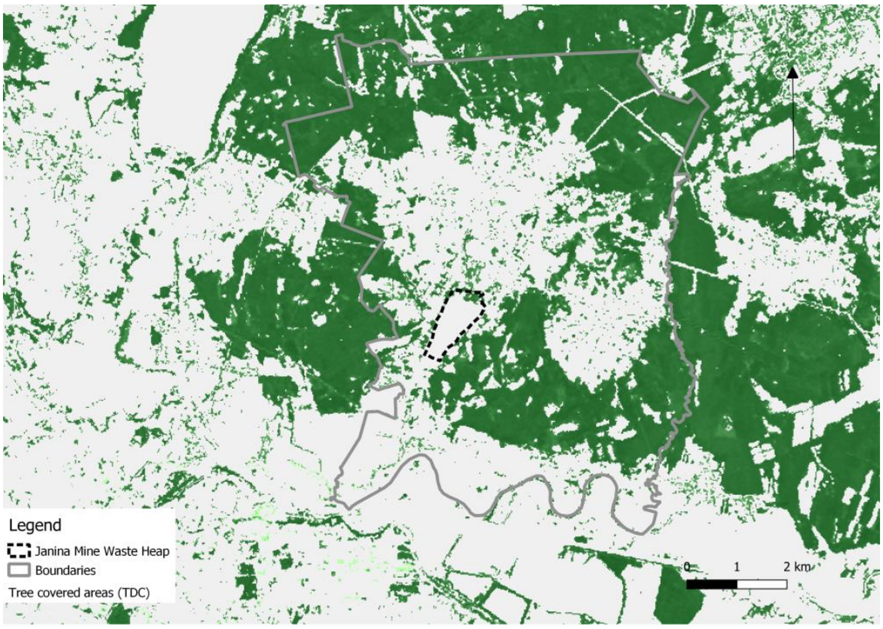

Figure 4-3. COPERNICUS Tree Cover Density 2015

Figure 4-4 presents the tree cover layer with two categories: broadleaved forest in light green and coniferous forest in dark green. White color represents non-forest areas. This information is used to refinement of CLC layers: broad-leaved forestand and coniferous forest.

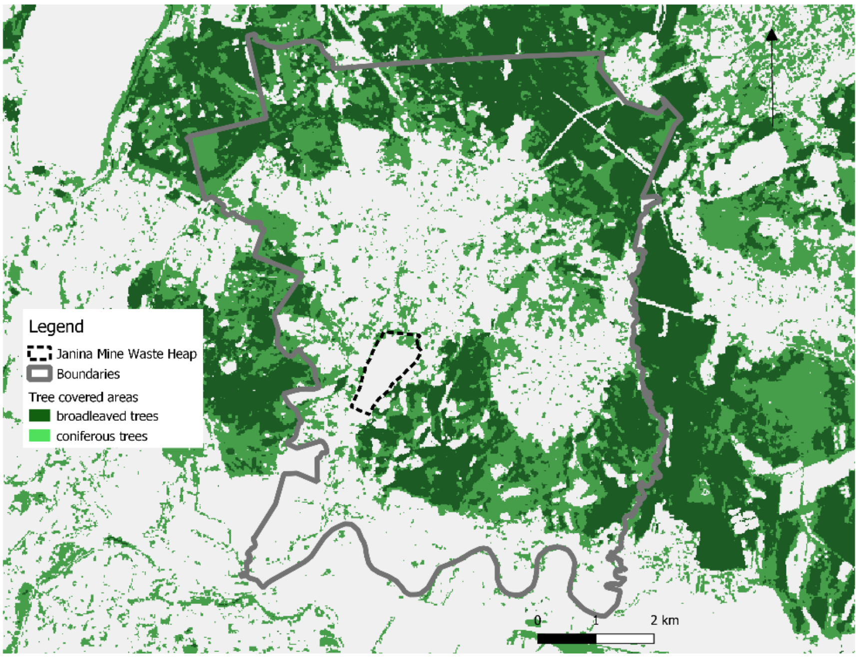

Figure 4-4. COPERNICUS Forest Type 2015

Figure 4-5 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 permanent water, temporary water, permanent wetness and temporary wetness. This information is used to refinement of water bodies CLC layers.

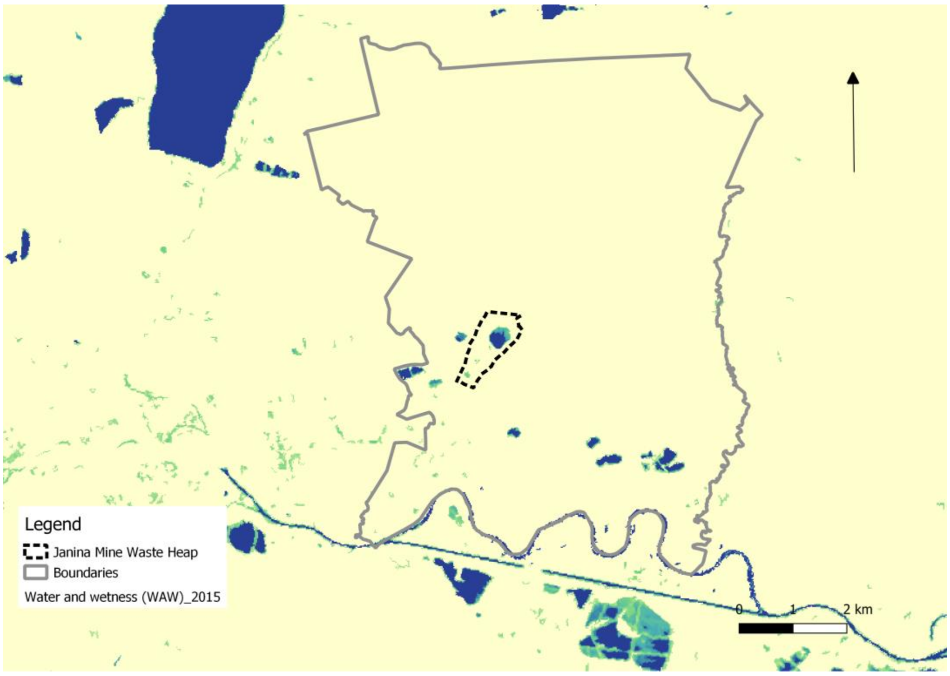

Figure 4-5. COPERNICUS Water and Wetness 2015

The Copernicus 2015 year grassland product doesn't indicate grassy and non-woody vegetation in area if Libiąż district.

There is no Natura 2000 network areas in the vicinity of Janina mine waste heap.

4.3 Open Street Map Landcover

The map provides worldwide Landuse/Landcover information on the basis of OpenStreetMap (OSM) data. Data is provided globally in an automated way. Information was obtained by QuickOSM plugin for QGIS software.

Web map server for visualization is available on:
https://osmlanduse.org/#14/19.31215/50.08129/0

The types of OSM land cover were assignment to CLC categories (Table 2). The information from OSM Land Cover allow to refinement of 6 layers (covers classes) of CLC map (Figure 4-6).

Table 2. Assignment of OSM land cover types to CLC categories

Sources	Landcover	Corine Land Cover classes	Code
OSM LAND USE	Allotments	Complex cultivation patterns	242
OSM LAND USE	Meadow	Pastures	231
OSM LAND USE	Grassland	Natural grassland	321
OSM LAND USE	Scrub	Transitional woodland shrub	324
OSM LAND USE	Farmland	Non-irrigated arable land	211
OSM LAND USE	Industrial	Industrial or commercial units	121
OSM LAND USE	Grass	Green urban area	141

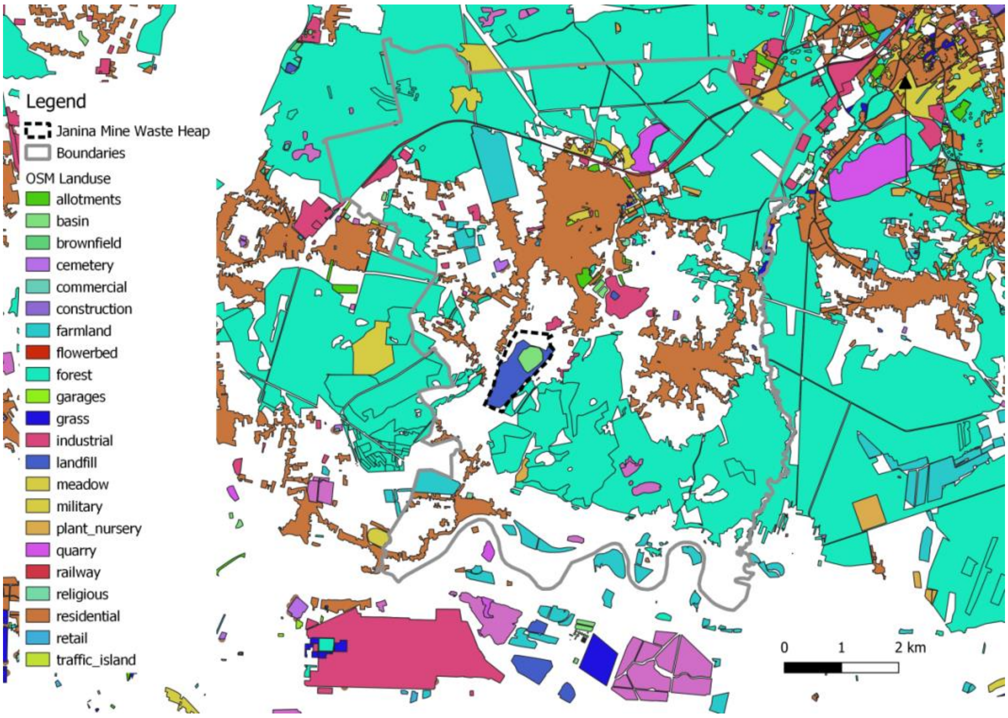

Figure 4-6. OpenStreetMap Landcover

4.4 COPERNICUS imagery and reference data

Other intermediate products coming from COPERNICUS are the European Digital Elevation Model that is presented in Figure 4-7. The EU-DEM is a 3D raster dataset with elevations captured at 1 arc second postings (2.78E-4 degrees) or about every 30 metre.

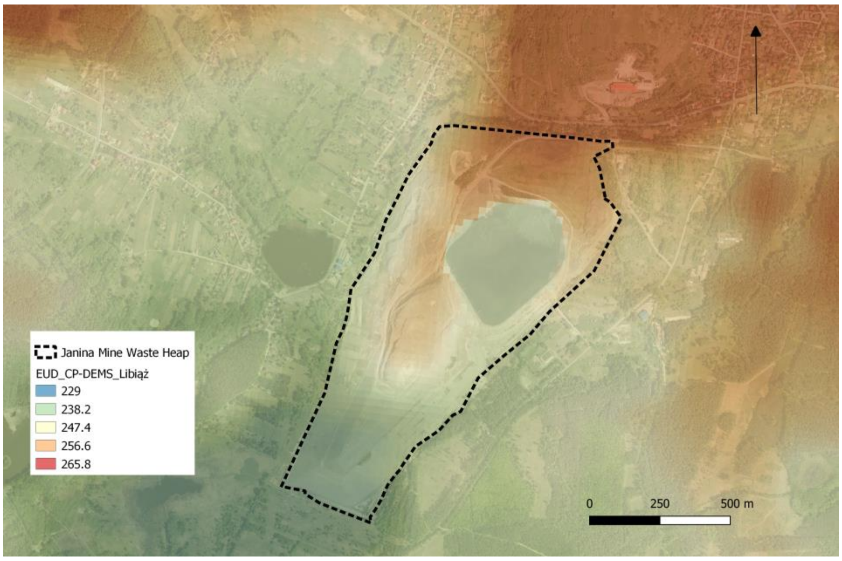

Figure 4-7. European Digital Elevation Model (EU-DEM) of Janina Mine Waste Heap

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 4-8).

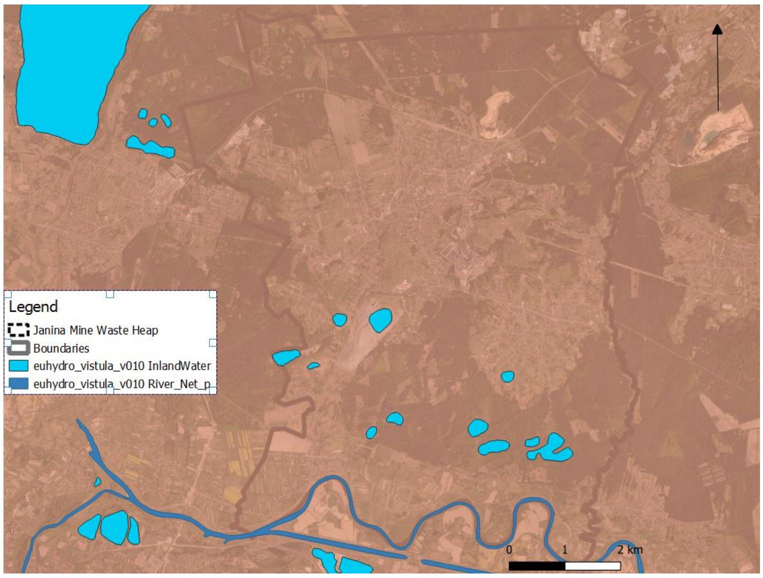

Figure 4-8. EU-Hydro - River Network Database

Finally, a cloud-free HR corresponding to the vegetation season in 2014-2015, representing in false colour the vegetative zone (Figure 4-9).

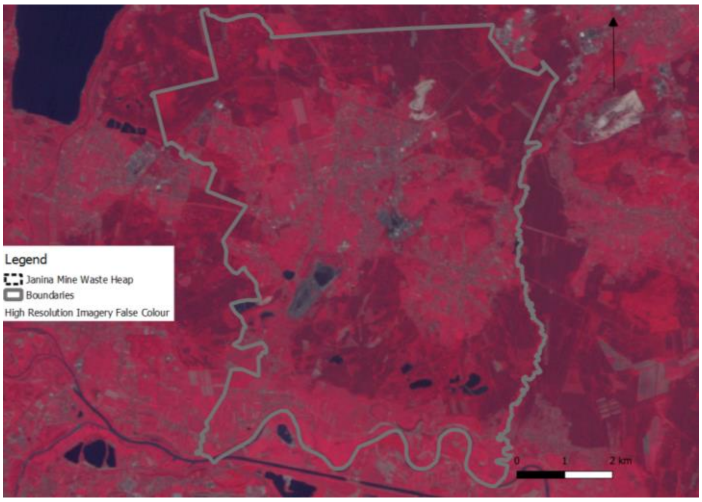

Figure 4-9. High Resolution Imagery False Colour 2015

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/).

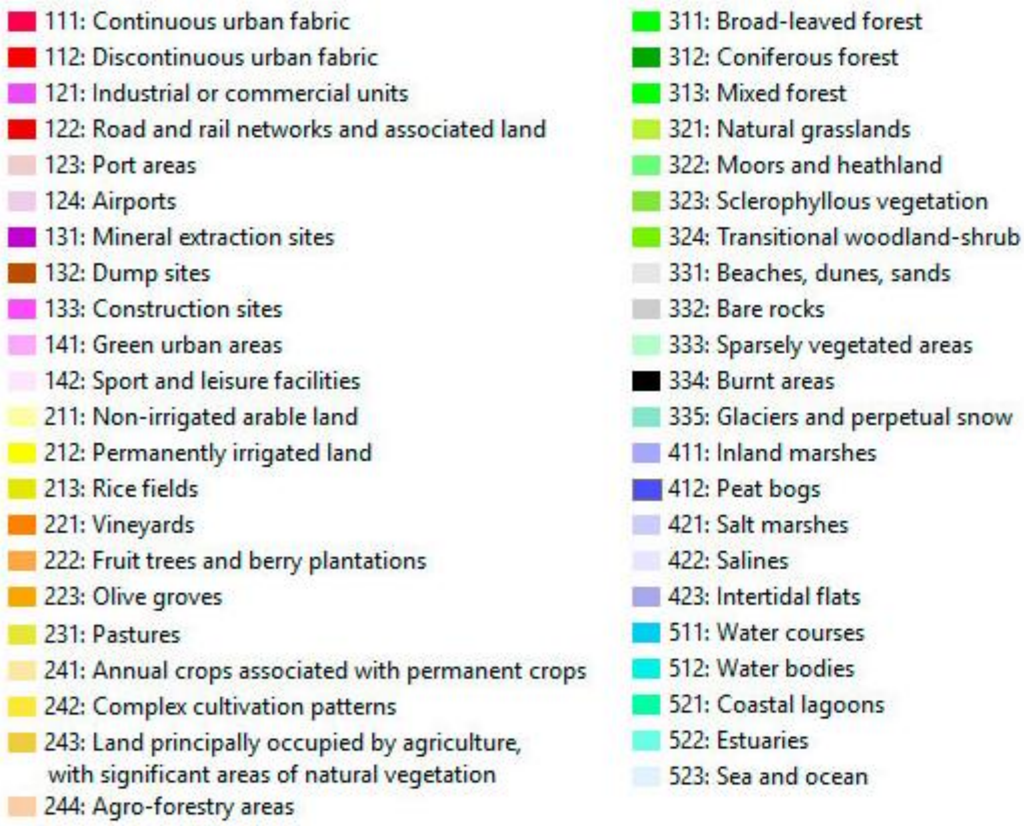

Figure 5-2. CORINE Land Cover pantone

Figure 5-3 presents the high resolution map of Libiąż ecosystem types that was developed with QGIS 3.4.9-Madeira.The next figure, presents the same map but over imposed to the orthoimage of the area (Figure 5-4).

Finally, Figure 5-5 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.

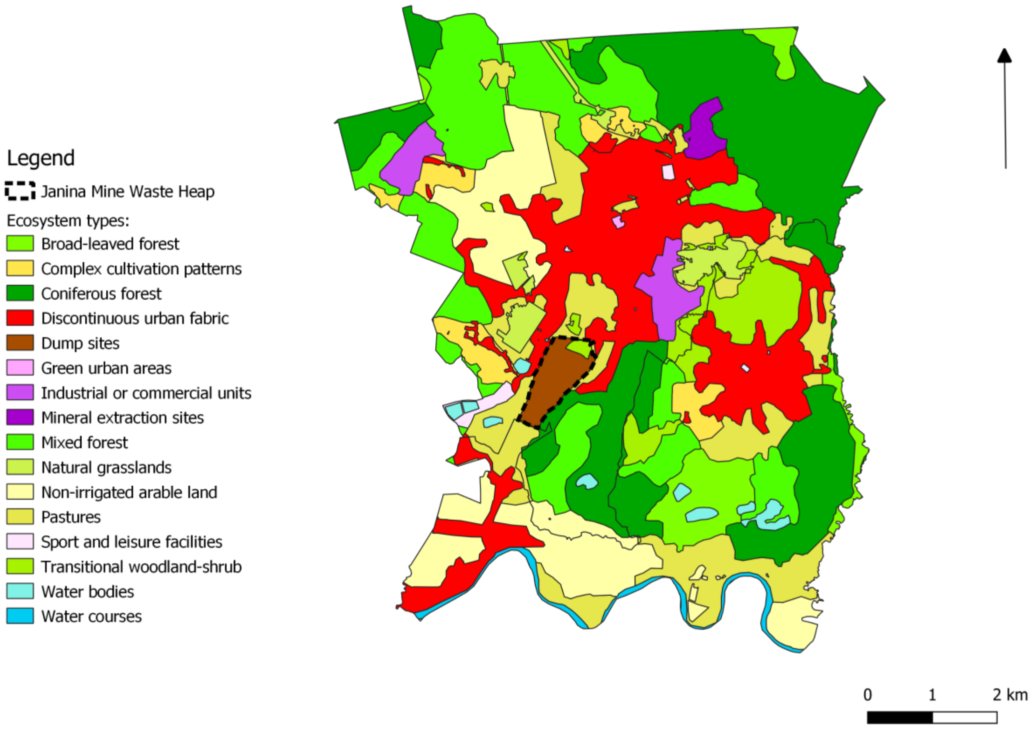

Figure 5-3. GIS presentation of CLC classes in Libiąż district

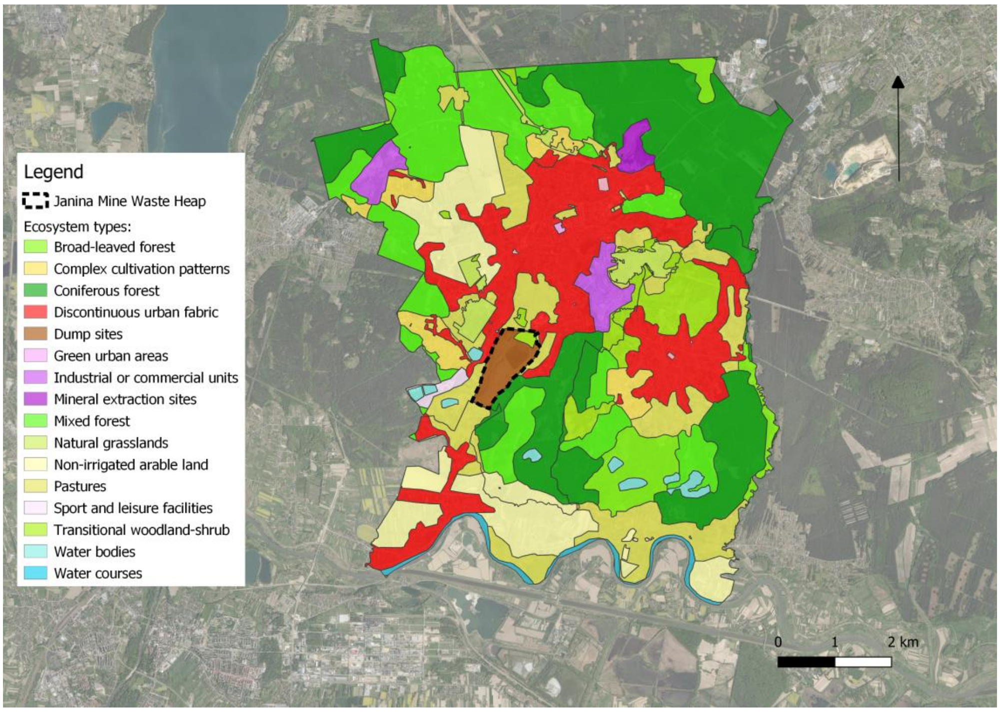

Figure 5-4. GIS presentation of CLC classes in Libiąż district over the orthoimage of the area

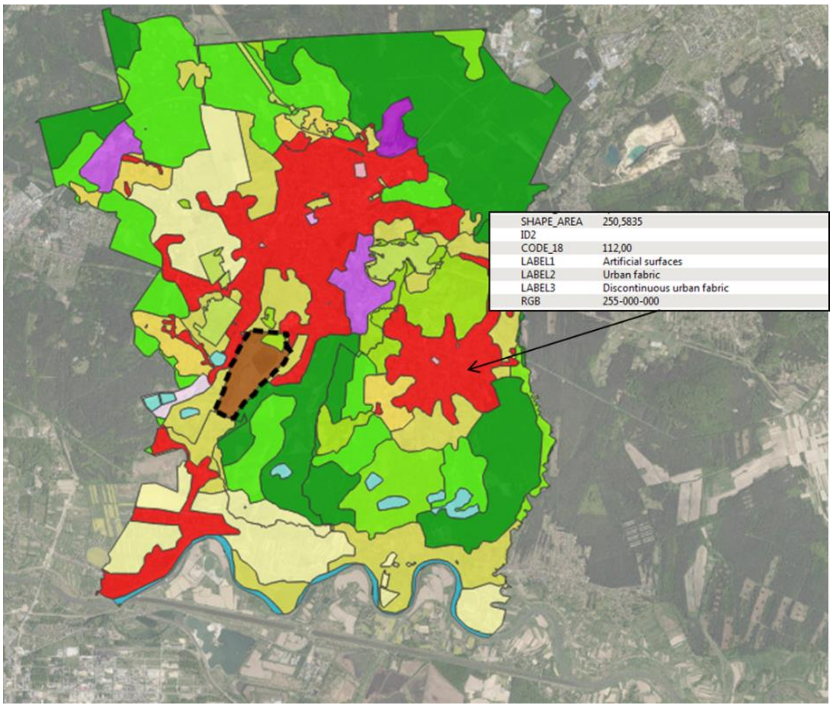

Figure 5-5. Polygon description in the GIS

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

The explanation of the different CLC classes used in Libiąż district 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 Industrial or commercial units (121)

Buildings, other built-up structures and artificial surfaces (with concrete, asphalt, tarmacadam, or stabilised like e.g. beaten earth) occupy most of the area. It can also contain vegetation (most likely grass) or other non-sealed surfaces.

This class is assigned for land units that are under industrial or commercial use or serve for public service facilities.

5.1.3 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.

5.1.4 Mineral extraction sites (131)

Areas with open-pit extraction of construction material (sandpits, quarries) or other minerals (opencast mines). Includes flooded gravel pits, except for riverbed extraction.

This class includes flooded gravel pits surface of which is less than 25 ha and temporary mining pools.

5.1.5 Dump sites (132)

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

5.1.6 Sport and leisure facilities

Camping grounds, sports grounds, leisure parks, golf courses, racecourses etc. belong to this class, as well as formal parks not surrounded by urban areas. Areas of any land cover type can belong to this class if the purpose and use of it is sport, leisure or recreation.

This class is assigned for areas used for sports, leisure and recreation purposes.

5.2 Agricultural areas (Main class 2)

5.2.1 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.

5.2.2 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.

5.2.3 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.

5.3 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.

The predominant classifying parameter for this class is a crown cover density of > 30 % or a minimum 500 subjects/ha density, with coniferous trees representing > 75 % of the formation. The minimum tree height is 5 m (with the exception of Christmas tree plantations).

5.3.3 Mixed forest (313)

Vegetation formation composed principally of trees, including shrub and bush understorey, where neither broad-leaved nor coniferous species predominate.

Mixed forests with a crown cover of > 30 % or a 500 subjects/ha density for plantation structure. The share of both coniferous and broad-leaved species exceeds 25 % within the canopy closure. The minimum tree height is 5 m.

5.3.4 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.

5.3.5 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 courses (511)

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

5.4.2 Water bodies (512)

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

This class is applicable for: natural freshwater and inland salt water lakes; water reservoirs, areas of water retention; archipelago of lakes inland; fish ponds, water surfaces used for freshwater fish-breeding activities; disused mineral extraction pits filled with water; fish ponds and water reservoirs temporarily without water (seasonal lack of water, maintenance, etc.), given that the area is most of the year covered by water.

6 Three-dimensional view

Finally, Figure 6-1 presents a 3D image of the study area with the CLC classes over impressed.

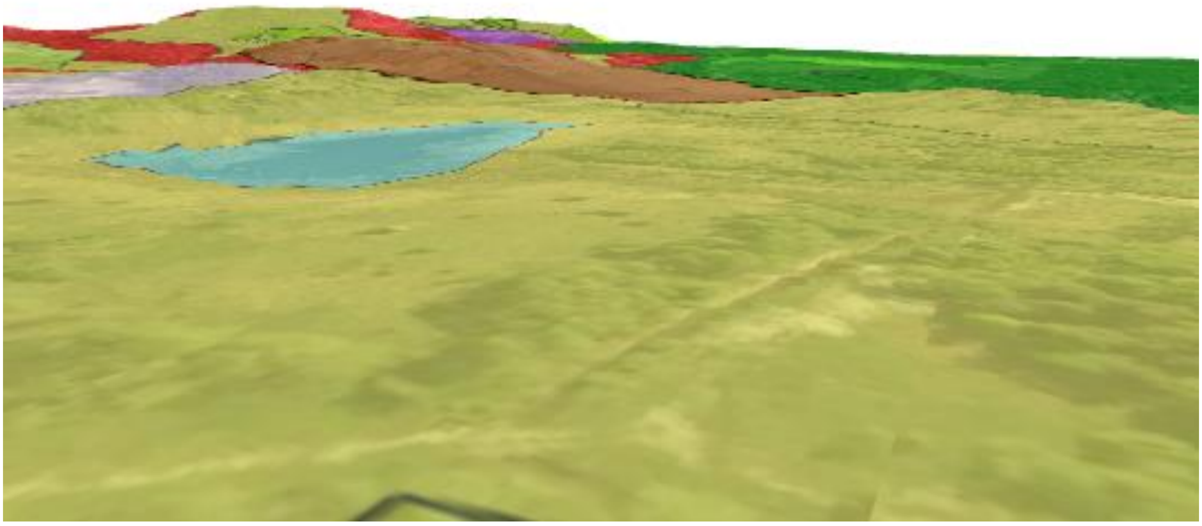

Figure 6-1. 3D image of the CLC classes

7 CONCLUSIONS AND LESSONS LEARNT

The identification of the environmental pressure of post-mining area was the first step of appropriate boundaries setting. In the case of Jania Mine the spatial range on air, water contamination, and landscape impact were analyzed. Base on these range of administrative units was set.

The HRLs are produced from satellite imagery through automatic processing and classification and provided information about percentage soil sealing, tree cover, and occurrence of water and wet surfaces. In the frame of the task, this spatial information was assigned to appropriate CLC categories and used to refine CLC map. The valuable source of land cover is also a project developing by OpenStreetMap. It is an international not-for-profit organization that provided worldwide Landuse/Landcover information. The OSM land cover has a different classification that CLC map. Before using this data assignment to CLC categories map have to be carried out.

In compare with information base on CLC 2018 map, a refined map allow to identify of more ecosystem types, and a better estimation of each ecosystem type area was obtained. Base on this approach e.q. the subsidence reservoirs were identified. These are valuable ecosystems that are formed as a result of underground mining activity and have a significant impact on ecosystem services potential. For this reason approach base on ecosystem types high-resolution map development is recommended for ecosystem services assessment. It is especially important in the case of underground mining activities where the range of spatial transformation is not so wide as in open-cost mining.

The lessons relevant to RECOVERY from the baseline mapping of relevant ecosystems of Janina Mine can be summarised as follows:

1. Use the ecosystem services assessment concept for mine impacted area assessment is the subject of ongoing research. The presenting approach especially concerns setting appropriate boundaries the coal mining-affected area was developed for local specific circumstances. Apply them to other studies, firstly need to carry out verification and make a decision if using the following approach is justified for analyzed study case.
2. Identifying the appropriate boundaries on existing spatial connectivity and functional cohesion of the coal mining-affected areas is difficult to carry out, needs a specific and dedicated approach. Setting boundaries base on administrative units is most often used for ecosystem services assessment.

2. Collecting socio-economic data for administrative units, in this case, is much easier, and this approach allows using results by decision-makers in the area of urban planning and environmental protection issues.

3. For developed for Janina Mine case study approach, the selection of administrative units for baseline mapping was correlated with extension of the negative impact of mining activity.
4. In the case of Janina Mine detailed mapping of different ecosystems types of land covers for delineate area shows that there are accessible open sources of data that allow for achieving high resolution maps of ecosystem types without time-consuming field research. It is possible thanks to the developing Copernicus Earth observation program realized by European Space Agency. In the frame of the work, the Pan-European High-Resolution Layers (HRL) were used, which allowed for detailed assessment of parameters in the evaluation of ecosystem assessment approach.

8 Glossary

CLC - CORINE Land Cover

CORINE - Coordination of information on the environment

EEA - European Environment Agency

GIS - Geographic information system

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