

DELIVERABLE D.T3.1.1.

ASSESSMENT OF SOIL AND CLIMATE CONDITIONS FOR 4 SMALL SPOTS WITH RECOMMENDATION OF PLANTS

Chorzów

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Introduction

Pilot actions in functional urban areas will consist of the implementation of four interventions in the framework of green and blue infrastructure in 4 small spots. These will be located in 4 FUAs which differ in scale, climate conditions, history, culture and development priorities. Therefore the experience from pilots will be valuable in showing solutions as a part of the urban environmental acupuncture approach supporting integrated environmental management in the scope of urban area. This document summarizes the characteristics of 4 small spots in Chorzów city including laboratory examinations of soil and analysis of climate conditions. Based on soil and climate characteristics planting of native or climate-resistant plants will be proposed.

1. General information about the city

Chorzów is a city with a county status, located in the center of the Upper Silesia Industrial Region, Poland. The city plays the role of an important center of the energy, metallurgy, machine, chemical, commercial and service industries.

In terms of physical and geographical distribution, Chorzów is located in the Polish Upland province and the Silesian Upland macro-region. The city area is located within the boundaries of the Katowice Upland mesoregion, within the so-called Bytom-Katowice Plateau. Contemporary terrain is a reflection of intensive urbanization and industry, especially mining. The hydrographic network, soil properties, and composition, as well as plant cover, were changed. Around the coal mines, a range of gangue and processing waste dumps were created. There are also depressions on the surface of the land, resulting from land denivelation as a result of many years of underground mining of coal seams.

Chorzów is located in the Vistula and partly Odra basin. It occurs in the water region of the Little Vistula, in the catchment area of the Rawa River, which is a tributary of Brynica. The natural system of the city of Chorzów is areas of urban greenery arranged and unorganized as well as watercourses and reservoirs. The functioning of biologically active areas in the city is associated with the degree of soil sealing, which due to intensive industrialization processes and the accompanying urbanization is high.

The number of inhabitants of Chorzów at the end of 2017 was 100 059. In terms of the number of inhabitants, Chorzów is the 36th city of Poland. The city is characterized by one of the highest population density indexes in Poland, amounting to 3,279.8 people / 1km², with the average in the region 372.9 people / 1km².



2. Climatic condition

The climatic conditions for the city are described as temperate. Mean, max and min temperature, as well as the sum of precipitation, are presented in Table 1.

Table 1. Basic climatic parameters for Chorzów city

	Mean temperaure (° C)	Min. temperature (° C)	Max. temperature (° C)	Rainfall (mm)
Jan	-3.5	-6.5	-0.5	35
Feb	-2.1	-5.4	1.2	32
Mar	3.3	-0.7	7.3	36
Apr	9	4	14.1	47
May	13.2	7.8	18.7	77
Jun	16.8	11.5	22.1	93
Jul	18.7	13.3	24.2	96
Aug	18.1	12.7	23.6	85
Sep	14.3	9.3	19.3	58
Oct	9.8	5.3	14.3	43
Nov	3.8	0.9	6.8	45
Dec	-0.7	-3.2	1.9	42

The rainfall in Chorzów is significant, with precipitation even during the driest month. The climate in this area has been classified as Dfb according to the Köppen-Geiger system. The average temperature in Chorzów is 8.4°C. The average annual sum of precipitation is 689 mm. The driest month is February, with 32 mm of rain. In July, rainfall reaches a peak, with an average of 96 mm. July is the warmest month of the year. The average temperature in July is 18.7°C. At -3.5°C on average, January is the coldest month of the year.

3. Description of the area of intervention, including results of soil analyses

3.1. Sampling and samples analyses methodology

- collected using a split tube soil sampler or garden shovel
- soil was taken from the depth 0-20 cm
- five representative soil samples were taken, location of the sampling points was determined on the base of detailed plan, depend on the area shape and size
- separate five soil samples from each investment area were labelled (i.e.):

A) sample No. 1 (No. from 1 to 5)

B) date of the sampling : 07.06.2019

C) investment place: Chorzów -Ch/1 (Bankowa St.)

- weight of the each of the soil sample was at least 500 g of fresh weight
- each of the taken sample got own GPS coordinates
- collected soil was putted into plastic sample bag.

Physicochemical soil characteristics such as pH and electrical conductivity were measured according to standardized methods. The pH was determined in H₂O and 1M KCl (ratio 1:2.5 m/v) with a combination glass and calomel electrode (OSH 10-10, METRON, Poland) and pH-meter (CPC-551, Elmetron, Poland). While, EC was measured by an ESP 2ZM electrode (EUROSENSOR, Poland) according to the Polish standard PN ISO 11265:1997, using the same device as for pH. Available phosphorus and potassium in soil were assessed by means of Egner-Riehm method. Total N content of soil was determined by the Kjeldahl method. Pb, Cd and Zn concentrations were analyzed by extraction of soil using hot plate digestion (concentrated HNO₃ and HClO₄, ratio 4:1 v/v, ETHOS 1, Milestone, Italy) and flame atomic absorption spectrometry (iCE 3500 FAAS, Thermo Scientific). Organic matter was measured according to PN-EN 15169:2011.

3.2. Results

3.2.1. Site 1. Green Street, 50° 17'41.5"N 18° 57'18.7"E, Bankowa Street

Site description

The general view of the area of investment is presented in Figure 1. The area of interest is an asphalt string between H. Dąbrowski and F. Chopin St., with the adjacent escarpment, covered with trees and bushes, while on the eastern side with a flat area partly developed with greenery, and next to the building with a fragment of the pavement. The location in the city center, the poor pavement condition, low species diversity of greenery and location meant that the street with roadsides was included in the project, which is to be the starting point for creating green corridors in the city.

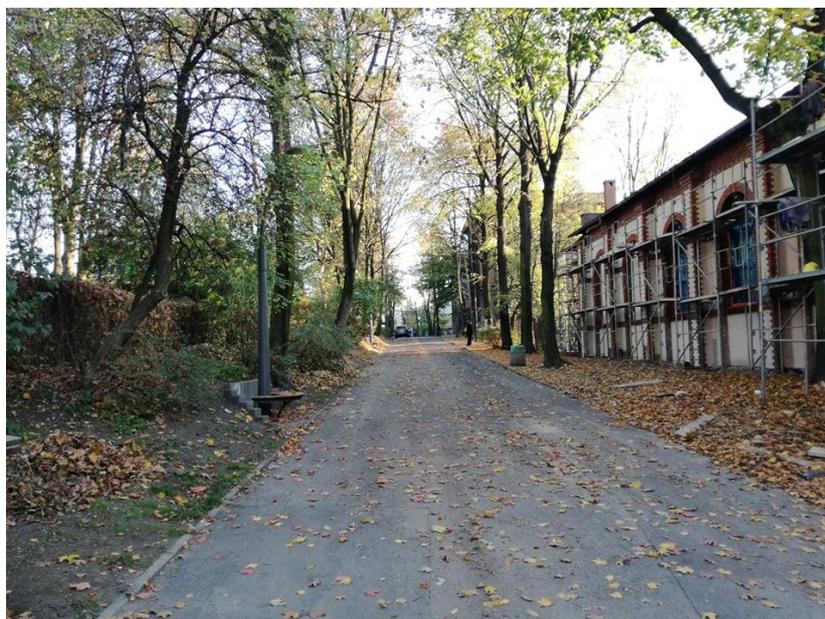


Fig. 1. General view of the investment area at Bankowa Street

Soil characteristics

The soil was characterized as loamy sand which indicates light soil texture with low water retention (Table 2). The pH on this site is close to neutral (7 pH) what was detected for both



pH measurement methods: in H₂O and 1 M KCl. Soil Electrical Conductivity (EC) is at the higher appropriate range detected in different agricultural sites that might refer to higher ion contents such as Na⁺, K⁺, Mg⁺², Ca⁺², Cl⁻, HCO₃⁻, NO₃⁻, SO₄⁻², and CO₃⁻². Despite this fact, those values of EC do not indicate salinity in that soils. The organic matter was measured at a really high level even for agricultural soils which usually in the Silesia region is about 5 %. Amount of primary macronutrients such as N_{total}, P_{available}, K_{available} is sufficient even for agricultural soils. According to the Polish regulation (Dz.U.2016.poz.1395) on the assessment of ground and soil contamination all heavy metals are above threshold values for urbanized areas (category I). It is 50%, 3-times, and 2-times over the threshold limits for Pb, Cd, and Zn, respectively.

Table 2. Soil characteristics for Site 1

Parameters	Values
Soil texture	loamy sand
pH (H ₂ O)	7.52 ± 0.08
pH (KCl)	7.02 ± 0.09
EC (μS cm ⁻¹)	170.6 ±15.2
OM (%)	9.03 ± 0.93
N (%)	0.23 ± 0.04
P (mg 100g ⁻¹)	4.92 ± 0.76
K (mg 100g ⁻¹)	40.50 ± 5.80
Pb (mg kg ⁻¹)	325 ± 31
Cd (mg kg ⁻¹)	6.24 ± 0.88
Zn (mg kg ⁻¹)	1092 ± 131

Values are mean ± SE (n=6)

3.2.2. Site 2. Green verge of the existing street with retaining wall, 50° 17'57.3"N 18° 57'12.1"E, Moniuszki Street

Site description

Area of interest refers to the roadside fragment of Moniuszki St., delimited by a retaining wall (exit from the flyover behind the wall). Location in the city center. The roadside of the street without greenery is dominated by a concrete retaining wall. There are also stairs which need reconstruction. The general view of the area of investment is presented in Figure 2.



Fig. 2. General view of the investment area at Moniuszki Street

Soil characteristics

The soil on Site 2 (Table 3) was characterized as loamy sand what is the same soil texture as in case of Site 1. The pH was slightly alkali (about 8). Electrical conductivity was at a similar range as on Site 2. Despite the fact that organic matter content was at about 7 % those values are still high even for agricultural soils. The content of primary macronutrients is sufficient even for agricultural soils and is in a range similar to Site 1. As it was for the previous site all analysed heavy metals are over permissible threshold levels, however, on Site 2 those are the highest compared to the other sites. The 4-times, 9-times, and 5-times higher values compared to the threshold limits (Dz.U.2016.poz.1395) were detected for Pb, Cd, and Zn, respectively. This is associated with a really close distance from closed down iron smelter which caused deposition of heavy metals in the vicinity areas.

Table 3. Soil characteristics for Site 2

Parameters	Values
Soil texture	loamy sand
pH (H ₂ O)	7.95 ± 0.09
pH (KCl)	7.50 ± 0.09
EC (μS cm ⁻¹)	188.6 ± 17.1
OM (%)	6.67 ± 0.87
N (%)	0.24 ± 0.04
P (mg 100g ⁻¹)	2.27 ± 0.43
K (mg 100g ⁻¹)	43.49 ± 7.95
Pb (mg kg ⁻¹)	848 ± 114
Cd (mg kg ⁻¹)	17.40 ± 2.35
Zn (mg kg ⁻¹)	2422 ± 244

Values are mean ± SE (n=5)



3.2.3. Site 3. Green wall (ChCK) 50° 17'49.6"N 18° 56'59.7"E, Sienkiewicza Street

Site description

The general view of the area of investment is presented in Figure 3. Area of interest refers to the north facade of the Chorzów Cultural Center (CHCK), including entrance to the building. In front of the entrance to CHCK, there is a square with a concrete cube surface. The same type of paving stone was used to make the surface of Sienkiewicza street. The cube is laid on the same level, thanks to which the square is not separated, it forms a uniform unit with the street surface. There is no greenery on the square and on the side of the street, due to the lack of free space. Hence the idea of greening the wall was raised up.



Fig. 3. General view of the investment area at Sienkiewicza Street

Soil characteristics

The soil on Site 3 was characterized as sandy clay loam what was the result of higher clay content fraction in the soil (Table 4). The pH was close to neutral with the balance shifted towards acidic what might be a result of existing conifer plants there. Electrical conductivity and organic matter content are at the same level as on Site 2. Primary macronutrients such as N and K have attained lower values when compared to the other sites, however, those were still in the appropriate range for agricultural soils with low fertility. Interestingly available phosphorus content was 4- times higher when compared to the other investment sites. Heavy metals concentration (Pb, Cd, and Zn) in soil were above threshold limits for Pb and Zn (Dz.U.2016.poz.1395) and it was 25% and about 100% over threshold limits, respectively.

Table 4. Soil characteristics for Site 3

Parameters	Values
Soil texture	sandy clay loam
pH (H ₂ O)	6.72 ± 0.47
pH (KCl)	6.34 ± 0.77
EC (μS cm ⁻¹)	173.3 ± 67.9
OM (%)	4.45 ± 1.71
N (%)	0.13 ± 0.03
P (mg 100g ⁻¹)	13.01 ± 2.18
K (mg 100g ⁻¹)	10.61 ± 1.94
Pb (mg kg ⁻¹)	247 ± 119
Cd (mg kg ⁻¹)	1.80 ± 1.01
Zn (mg kg ⁻¹)	1196 ± 566

Values are mean ± SE (n=3)

3.2.4. Site 4. Green yard, 50° 16'51.9"N 18° 56'24.5"E, 32 Armii Krajowej Street

Site description

The general view of the area of investment is presented in Figure 4. The development area is a paved yard at the entrance to the building. In addition, the ground is concave with a fragmented lawn.



Fig. 4. General view of the investment area at Armii Krajowej Street

Soil characteristics

The soil on Site 4 (Table 5) was characterized as loamy sand what is the same soil texture as those found on Site 1 and Site 2. As in the case of Site 2, pH was slightly alkali but still close to neutral. Electrical conductivity was about 70 μS cm⁻¹ lower when compared to the other



sites what might be a result of lower different ions concentration including Nitrogen and Potassium, while phosphorus was in the range similar to Site 1 and Site 2. Organic matter content was also really low even for agricultural soils. As Site 4 is located in the highest distance from Chorzów city center, while other sites and closed down smelter is located only Zn concentration was detected over threshold limits (Dz.U.2016.poz.1395) but still those values were only slightly elevated. Both P and Cd were in the appropriate range for urbanized areas.

Table 5. Soil characteristics for Site 4

Parameters	Values
Soil texture	loamy sand
pH (H ₂ O)	7.82 ± 0.05
pH (KCl)	7.68 ± 0.05
EC (μS cm ⁻¹)	117.8 ± 12.6
OM (%)	2.69 ± 0.76
N (%)	0.10 ± 0.03
P (mg 100g ⁻¹)	4.93 ± 0.59
K (mg 100g ⁻¹)	15.71 ± 7.32
Pb (mg kg ⁻¹)	166 ± 38
Cd (mg kg ⁻¹)	0.81 ± 0.23
Zn (mg kg ⁻¹)	604 ± 131

Values are mean ± SE (n=3)

4. Proposed plant species to be potentially used during the Pilot action

Selection took into account results of soil characteristics, climatic conditions as well as final proposed land use type.

Site 1. Green Street, Bankowa Street

Sambucus ebulus, *Paris quadrifolia*, *Osmunda regalis*, *Lathyrus vernus*, *Melittis melissophyllum*, *Scrophularia nodosa*, *Carex sylvatica*, *Carex digitata*, *Sanicula europaea*, *Pyrola rotundifolia* - from metaplantation, *Corydalis cava*, *Convallaria majalis*, *Asarum europaeum*, *Pulmonaria obscura*, *Hepatica nobilis*, *Galium odoratum*, *Anemone nemorosa*, *Anemone ranunculoides*, *Symphytum tuberosu*

Site 2. Green verge of the existing street with retaining wall, Moniuszki Street

Humulus lupulus

Site 3. Green wall (ChCK), Sienkiewicza Street

Schisandra chinensis, *Aristolochia macrophylla*, *Celastrus scandens*, *Schizophragma hydrangeoides*



Site 4. Green yard, 32 Armii Krajowej Street

Plants on racks

Actinidia, Ampelopsis brevipedunculata, Clematis, Vitis coignetiae

Flowerbeds with herbs

Origanum vulgare, Symphytum officinale, Pimpinella major; P. magna, Asarum europaeum, Valeriana simplicifolia, Levisticum officinale, Ruta graveolens, Salvia officinalis, Veronica chamaedrys, Alchemilla vulgaris, Ononis arvensis, Ononis spinosa, Nepeta cataria, Thymus serpyllum, Mentha arvensis, Fragaria vesca, Marrubium vulgare, Galium odoratum, Centaurea jacea, Centaurea rhenana, Hypericum perforatum, Galeobdolon luteum, Lamium album, Lamium purpureum, Origanum vulgare, Thymus serpyllum, Thymus pulegioides, Melissa officinalis, Mentha longifolia, Mentha arvensis, Pulsatilla vulgaris, Primula sp., Tussilago farfara, Salvia officinalis

References

1. Polish Regulation Dz.U.2016.poz.1395 on the Assessment of Ground and Soil Contamination (in Polish)