

DELIVERABLE D.T3.4.1.

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

Liptovsky Mikulas

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Jana Kormaníková, Barbara Vojvodikova, Marta Pogrzeba, Jacek Krzyżak, Szymon Rusinowski, Alicja Szada-Borzyszkowska, Leszek Trząski, Waldemar Szendera





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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. This document summarizes the characteristics of 4 small spots in Liptovský Mikuláš 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

Liptovský Mikuláš, a Slovak town in the Žilina Region, in Liptov basin under the Tatras on the river Váh, 65 km east of Žilina. The population is over 31.5 thousand.

The town of Liptovský Mikuláš lies in the north of central Slovakia at an altitude of 576 m above sea level, in the middle of the Liptov basin. It is surrounded by the Western Tatras in the north, the Low Tatras in the south and Choč Hills in the northwest. The town is situated on the main railway line No. 180 Bratislava - Žilina - Košice, the D1 motorway passes through the southern part of the town and the town is located at the intersection of roads I / 18 and II / 584.

It extends mainly on the right bank of the river Váh, directly at its inlet into the water reservoir Liptovská Mara, whose surface reaches an area of 21.6 km². The river Váh in the town gradually gains several tributaries: Stošianka with tributary Bródok, Okoličianka, Smrečianka, Ilanovianka with tributary Lažtek, Ploštínka, Demänovka.

The territory of Liptov is rugged, with larger temperature differences. The lower part of the region in the Váh valley belongs to a slightly warm climatic area. The characteristic feature of the region is the diversity of flora and its arrangement into several height vegetation stages.

The 20th century brought the city dynamic political, economic and demographic changes, and in 1952 the name changed. Liptovský Svätý Mikuláš (Liptov Saint Nicholas) was renamed to Liptovský Mikuláš. Decades from the foundation of Czechoslovakia (1918) to the era of the independent Slovak Republic (1993) were marked by development, but also by war destruction. The wars of Liptovský Mikuláš in 1945 are a testament to the great war cemetery above the town. The peace years brought industrialization and extensive construction of the city. The population of Liptovský Mikuláš has tripled. People moved here to work in new factories and offices, in the 1970s, new residents from nearby villages found flooded the waters of Liptovská Mara. The old streets were replaced by prefabricated housing estates, family houses were enlarged, new schools, cultural institutions, sports facilities were added. For centuries, Liptovský Mikuláš has been shaped up to the present-day form of the economic, cultural and tourist center of upper and middle Liptov.



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 Liptovský Mikuláš city.

	Mean temperaure (° C)	Min. Temperature (° C)	Max. temperature (° C)	Rainfall (mm)
Jan	-3,8	-7,8	0,5	7
Feb	-2,3	-6,5	2,7	6
Mar	1,5	-2,8	7,1	7
Apr	6,4	1,3	12,1	8
May	11,9	5,7	18,0	10
Jun	14,8	8,6	20,9	12
Jul	16,3	10,0	22,6	10
Aug	15,6	9,4	22,8	8
Sep	11,6	6,3	18,1	8
Oct	6,7	2,2	12,9	8
Nov	1,4	-1,9	5,5	8
Dec	-2,5	-5,9	1,3	9

The territory of Liptov is rugged, with larger temperature differences. The lower part of the region in the Váh valley belongs to a slightly warm climate area with an average July temperature of around 16 ° C and January around -3 ° C.

The marginal and higher parts belong to a cold climatic area where the average July temperature ranges from 10 to 16 ° C, in the highest positions of the Western and Low Tatras it does not exceed 10 ° C. The average January temperature at higher altitudes ranges from -4 ° C to -7 ° C and in the peaks of the mountains up to -10 ° C. Climatic conditions in Liptov are well characterized by the number of summer days a year (the number of days with a maximum air temperature of 25 ° C and more is in the basin just over 30) and the number of days with snow cover (in Liptovsky Mikulas 135, 160-180 mountains). The amount of precipitation varies from place to place depending on the altitude and slope exposure. In general, as the altitude increases, the value of the annual rainfall increases as well. The central part of the Liptov basin is an exception. Because it lies in the shadow of high mountains such as Veľká Fatra a Chočské vrchy. The highest rainfall in Liptovsky Mikulas is 88 mm in June, 90 mm in July, and in August it is the third highest total of 77 mm. The highest parts of the mountains have an annual rainfall of 1500 mm. Most precipitation will fall in July and August.



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 : 17.06.2019

C) investment place: Liptovský Mikuláš - L/1 (Revitalizácia vnútrobloku Senická - Jefremovská)

- 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 characteristic 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 PNISO 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.

3.2. Results

3.2.1. Site 1. Revitalizácia vnútrobloku Senická - Jefremovská - Hradišská GPS N 49° 4.87635', E 19° 38.97733'

Site description

The site is part of the suburb of the town of Liptovský Mikuláš. Podbreziny lie in the eastern part of the city. The river Smrečianka is divided into two parts.

The area selected for revitalization is delimited by apartment buildings on three sides. From the east side open to free space. Along this side there is a footpath for pedestrians and cyclists, and in their close proximity flows the river Smrečianka. Its area is abot 0,2 ha (Fig. 1).

Nowadays, it is a grassy area with pedestrian walkways, with several coniferous trees planted by residents of a residential block, and several elements of a playground. It is a relatively shaded place due to the location of individual blocks. In shady places (southwestern part of the territory) the ground parts of the walls are covered with moss.

It is an area where, apart from regular mowing of lawn, maintenance of children's elements and trees, no more extensive revitalization has been carried out since the construction of residential blocks.

A positive element of this area is the Smrečianka watercourse. Its use is limited by the flood protection zone.

Prepared by the revitalization will positively improve the environment for the residents of the apartment block (approximately 600 persons). The proposed changes will have an impact on cyclists who use a frequented cycling route ending in Žiarska valley, as this route runs along the eastern side of the territory. This change will also be felt by all who use the footpath along the Smrečianka River as a way to transport or work, or use the footpath for walks only (seniors, pupils).



Fig. 1. General view of the investment area.

Soil characteristics

Soil at Site 1 (Table 2) exhibit similar characteristics to those found on Site 3. It was visible as the similar soil texture and similar electrical conductivity and pH values. Organic matter content was found to be the lowest among all sites, however despite this fact is still in the appropriate range (>5%). The huge scarcity of phosphorus was detected alongside with low values of potassium. Nitrogen concentration at 0.17 % is sufficient even for agricultural soils.

Table 2. Soil characteristics for Site 1.

Parameters	Values
Soil texture	Sandy Clay Loam
pH (H ₂ O)	7.69 ± 0.06
pH (KCl)	7.32 ± 0.06
EC (µS cm ⁻¹)	227 ± 8
OM (%)	5.20 ± 0.68
N (%)	0.17 ± 0.02
P (mg 100g ⁻¹)	0.05 ± 0.00
K (mg 100g ⁻¹)	12.9 ± 1.9

Values are mean ± SE (n=5)

3.2.2. Site 2. Mierové námestie GPS : N 49° 5.12637', E 19° 36.69143'

Site description

Mierove Square is located in the central part of Liptovský Mikuláš, close to shopping centers. It is triangular in shape with the northern part of the department store parking lot, the eastern part of the bicycle path and the south by local road. The current park is only a part of the original park, whose areas were taken up by an asphalt parking lot and paved access areas to a department store. The surface of the square is grassed with several coniferous and deciduous trees. In its northern part there is a playground with two elements. It is divided into two parts of approx. 20 m concrete pavement, which provides access to the department store from the adjacent street. Its total area is about 1859 m². The location in which the park is located is one of the busiest parts of the city - in close proximity are two department stores, municipal library, hotel, bicycle path, shops with various goods. In its wider surroundings there is a cultural house, a synagogue. The road running along its southern side is a link to the city's central square. The general view of the area of investment is presented in Figure 2.



Fig. 2. General view of the investment area Site 2.

3.2.3. Site 3. Kultúrny dom Lipovský Mikuláš - zelená stengreen wall GPS N 49°5.05458', E 19°36.62723'

Site description

The general view of the area of investment is presented in Figure 3.

The House of Culture, built in the 1980s, is located in the historic part of Liptovský Mikuláš. It is a building with a square ground plan, with a flat terrace roof, with an outer light brown marble cladding. Until now the exterior has not been reconstructed. The facade on which the green area is to be installed, consists of a marble wall with small architectural elements and windows. Adjacent to the entrance to the building is an asphalt area, partly used as a parking lot. Greenery is represented by several mobile pots. In a larger number of trees are found around its remaining perimeter. The House of Culture provides citizens of the city and the region with a rich range of cultural and social events. Concerts of popular and classical music, theaters, shows, performances of dance groups, puppet theater, as well as balls and occasional exhibitions. The installation of a green wall on its façade will contribute to the improvement of the quality of the environment in this locality and it will be felt by the visitors of the culture house.



Fig. 3. General view of the investment area at Site 3.

Soil characteristics

Soil texture on Site 3 (Table 3) was the same as this found for Site 1. The pH was also neutral however balance from neutral was slightly shifted towards alkali when compare to the Site 1. Interestingly, soil electrical conductivity was at high range what alongside with low P and K concentration might indicate soil salinity. Total Nitrogen content is in the sufficient amount even for agricultural purposes. The organic matter content was the highest for this site compare to the other sites.

Table 3. Soil characteristics for Site 3.

Parameters	Values
Soil texture	Sandy Clay Loam
pH (H ₂ O)	7.47 ± 0.09
pH (KCl)	6.97 ± 0.11
EC (μS cm ⁻¹)	224 ± 13
OM (%)	8.10 ± 0.53
N (%)	0.26 ± 0.02
P (mg 100g ⁻¹)	0.72 ± 0.26
K (mg 100g ⁻¹)	18.0 ± 3.5

Values are mean ± SE (n=5)

3.2.4. Site 4. Základná škola arboretum, GPS N 49° 5.08790', E 19° 36.05367'

Site description

The area on which the design of “grandfather's grandmother's orchard” is solved is part of the premises of the Primary School with a kindergarten in Demänovská Street in the Palúdzka district. The territory in question is located in its north-eastern part. On three sides it is separated from the rest of the school by fencing. From the west side there is free access to it. In its close proximity i garden with raised beds for growing vegetables and herbs. At present the area is grassed without any trees and is used as an open area. Its maintenance consists in regular mowing. Its area is about 600 m². The school wants to integrate the territory into its educational activities for children of kindergarten as well as pupils of the first and second level of the school - elementary school, science, biology, work and technical education. Removing the fence between the vegetable garden and the area in question will allow them to be interconnected and thus increase their use. As the area is in close proximity to the catering facility, schools will be able to use it as well as pupils and outside their classroom as well as their parents when picking up from school. The park will also be available to residents of an apartment building which is part of the school grounds.



Fig. 4. General view of the investment area Site 4.



Soil characteristics

Soil on Site 4 was characterized as Sandy Clay Loam which is light structure soil with low water retention due to high sand fraction content in the soil (70-80%). Moreover soil was characterized as neutral what was confirmed by analysis using two method of pH measurements in H₂O and KCl. Electrical conductivity of soil was at the higher appropriate range detected in different agricultural sites what might refer to higher ion contents such as Na⁺, K⁺, Mg⁺², Ca⁺², Cl⁻, HCO₃⁻, NO₃⁻, SO₄⁻². Also organic matter content was high as usually in good quality agricultural soil value of this parameter is about 5%. The same was also true for primary macronutrients content (N_{total}, P_{available}, K_{available}) which were in range detecting in agricultural soils.

Table 4. Soil characteristics for Site 4.

Parameters	Values
Soil texture	Sandy Clay Loam
pH (H ₂ O)	7.34 ± 0.11
pH (KCl)	6.68 ± 0.16
EC (μS cm ⁻¹)	180 ± 23
OM (%)	6.86 ± 0.31
N (%)	0.23 ± 0.02
P (mg 100g ⁻¹)	3.61 ± 0.44
K (mg 100g ⁻¹)	29.8 ± 6.0

Values are mean ± SE (n=5)

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

Site 1. Neighbourhood green space in Podbreziny

Lawn: a standard grass mix for recreational lawn (*Lolium perenne*, *Festuca rubra*, *Poa pratensis*, *Festuca ovina*)

Flowery meadow: Seed mix of:

Grass:

Agrostis capillaris, *Anthoxanthum odoratum*, *Deschampsia caespitose*, *Festuca rubra commutate*, *Festuca rubra*, *Festuca rubra trichophylla*, *Festuca rupicola*, *Festuca trachyphylla*, *Koeleria macrantha*, *Koeleria pyramidata*, *Poa pratensis*

Flowers

Agrimonia eupatoria, *Agrimonia procera*, *Achillea collina*, *Achillea millefolium*, *Anthemis tinctoria*, *Berteroa incana*, *Betonica officinalis*, *Carum carvi*, *Centaurea cyanus*, *Centaurea jacea*, *Centaurea scabiosa*, *Cichorium intybus*, *Coronilla varia*, *Daucus carota*, *Dianthus carthusianorum*, *Dianthus deltoids*, *Echium vulgare*, *Galium album*, *Galium verum*, *Helianthemum grandiflorum*, *Hypericum perforatum*, *Knautia arvenss*, *Lavandula angustifolia*, *Leontodon hispidus*, *Leucanthemum vulgare*, *Linum perenne*, *Lotus corniculatus*, *Lychnis coronaria*, *Lychnis viscaria*, *Marrubium vulgare*, *Matricaria chamomilla*,



Origanum vulgare, Papaver rhoeas, Plantago lanceolata, Potentilla argentea, Potentilla recta, Prunella vulgaris, Pyrethrum corymbosum, Pyrethrum parthenium, Salvia pratensis, Salvia verticillata, Sanguisorba minor, Saponaria officinalis, Scabiosa ochroleuca, Silene nutans, Silene vulgaris, Succisa pratensis, Thymus pulegioides, Veronica teucrium, Vicia cracca, Vicia villosa

Shrubs to choose from (choose only those varieties that are recommended for the urban environment):

Euonymus europaeus, Euonymus verucosus, Hippophaë rhamnoides, Ligustrum vulgare, Lonicera xylosteum, Potentilla fruticose, Prunus spinose, Rosa canina, Cornus alba, Cotoneaster lucidus, Potentilla fruticose, Pyracantha coccinea, Salix purpurea, Sambucus racemose, Syringa vulgaris, Viburnum lantana, Viburnum opulus

Small trees to choose from (only dwarf or fastigate varieties) well growing in urban conditions:

Acer campestre ('Nanum','Elsrijk', 'Green column', 'Red Shine'), *Acer platanoides* ('Globosum'), *Betula pendula* ('Fastigiata, 'Obelisk'), *Crataegus monogyna* ('Stricta', 'Compacta' 'Variegata'), *Crataegus ×media* ('Paul's Scarlet', 'Rosea Plena'), *Carpinus betulus* ('Columnaris', 'Frans Fontaine', 'Fastigiata'), *Sorbus intermedia* ('Brouwers'), *Sorbus aucuparia* 'Fastigiata', 'Fingerprint'), *Quercus robur* ('Fastigiata'), *Tilia cordata* ('Green Globe', 'Grune Kugel', 'Peve Kronenberg'), *Fagus sylvatica* ('Dawyck', 'Dawyck Purple')

Rockery (low stone wall) - perennials - native or permanently established species in north part of Slovakia:

Ajuga reptans, Aurinia saxatilis, Campanula carpatica, Carex sp., Cymbalaria murowa (Cymbalaria mularis), Dianthus deltoids, Dianthus plumarius, Dryas octopelata, Festuca sp., Geranium sanguineum, Geum coccineum, Glechoma hederacea, Koeleria glauca, Lysimachia nummularia, Origanum vulgare, Potentilla neumanniana, Primula sp. - native species, Pulsatilla vulgaris, Sagina subulata, Saxifraga sp. (native species), Sedum - native species, Sempervivum - native species, Sesleria albicans, Thymus serpyllum, Thymus vulgaris, Veronica prostrata, Vinca minor, Viola odorata

SITE 2. - “Pocket park” updating - a green „tunnel“ with sparger (water fog) over the concrete walkway

If it is something like a roof: the plant material must be placed on a non-degradable carrier (pitch exceeding 15%)!

Carrier: rot-proof coconut fabric carrier with substrate layer and pre-cultivated sedum vegetation.

Sedum seedlings - possible species:

S. album, S. sexangulare, S. spurium, S. rupestre,

Additional plants (seeds):

Grass: *Festuca ovina*

Wild flowers:



Achillea millefolium, Allium schoenoprasum, Campanula rotundifolia, Dianthus carthusianorum, Dianthus deltoids, Euphorbia cyparissias, Hieracium pilosella, Hypericum perforatum, Linaria vulgaris, Linum perenne, Origanum vulgare light, Prunella grandiflora, Saponaria officinalis, Sedum reflexum, Teucrium chamaedrys, Thymus pulegioides, Thymus serpyllum

If the construction is like pergola it is a kind of pergola or arbor:

Hedera helix, Lonicera caprifolium, Clematis vitalba

Site 3. House of Culture

Climbers: trellis support

Freestanding green facade/trellis

Plants: *Hedera halix, Visteria sp., Parthenocissus sp., Lonicera caprifolium, Clematis vitalba*

Site 4 School garden „Arboretum of native fruit trees

Fruit trees to choose from (only those varieties that are cultivated traditionally in Slovakia, adapted to the local climate in Liptovský Mikuláš, the trees not reaching large sizes, and the fruits to be collected not on time of school holidays):

Malus domestica (apple):

solivarske uslachte, batul, panenske ceske, sudetska reneta

Pyrus communis (pear):

president mas, solanka, eliska

Prunus cerasus (cherry):

Vanda, Karesova, Techlovan

Fruit shrubs:

Corylus avellana (common hazel), *Ribes grossularia* (gooseberry), *Ribes rubrum* (redcurrant)

Ribes nigrum (blackcurrant)

Ornamental plants - covering plants to choose from:

Vinca minor, Ajuga reptans, Asarum europaeum, Lamium maculatum, Aruncus dioicus, Glechoma hederaceauszczyk, Galeobdolon luteum, Convallaria maialis, Pulmonaria obscura

Medicinal herbs to choose from (only native species, traditionally used as herbs) :

Aegopodium podagraria, Arnica montana L. - Arnika Górska, *Artemisia vulgaris, Artemisia absinthium, Centaurea cyanus* L. - Chaber bławatek, *Chelidonium maius* L. - Glistnik (jaskótcze ziele), *Cichorium intybus* L. - Cykoria podróznik, *Cirsium oleraceum, Equisetum arvense, Fragaria vesca, Hypericum perforatum, Lamium album, Matricaria chamomilla, Plantago lanceolate, Potentilla anserine, Polygonum aviculare, Potentilla tormentilla, Ruta graveolens, Salvia officinalis* L., *Sanguisorba officinalis, Tanacetum vulgare, Taraxacum*



officinale, Thymus serpyllum, Ussilago farfara, Viola tricolor, Valeriana officinalis, Veronica officinalis

Lawn with field flowers (as a mix):

Leucanthemum vulgare, Papaver rhoeas, Vicia cracca, Vicia villosa, Securigera (Coronilla) varia, Vicia grandiflora, Centaurea scabiosa, Lotus corniculatus, Knautia arvensis, Echium vulgare, Cichorium intybus, Achillea millefolium, Centaurea jacea, Verbascum thapsiforme, Anthemis tinctoria, Saponaria officinalis, Daucus carota, Agrimonia eupatorium, Betonica officinalis, Verbascum nigrum, Salvia pratensis, Oenothera sp., Succisa pratensis, Leontodon hispidus, Tripleurospermum inodorum, Cynoglossum officinale, Tragopogon pratensis

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