EUROSOIL 2008 - EXCURSION 1SVK-post-congress

"SOILS OF THE DANUBE LOWLAND"

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1 GENERAL INTRODUCTION

1.1 Aim of the excursion

The aim of the excursion is to present an unique soilscape of Danube Lowland comprising of two contrast environments, the alluvial plane and the loess hilly lands. The pedogenesis was very different in these two landscape units.

At the alluvial plains the hydromorphic processes caused by river flooding and groundwater influence were active and the soilscape is dominated by various types of Fluvisols usually calcareous as the alluvial deposits of Danube contain great portion of calcareous material. Gleysols are abundant in low elevated parts of the alluvial plains and minute patches of Solonetzes and Solonchaks occur rarely in the deepest depressions.

At the loess hilly lands an extraordinary piedmont soil zonality developed. It originated due to differentiation of climate humidity in the piedmont belt of northern part of Danube Lowland resulting in different level of soil leaching. In the dry areas the organic matter accumulation under steppe conditions resulted in formations of Chernozems. In moist areas the clay leaching took place and the Luvisols with well developed Bt-horizons were formed. Among these two extremes the continual transitions exist.

1.2 Route

Itinerary:

Vienna – Bratislava – Hamuliakovo – Gabcikovo – Voderady – Kocin – Bratislava – Vienna

Stops:

Stop 1 Hamuliakovo, Soil profile 1 - Calcic Fluvisol

Stop 2 Gabcikovo, Soil profile 2 - Mollic Fluvisol Calcaric

Stop 3 Gabcikovo, visit of Gabcikovo Hydrostructure

Stop 4 Voderady, Soil profile 3 - Haplic Chernozem

Stop 5 Kocin, Soil profile 4 - Cutanic Luvisol

1.3 Climate

Slovakia is situated approximately in the middle of the temperate macroclimatic zone. According to Koppen climatic classification the Danube Lowland belongs to ***Cfb*** climatic class (***C*** – temperate climate, mean temperature of warmest month is over 10 ºC and mean temperature of coldest month is between -3 and 18 ºC, ***f*** – precipitations are distributed during all seasons, ***b*** – mean temperature of warmest month is below 22 ºC) (PETROVIC, 1972).

The basic climatic data:

Mean annual temperature: 9 – 11 ºC,
Mean monthly temperature of July: 19 – 21 ºC,
Mean monthly temperature of January: -1 – -3 ºC,
Mean annual sum of precipitation: 450 – 600 mm.

1.4 Topography

The basic structures of present relief of Slovakia were formed by Alpine orogene. In Paleogene the originally slightly undulated plateau was disintegrated by network of faults to large blocks. The tectonic movements were active selectively in several phases during Neogene starting in Burdigalian and they were most intensive in Pontian. The Carpathians were uplifted to more than 2000 m and the basins south of Carpathians were sunken more than 4000 m (MAZUR & KVITKOVIC, 1980). The sunken basins were filled by marine and lacustrine deposits and the flat or slightly undulated accumulation relief originated.

The Danube Lowland comprise of two geomorphological units: 1) The more sunken central part called Danube Plain and 2) the relatively less sunken peripheral parts called Danube Hilly Land. In the area of Danube Plain the Neogeneous filling were covered by thick layer of Quaternary fluvial gravels and sands and flat alluvial plane slightly inclined towards south-east was formed. Its elevation reaches 136 m above see below Bratislava and it decreases gradually to 107 m above see nearby Komarno.

The Danube Hilly Land is relatively elevated above the Danube. It forms an undulated plateau inclined from the Carpathian foot slopes towards Danube Plain. In contrary to Danube Plain the Neogeneous basement of this area is covered only by several meters thick layer of Quaternary

deposits. The lowest part of the plateau is flat and towards the mountains it is gradually changing to strongly undulated hilly land. The elevation fluctuates from approximately 150 to 300 m above see. The whole hilly land is cut by rivers approaching from Carpathians towards the Danube (Vah, Nitra, Zitava, Hron, Ipel). Each of these rivers form own alluvial plane bordered by remnants of river terraces. The areas between these alluvial planes are covered by loess deposits and form several separated hilly lands (Trnavska Hilly Land, Nitrianska Hilly Land, Zitavska Hilly Land, Pohronska Hilly Land, Ipelska Hilly Land).

1.5 Geology

The Danube Lowland belongs geologically to *Pannonian Basin*. It is a sunken unit of Alpine - Himalayan orogenic zone. It separates the Carpathians from Dinarides. The basement of northern parts of this basin is built by Carpathian structural units built by crystalline rocks of Tatrides and Veporides and Mesozoic complexes of Fatricum. It is filled by several thousand meter thick Neogeneous deposits. Their greatest thickness in Slovak parts of the Pannonian basin reaches 5 000 m. Before the Early Miocene this area was uplifted and strongly eroded, later it sunk. The Neogeneous sinking and sedimentation began in Tortonian. The lower members of the sequence (Tortonian, Sarmatian and Pannonian) are marine, predominantly clays, less frequently sands, sandstones, gravels and limestones. The last two members of Neogeneous sedimentation (Pontian and Levantian) are lacustrine, mostly sands and gravels (FUSAN, 1972).

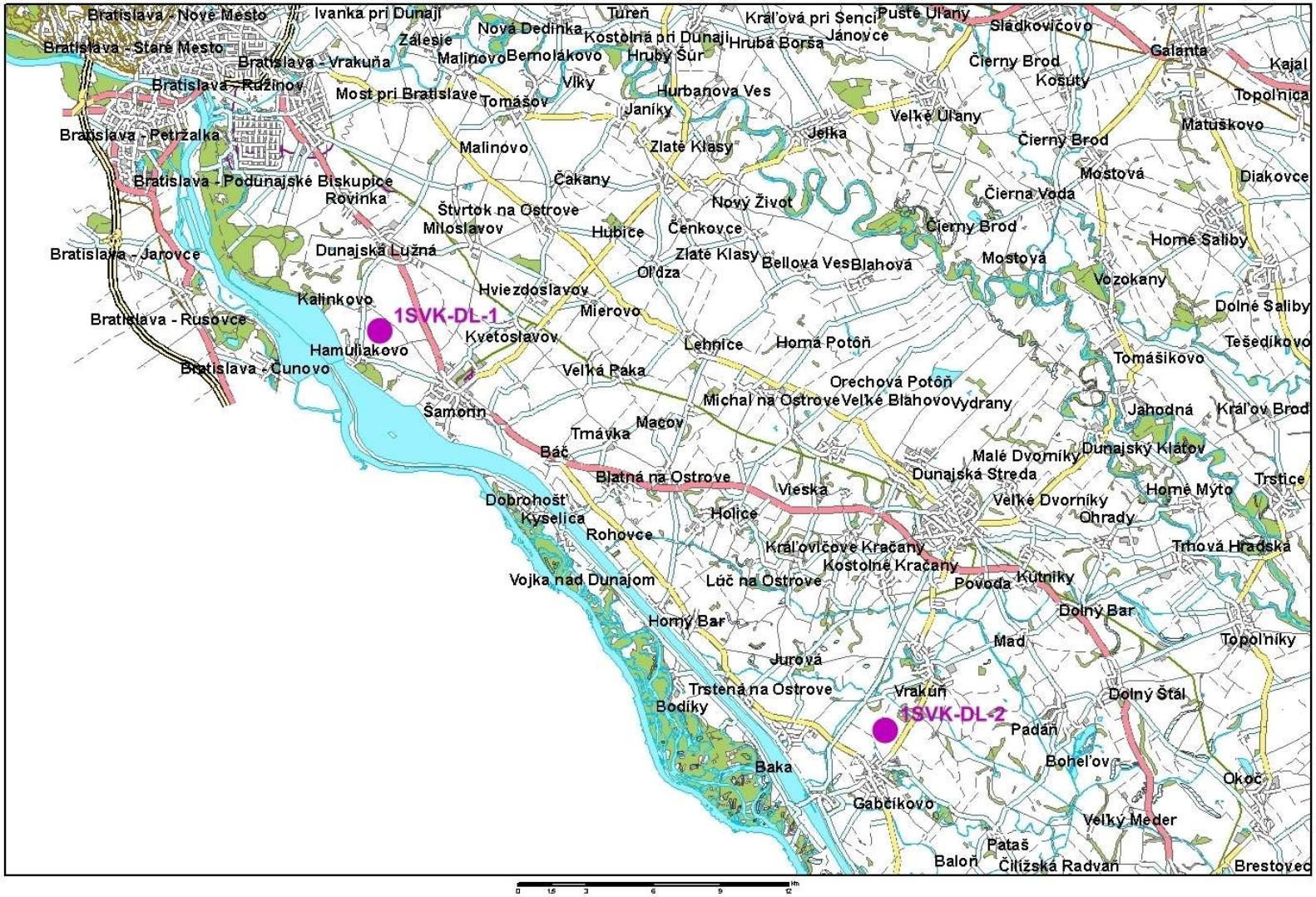
The neogeneous fillings of the Pannonian Basin are covered by Quaternary deposits up to 300 m thick (VASKOVSKY, 1977). The central parts of the basin are usually most sunken and are filled by coarse Pleistocene fluvial gravels. Pleistocene deposits are usually covered by Holocene gravels and fine material deposited by flooding which may be few tens of centimetres up to few meters thick. Close to the river banks, where the flooding have the highest energy these deposits are sandy, the more the distance from the rivers increase the finer the deposits are. In deepest depressions very fine clays with high organic matter content accumulated. The peripheral parts of the basin are relatively less sunken and the alluvial gravels are thin or missing here. The Neogeneous formations are covered by loess deposits. Their thickness varies from few meters up to about 40 meters. Along the foot slopes of mountain ranges surrounding the basin the ring of *proluvial cones* was formed.

1.6 Land use

The original vegetation of Danube Lowland was determined by the moisture and temperature variability. At alluvial plains the poplar-willow forest occupied the areas with intensive seasonal flooding and ash-elm forests grew in areas free of flooding but affected by ground water. The major parts of the loess hilly lands were occupied by oak-hornbeam forests. In the driest and warmest south-facing slopes of the loess hills the termophilous oak forests occurred.

Recently most forests are removed and only in most wet parts of alluvial plains the original poplar-willow and ash-elm forests although strongly altered by man are still preserved. The great majority of Danube Lowland is intensively cultivated. The major crops are maize (both grain and forage), winter wheat, spring barley, sunflower, oil rape and sugar beet.

1.7 Map of the route (next pages)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Kostolná pri Dunaji
Hrubá Borša
Jánovce
Galanta
Bratislava - Vrakuňa
Malinovo
Bernolákovo
Hrubý Šúr
Čierny Brod
Kajal
Bratislava - Ružinov
Most pri Bratislave
Tomášov
Vlky
Hurbanova Ves
Košúty
Topoľnica
Janíky
Veľké Úľany
Bratislava - Petržalka
Malinovo
Zlaté Klasy
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Čierny Brod
Matúškovo
Čakany
Mostová
Diakovce
Bratislava - Podunajské Biskupice
Rovinka
Čierna Voda
Štvrtok na Ostrove
Nový Život
Miloslavov
Hubice
Čenkovce
Čierny Brod
Horné Saliby
Bratislava - Jarovce
Dunajská Lužná
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Orechová Potôň
Michal na Ostrove
Veľké Blahovo
Vydrany
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Šamorín
Mačov
Trnávka
Malé Dvorníky
Dunajský Klátov
Báč
Dunajská Streda
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Trstice
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Kyselica
Holice
Ohrady
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Povoda
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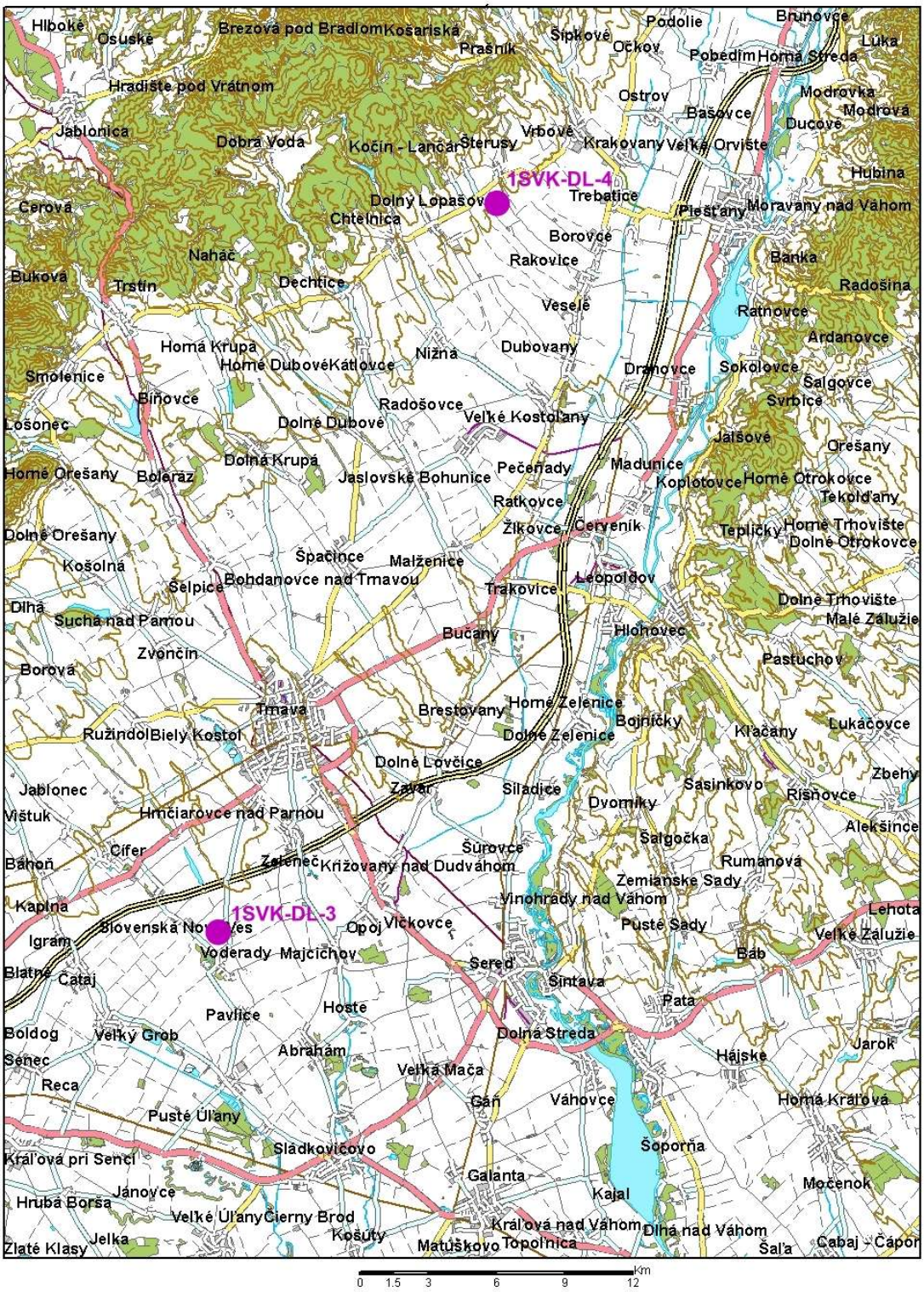
1SVK-DL-4
1SVK-DL-3
Hlboké
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Košariská
Prašník
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Očkov
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Bruhovce
Luka
Pobedím
Horná Streda
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Modrovka
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Ducové
Jablonica
Dobrá Voda
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Šterusy
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Krakovany
Veľké Orvište
Hubina
Trebatice
Dolný Lopašov
Piešťany
Moravany nad Váhom
Cerová
Chtelnica
Borovce
Rakovce
Banka
Nahač
Buková
Trstín
Dechtice
Radošina
Veselé
Ratnovce
Ardanovce
Horná Krupá
Horné Dubové
Kátlovce
Nižná
Dubovany
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Sokolovce
Smolenice
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Jaslovské Bohunice
Pečeňady
Madunice
Koplotovce
Horné Otrokovce
Tekoľany
Ratkovce
Žlkovce
Červenik
Teplička
Horné Trhovište
Dolné Orešany
Dolné Otrokovce
Košolná
Špačince
Malženice
Bohdanovce nad Trnavou
Šelpice
Trakovice
Leopoldov
Dolné Trhovište
Malé Žaluže
Dlhá
Suchá nad Parnou
Hlohovec
Bučany
Zvončín
Pastuchov
Borová
Trnava
Brestovany
Horné Zelenice
Bojničky
Lukáčovce
Ružindol
Biely Kostol
Dolné Zelenice
Kľačany
Dolné Lovčice
Zbehy
Jablonec
Zavar
Siladice
Sasinkovo
Rišňovce
Dvorníky
Hrnčiarovce nad Parnou
Alekšince
Šalgočka
Cífer
Šúrovce
Rumanová
Báhoň
Križovany nad Dudváhom
Zeleneč
Zemianske Sady
Vinohrady nad Váhom
Kapina
Lehota
Pusté Sady
Opoj
Vlčkovce
Veľké Žaluže
Igram
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Čataj
Sered
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Pata
Pavlice
Hoste
Boldog
Veľký Grob
Dolná Streda
Jarok
Abrahám
Hájske
Senec
Veľká Mača
Reca
Gán
Váhovce
Horná Kráľová
Pusté Úľany
Šoporňa
Sládkovičovo
Kráľová pri Senci
Galanta
Močenok
Jánovce
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Hrubá Borša
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Kráľová nad Váhom
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Topoľnica
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Čabaj - Čápor
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2 METHODS

2.1 Soil physical analyses

Soil physical parameters were analysed using traditional analytical methods used in Slovakia which are based on treating the soil ring samples. All these methods are described in the soil analytical handbook assembled by FIALA et al. (1999).

- Particle size distribution: Pipette-Method after Novak (FIALA et al., 1999).
- Dry bulk density: determination from ring samples after FIALA et al. (1999).
- Soil particle density: Pycnometer Method after FIALA et al. (1999).
- Total porosity: calculated from bulk density and particle density.
- Hydrolimits (Vol. % water at pF 2.0; 2.5; 4.2):
- Pore size distribution (non-capillary, semi-capillary and capillary porosity) and available field capacity: determination from ring samples after FIALA et al. (1999).
- Saturated water conductivity: determination from ring samples after VELEBNY (1982).

2.2 Soil chemical analyses

Most of chemical parameters (except for available Phosphorus and available Potassium) are analysed using international standardised methods (ISO Standards).

- pH($CaCl_2$): ISO 10 390
- $CaCO_3$: volumetric method, STN ISO 10 693
- Electric Conductivity: STN ISO 11 265
- C_{org}: Walkey-Black Method, ISO 14 235
- N_{tot}: modified Kjeldahl method, STN ISO 11 261
- „Plant available“ P: Egner method (FIALA et al., 1999)
- „Plant available“ K: Schachtschabel method (FIALA et al., 1999)
- Exchangeable cations, CEC_{eff}, base saturation: STN ISO 13 536
- Total contents in Aqua Regia-extract of the elements (P, Ca, Mg, K, Na, Fe, Al, Mn): STN ISO 11 466, STN ISO 11 047

2.3 Soil classification

- Classification system used: WRB 2006.

3 EXCURSION POINTS

3.1 Excursion point 1: Soil profile Hamuliakovo, Danube Plain: Calcic Fluvisol from alluvial loam

Site characterisation

Location

Alluvial plain of Danube, (48° 02.650' northern latitude, 17° 15.246' eastern longitude, 130 m above sea)

Climate

Climate type: Cfb (Koppen)

Table 1: Basic climatic characteristics of Hamuliakovo site.

Parameter	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
T [°C]	-1.4	0.9	5.0	10.2	15.1	18.3	20.1	19.3	15.4	9.9	4.4	0.5	9.8
R [mm]	40	37	31	36	52	61	55	54	41	36	51	43	537

Relief

Flat alluvial plain.

Land use/vegetation

Arable land (major crops: grain maize, winter wheat, spring barley, sunflower).

Soil profile description: **Calcic Fluvisol, Hamuliakovo**

Ap (0 – 25 cm): clay loam, 2.5Y/5/3 (dry), 2.5Y/4/3 (moist), strongly calcareous, moist, loose, fine to medium crumby, abundant roots, clear wavy boundary.

AC (25 – 45 cm): loam, 2.5Y/6/3.5 (dry), 2.5Y/4.5/4 (moist), strongly calcareous, moist, friable, fine to medium crumby, abundant roots, diffuse smooth boundary.

Cl (45 – 100 cm): loam, 2.5Y/6/3 (dry), 2.5Y/5/4 (moist), strongly calcareous, moist, friable, no structure, few rusty mottles, few roots, clear smooth boundary.

2Cl (100 – 110 cm): sandy loam, 2.5Y/6/2 (dry), 2.5Y/7/2-5.5/3 (moist), strongly calcareous, moist, loose, no structure, abundant rusty mottles (20 % of soil volume), visible sedimentary stratification of alluvial deposit.

Table 2: Soil texture of Soil profile 1, Hamuliakovo.

Horizon	Sample depth	Clay [%]	Fine silt [%]	Medium silt [%]	Coarse silt [%]	Fine sand [%]	Medium sand [%]	Coarse sand [%]
[cm]		<0.002 mm	0.002-0.0063 mm	0.0063-0.02 mm	0.02-0.063 mm	0.063-0.2 mm	0.2-0.63 mm	0.63-2.0 mm
Ap	0-10	28.1	9.3	18.0	19.2	18.0	7.3	0.1
AC	30-35	25.4	10.2	14.2	18.9	22.3	8.9	0.1
Cl	50-55	23.9	9.0	15.5	21.7	22.1	7.7	0.1
2Cl	110-120	13.7	1.1	6.6	17.8	43.6	17.2	0.1

Table 3: Soil physical parameters of Soil profile 1, Hamuliakovo.

Horizon	Sample	Bulk density	Total porosity	Capillary pores	Semi-capillary pores	Non-capillary pores	pF 2,0	pF 2.5	pF 4,2	k_f
[cm]		[g/cm^3]	[vol.%]							[cm. min^{-1}]
Ap	0-10	1.38	48.9	34.8	4.1	9.9	36.7	26.1	10.4	0.0583
AC	30-35	1.48	46.4	33.4	4.3	8.6	35.4	24.8	8.8	0.0143
Cl	50-55	1.34	51.2	31.6	6.1	13.5	34.6	23.4	6.6	0.0417
2Cl	110-115	1.39	49.6	29.0	14.6	6.0	39.4	25.8	5.4	0.1187

Table 4: Soil chemical parameters of Soil profile 1, Hamuliakovo.

Horizon	Sample	pH_{CaCl2}	$CaCO_3$	EC	C_{org}	N_{tot}	C/N ratio	P_{avail}	K_{avail}	K_{exch}	Na_{exch}	Ca_{exch}	Mg_{exch}	CEC	Base sat.
[cm]			[%]	[mS/cm]	[%]	[mg/kg]		[mg/kg]		[cmol+/kg]					[%]
Ap	0-10	7.3	22.5	0.18	1.4	1651	8.2	<20	109	0.3	0.4	17.4	1.3	17.3	100
AC	30-35	7.6	29.8	0.16	0.3	763	-	<20	55	0.1	0.0	19.9	1.4	10.0	100
Cl	50-55	7.6	24.6	0.14	0.1	782	-	<20	49	0.0	0.0	25.3	2.0	10.7	100
2Cl	110-120	7.7	20.2	0.13	0.1	396	-	<20	35	0.0	0.1	8.5	2.2	7.8	100

Table 5: Total analyses of Soil profile 1, Hamuliakovo.

Horizon	Sample	P	Ca	Mg	K	Na	Fe	Al	Mn
[cm]		[mg/kg]							
Ap	0-10	717	60784	29207	8722	339	21385	12914	420
AC	30-35	426	67067	28717	6008	260	18932	9667	353
Cl	50-55	465	72465	30077	6160	384	19881	10242	352
2Cl	110-120	355	52355	27092	3388	258	16385	6841	292

Figure 1: Soil profile 1, Hamuliakovo.

3.2 Excursion point 2: Soil profile Gabcikovo, Danube Plain: Mollic Fluvisol Calcaric from alluvial loam

Site characterisation

Location

Alluvial plain of Danube, (47° 54.387' northern latitude, 17° 35.424' eastern longitude, 116 m above sea)

Climate

Climate type: Cfb (Koppen)

Table 6: Basic climatic characteristics of Gabcikovo site.

Parameter	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
T [°C]	-1.7	0.7	4.9	10.1	15.0	18.0	19.6	18.7	14.9	9.7	4.3	0.2	9,5
R [mm]	40	37	31	36	52	61	55	54	41	36	51	43	537

Relief

Flat alluvial plain.

Landuse/vegetation

Arable land (major crops: grain maize, winter wheat, spring barley, sunflower).

Soil profile description: **Mollic Fluvisol Calcaric, Gabčíkovo**

Ap (0 – 30 cm): silty clay, 2.5Y/4/2 (dry), 2.5Y/3/1 (moist), moist, loose, strongly calcareous, fine to medium granular, loose, few crop residues (maize), clear smooth boundary.

A (30 – 50 cm): silty clay loam, 2.5Y/4,5/1 (dry), 2.5Y/3/2 (moist), strongly calcareous, moist, friable, medium subangular blocky, humiferous coatings, few rusty mottles, few roots, gradual smooth boundary.

AC (50 – 65 cm): silty clay, 2.5Y/5/2 (dry), 2.5Y/4/1-7/3 (moist), contrast colors, strongly calcareous, moist, medium to coarse angular blocky, abundant rusty mottles, humiferous coatings abundant small to medium calcareous nodules (2-20 mm) , diffuse wavy boundary.

Cl1 (65 – 95 cm): silty clay loam, 2.5Y/6/2 (dry), 5Y/6/2-2.5Y/5/6 (moist), contrast colours, strongly calcareous, moist, firm, massive (few large prism faces and fissures), rusty mottles (20% of soil volume), abundant small to large

calcareous nodules (5-40 mm), abundant krotovinas (humiferous filling of vertical channels), few humiferous coatings, smooth diffuse boundary.

Cl2 (90 – 130 cm): silty clay, 2.5Y/6/2 (dry), 10YR/6/8-5Y/6.5/2 (moist), contrast colours, strongly calcareous, moist, firm, massive, rusty mottles (50% of soil volume), few calcareous nodules, few humiferous coatings.

Cr (130 – 135 cm): sandy loam, 2.5Y/5/2-6/8 (5/2 >50 %) (moist), strongly calcareous, moist, firm, massive, (reduction Gley-horizon).

Table 7: Soil texture of Soil profile 2, Gabcikovo.

Horizon	Sample depth	Clay [%]	Fine silt [%]	Medium silt [%]	Coarse silt [%]	Fine sand [%]	Medium sand [%]	Coarse sand [%]
[cm]		<0.002 mm	0.002-0.0063 mm	0.0063-0.02 mm	0.02-0.063 mm	0.063-0.2 mm	0.2-0.63 mm	0.63-2.0 mm
Ap	10-15	41.0	20.6	24.8	9.3	2.5	1.7	0.2
A	35-40	39.1	18.3	19.9	15.9	5.1	1.7	0.1
AC	50-60	41.2	18.6	20.2	13.5	3.2	1.5	1.7
Cl1	75-85	29.1	12.4	23.6	26.5	6.5	1.0	0.9
Cl2	115-120	22.4	6.9	16.2	31.5	20.3	2.8	0.1

Table 8: Soil physical parameters of Soil profile 2, Gabcikovo.

Horizon	Sample	Bulk density	Total porosity	Capillary pores	Semi-capillary pores	Non-capillary pores	pF 2,0	pF 2.5	pF 4,2	k_f
[cm]		[g/cm^3]	[vol.%]							[cm. min^{-1}]
Ap	10-15	1.09	59.3	35.4	4.3	19.6	37.9	28.9	15.4	0.3535
A	35-40	1.32	50.9	40.7	3.6	6.6	42.4	32.8	18.4	0.0170
AC	55-60	1.43	47.7	37.0	2.8	7.9	38.7	28.9	14.2	0.0190
Cl1	70-80	1.57	42.9	36.9	2.9	3.1	38.4	27.2	10.4	0.0268
Cl2	115-120	1.60	42.3	40.1	1.8	0.4	40.7	27.9	8.7	0.0021

Table 9: Soil chemical parameters of Soil profile 2, Gabcikovo.

Horizon	Sample	pH_{CaCl2}	$CaCO_3$	EC	C_{org}	N_{tot}	C/N ratio	P_{avail}	K_{avail}	K_{exch}	Na_{exch}	Ca_{exch}	Mg_{exch}	CEC	base sat.
[cm]			[%]	[mS/cm]	[%]	[mg/kg]		[mg/kg]		[cmol+/kg]					[%]
Ap	10-15	7.5	28.2	0.18	2.9	3032	9.5	<20	165	0.4	0.0	34.8	4.1	34.9	100
A	35-40	7.6	31.7	0.19	1.9	2384	8.0	<20	99	0.2	0.0	30.9	4.3	30.2	100
AC	50-60	7.7	35.4	0.24	0.8	1444	5.5	<20	103	0.2	0.5	52.5	8.0	28.0	100
Cl1	75-85	7.7	41.9	0.39	0.1	618	-	<20	69	0.1	0.2	108.7	10.1	18.5	100
Cl2	115-120	7.6	34.2	0.52	0.1	584	-	<20	48	0.1	0.1	16.7	4.2	12.5	100

Table 10: Total analyses of Soil profile 2, Gabcikovo.

Horizon	Sample	P	Ca	Mg	K	Na	Fe	Al	Mn
[cm]		[mg/kg]							
Ap	10-15	754	68391	26166	11509	585	27868	17462	469
A	35-40	464	85831	28464	9301	438	25780	15057	411
AC	50-60	361	97325	32215	8415	401	24408	13442	362
Cl1	75-85	384	106712	35469	5365	284	20655	9810	418
Cl2	115-120	429	74867	34571	4035	226	22904	9150	289

Figure 2: Soil profile 2, Gabcikovo.

3.3 Excursion point 3: Gabcikovo, Danube Plain: Visit of Gabcikovo Hydrostructure

Unique phenomenon of present-day landscape is the Gabcikovo Hydrostructure built on the Danube. It is a multifunctional structure used for electricity production, flooding prevention, river transport support and overall river management. Its ecological effects were intensively studied and this research involved also the monitoring of the hydro-structure's effect on the soils, especially on moisture regime and organic matter quality. The results proved the predominance of positive effects.

3.4 Excursion point 4: Soil Profile Voderady, Trnava Hilly Land: Haplic Chernozem from loess

Site characterisation

Location

Lower part of Trnava Hilly Land (Trnava Plateau) built by loess, (48° 17.042' northern latitude, 17° 33.192' eastern longitude, 139 m above sea)

Climate

Climate type: Cfb (Koppen)

Table 11: Basic climatic characteristics of Voderady site

Parameter	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
T [°C]	-1.8	0.6	4.8	10.1	15.0	18.2	19.9	19.3	15.4	9.9	4.4	0.2	9.7
R [mm]	40	38	31	35	52	63	53	55	39	36	53	46	541

Relief

Flat plateau at wide loess ridge.

Land use/vegetation

Arable land (major crops: grain maize, winter wheat, spring barley, sunflower, oil rape).

Soil profile description: **Haplic Chernozem, Voderady**

Ap (0 – 30 cm): silty clay loam, 10YR/4/2 (dry), 10YR/2/2 (moist), slightly calcareous, moist, friable, medium granular to subangular blocky, few crop residues, abundant fine roots, clear smooth boundary.

A (30 – 60 cm): silty clay loam, 10YR/4/2 (dry), 10YR/2/2 (moist), slightly calcareous, moist, friable, fine to medium granular, few calcareous pseudomycelia, humiferous coatings, abundant fine roots, diffuse smooth boundary.

AC (60 – 85 cm): silty clay, 10YR/4/2 (dry), 10YR/5/4-3.5/3 (moist), contrast colours, strongly calcareous, moist, friable, medium angular blocky, abundant calcareous pseudomycelia, abundant fine roots, diffuse irregular boundary.

Ck (85 – 130 cm): silty clay loam, 10YR/4/2 (dry), 10YR/6.5/6 (moist), strongly calcareous, moist, firm, coarse blocky in upper part of the horizon, massive in lower part, abundant pseudomycelia, few small calcareous nodules (2-10 mm), abundant krotovinas, few fine roots.

Table 12: Soil texture of Soil profile 3, Voderady.

Horizon	Sample depth	Clay [%]	Fine silt [%]	Medium silt [%]	Coarse silt [%]	Fine sand [%]	Medium sand [%]	Coarse sand [%]
[cm]		<0.002 mm	0.002-0.0063 mm	0.0063-0.02 mm	0.02-0.063 mm	0.063-0.2 mm	0.2-0.63 mm	0.63-2.0 mm
Ap	0-10	32.0	9.7	28.0	25.7	3.4	1.0	0.2
A	40-50	37.5	11.4	25.4	22.1	2.9	0.6	0.1
AC	65-70	40.4	10.2	23.1	23.5	2.2	0.6	0.1
Ck	110-120	33.6	10.5	28.2	25.3	1.9	0.6	0.0

Table 13: Soil physical parameters of Soil profile 3, Voderady.

Horizon	Sample	Bulk density	Total porosity	Capillary pores	Semi-capillary pores	Non-capillary pores	pF 2,0	pF 2.5	pF 4,2	k_f
[cm]		[g/cm^3]	[vol.%]							[cm. min^{-1}]
Ap	0-10	1.44	45.8	35.6	3.8	6.3	37.9	29.8	17.8	0.0151
A	40-45	1.55	42.3	33.6	2.8	5.9	34.9	28.2	18.0	0.1244
AC	65-70	1.36	49.5	32.1	4.7	12.8	34.1	26.9	16.2	0.0626
Ck	110-120	1.47	46.3	34.8	6.3	5.1	38.4	27.8	11.8	0.0282

Table 14: Soil chemical parameters of Soil profile 3, Voderady.

Horizon	Sample	pH_{CaCl2}	$CaCO_3$	EC	C_{org}	N_{tot}	C/N ratio	P_{avail}	K_{avail}	K_{exch}	Na_{exch}	Ca_{exch}	Mg_{exch}	CEC	Base sat.
[cm]			[%]	[mS/cm]	[%]	[mg/kg]		[mg/kg]		[cmol+/kg]					[%]
Ap	0-10	7.1	0.5	0.16	1.9	2513	7.7	122	481	0.1	0.2	23.2	3.0	30.1	88
A	40-50	7.3	0.4	0.17	1.4	1776	8.1	28	200	0.4	0.1	25.2	2.6	30.1	94
AC	65-70	7.6	15.6	0.17	0.9	1284	7.1	<20	132	0.3	0.1	30.3	2.6	18.9	100
Ck	110-120	7.6	32.2	0.18	0.2	717	-	<20	96	0.2	0.1	38.0	4.3	22.1	100

Table 15: Total analyses of Soil profile 3, Voderady.

Horizon	Sample	P	Ca	Mg	K	Na	Fe	Al	Mn
[cm]		[mg/kg]							
Ap	0-10	973	4142	6595	11764	319	28955	31785	630
A	40-50	653	4195	6414	10371	321	30596	31140	612
AC	65-70	568	38252	11361	8514	343	26321	15665	457
Ck	110-120	440	84349	20500	5786	228	21457	9787	361

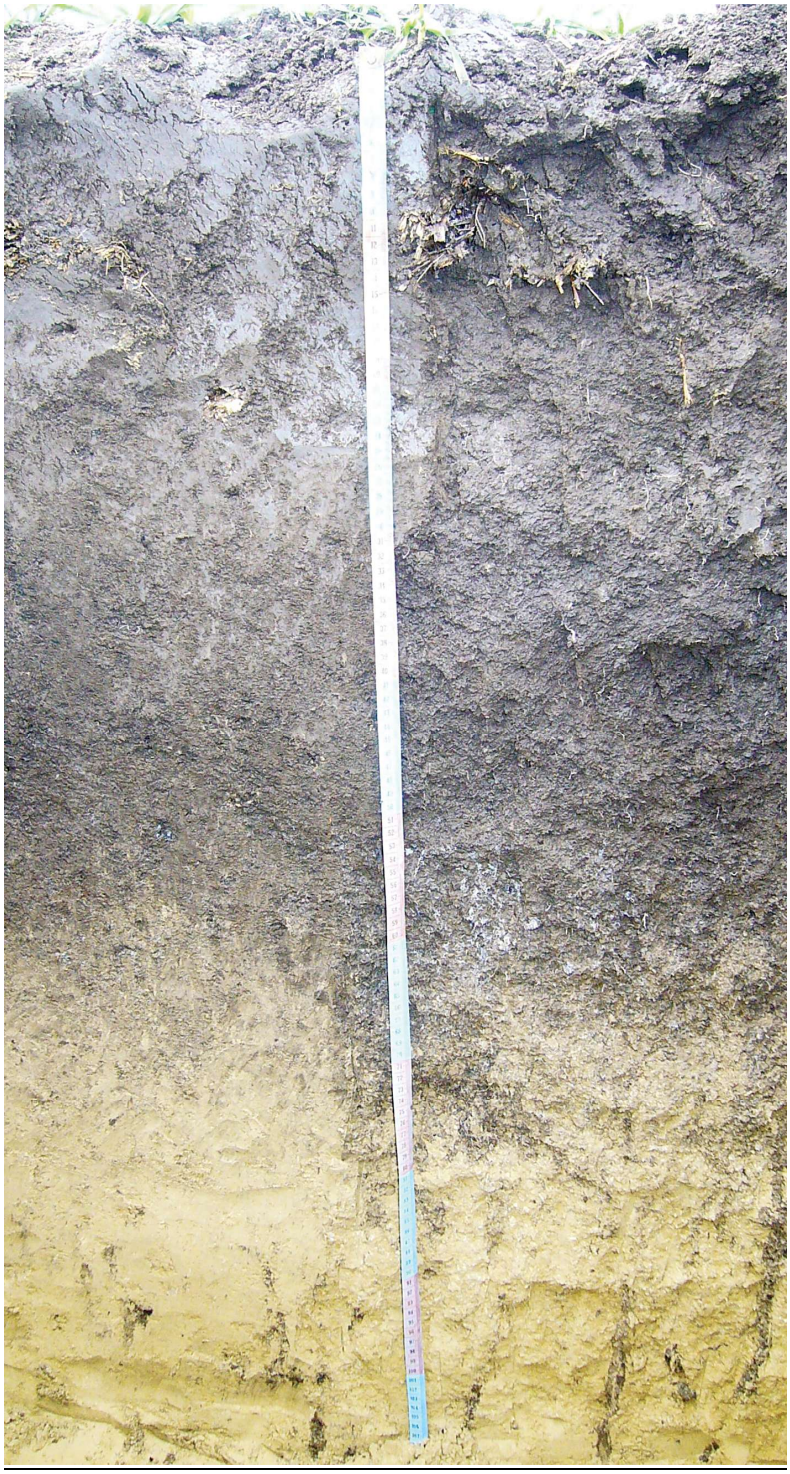

Figure 3: Soil profile 3, Voderady.

3.5 Excursion point 5: Soil profile Sterusy, Trnava Hilly Land: Cutanic Luvisol from loess

Size characterisation

Location

Upper part of Trnava Hilly Land below the footslopes of Little Carpathians built by loess, (48° 35.949' northern latitude, 17° 41.117' eastern longitude, 225 m above sea)

Climate

Climate type: Cfb (Koppen)

Table 16: Basic climatic characteristics of Sterusy site.

Sterusy	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Year
T [°C]	-2.0	0.4	4.5	9.6	14.5	17.4	18.9	18.4	14.6	9.7	4.2	-0.1	9.2
R [mm]	40	37	32	42	61	68	58	62	42	38	55	52	587

Relief

Slightly inclined top of wide loess ridge.

Landuse/vegetation

Arable land (major crops: maize (grain and forage), winter wheat, spring barley, oil rape, sugar beet).

Soil profile description: **Cutanic Luvisol, Sterusy**

Ap (0 – 33 cm): silty clay loam, 10YR/4/3 (dry), 10YR/4/4 (moist), wet, non-plastic, medium subangular blocky, clods of Bt material admixed in lower part of horizon, few fine roots, abrupt wavy boundary.

Bt (33 – 90/100 cm): silty clay, 10YR/4/3 (dry), 7.5YR/4/4 (moist), moist, friable, angular blocky to prismatic, abundant clay coatings, abundant krotovinas (humiferous fillings of vertical channels), clear wavy boundary.

Ck (90/100 – 120 cm): silty clay loam, 2.5Y/6/3.5 (dry), 10YR/7/4 (moist), moist, strongly calcareous, slightly moist, friable, large prismatic to massive, few clay coatings, few krotovinas (fillings of vertical channels with decalcified Bt material), abundant small calcareous nodules (5-10 mm), abundant pseudomycelia.

Table 17: Soil texture of Soil profile 4, Sterusy.

Horizon	Sample depth	Clay [%]	Fine silt [%]	Medium silt [%]	Coarse silt [%]	Fine sand [%]	Medium sand [%]	Coarse sand [%]
[cm]		<0.002 mm	0.002-0.0063 mm	0.0063-0.02 mm	0.02-0.063 mm	0.063-0.2 mm	0.2-0.63 mm	0.63-2.0 mm
Ap	0-10	32.7	9.4	27.1	28.8	1.0	0.6	0.4
Bt	40-45	44.6	10.0	22.0	22.9	0.4	0.2	0.0
Bt	70-75	40.6	9.6	25.1	24.1	0.6	0.1	0.0
Ck	90-100	32.4	11.3	27.6	25.8	0.9	1.5	0.5

Table 18: Soil physical parameters of Soil profile 4, Sterusy.

Horizon	Sample	Bulk density	Total porosity	Capillary pores	Semi-capillary pores	Non-capillary pores	pF 2,0	pF 2.5	pF 4,2	k_f
[cm]		[g/cm^3]	[vol.%]							[cm. min^{-1}]
Ap	10-20	1.68	36.7	33.7	1.5	1.5	34.5	27.2	16.1	0.0403
Bt	40-45	1.62	40.6	34.7	1.2	4.6	35.5	29.7	21.2	0.0009
Bt	70-75	1.51	44.3	35.1	2.5	6.8	36.4	29.5	19.1	0.0207
Ck	90-100	1.49	45.4	34.9	3.6	6.8	36.8	26.8	11.7	0.0077

Table 19: Soil chemical parameters of Soil profile 4, Sterusy.

Horizon	Sample	pH_{CaCl2}	$CaCO_3$	EC	C_{org}	N_{tot}	C/N ratio	P_{avail}	K_{avail}	K_{exch}	Na_{exch}	Ca_{exch}	Mg_{exch}	CEC	Base sat.
[cm]			[%]	[mS/cm]	[%]	[mg/kg]		[mg/kg]		[cmol+/kg]					[%]
Ap	0-10	7.2	0.8	0.11	1.0	1413	7.2	132	365	1.1	0.0	14.1	2.3	15.1	100
Bt	40-45	7.1	0.1	0.09	0.3	974	-	42	208	0.5	0.1	15.2	3.6	21.2	91
Bt	70-75	7.2	0.1	0.09	0.2	528	-	56	169	0.3	0.2	15.6	3.4	22.5	86
Ck	90-100	7.5	21.6	0.13	0.2	426	-	<20	131	0.3	0.0	22.4	2.8	18.1	100

Table 20: Total analyses of Soil profile 4, Sterusy.

Horizon	Sample	P	Ca	Mg	K	Na	Fe	Al	Mn
[cm]		[mg/kg]							
Ap	0-10	657	3100	5691	9285	258	25209	20099	593
Bt	40-45	518	1710	6655	11682	255	33856	35863	503
Bt	70-75	608	1978	6886	9386	321	32973	31397	540
Ck	90-100	486	48803	15161	7775	221	25300	13913	458

Figure 4: Soil profile 4, Sterusy.

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