Soil Conditions in Sopron

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Abstract – The aim of our study was the investigation of the physical and chemical characteristics of soils of Sopron. Based on our results the physical assortment of the samples was highly clay in 60 % of the samples. The pH measurements show that the deeper soil layers belong to the slightly high class. 25 % of the samples does not contain calcium-carbonate, but calcium-carbonate has been found in the majority of the samples in the city center. The upper layers of the soils in Sopron are rich in humus. Especially in the forest soils in the South-western part of the city (next to the TV tower), we detected higher humus and nitrogen values but these values are typically smaller in the deeper soil layer. For the AL-solvent potassium, the lowest values have been measured in the area of the city. We found extremely high values of AL-solvent phosphorus, of KCl-solvent calcium and magnesium in the traffic zones, as well as near to the agricultural area. The highest values have been detected in the Sopron-hills, also in the case of iron. The manganese contents follow the tendencies of the iron values in most of the samples. In both soil layers the higher zinc content have been found in the downtown area, especially near to the busy roads in the center and near to the bus station. The copper content was high in the Virágvölgy and the suburban district of the town.

Keywords: Sopron / urban, suburban, agricultural and forested area / upper and lower soil layers / physical and chemical characteristics

1. INTRODUCTION

1.1 Characteristic environmental factors of the city Sopron

Sopron is located in the north-western part of Hungary on the western border of the country. The area looks like a pothole depression which has been evolved at a margin fault with a diagonal structure (TÓTH ed., 1984). The most part of the city is in the Sopron-basin, which is located between the Fertőside Hills and the Sopron Mountains. It is covered by neogene deposits (DÖVÉNYI ed., 2010). The Sopron-hills may be the oldest Mountains of Hungary, which have been arisen 580-520 million years ago in the Cambrian period. The Sopron-hills consist of polymetamorphic mica-schist and gneiss rock mass, which is faulted toward North-East and had got into a nappe shape (FÜLÖP 1990; BUDAI – KONRÁD 2011). Many parts of the town are covered by tertiary deposits (for example Badenian Clay), which has been covered by the Parent-Ikva more meter thick and good water-bearing gravel cover and by glacial loam, a washover loessal sediment together with the recent (holocene) alluvium. Brown and acid woodland soil evolved in the mountains. In the valleys the characteristic soil type is the lessivage brown woodland soil decisively. The climate of the city is temperate cold, the annual precipitation sum is 500-600 mm. In Sopron-hills the annual precipitation amount is above 750 mm. Hydrogeologically the most important water-course is the Ikva-stream (DÖVÉNYI ed., 2010). The area of the city is inhabited since the prehistoric age. In the Roman age the city was called Scarbantia. After 1277 the was called Suprun, when it became a free royal city. In the time of the occupation of the Turkish, the city became the center of free

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space. In 1676 a conflagration destroyed the most part of Sopron. In World War II the city survived many air raids (TÓTH 2011). Nowadays the largest anthropogenic effects appear in the city construction and in the soils of the city center.

2. MATERIALS AND METHODS

We collected 208 samples on 104 points from two soil layers (in 0-10 and 10-20 cm depths).in the town and its surroundings. First, we noted the characteristics of the study area and the soil samples. Then we measured the most important chemical and physical parameters of soils in a laboratory (BELLÉR 1997). The sampling methods and the methods of the analyses are introduced more in detail in our other article: BIDLÓ et al. (2012). Applying GIS methods (DigiTerraMap), an integrated analysis of the results of the field- and laboratory measurements has been also carried out. In this way we could draw conclusions based on the field data, the laboratory analyses of the samples, as well as on the construction of the settlement and on the earlier experiences.

3. RESULTS

3.1 Acidity

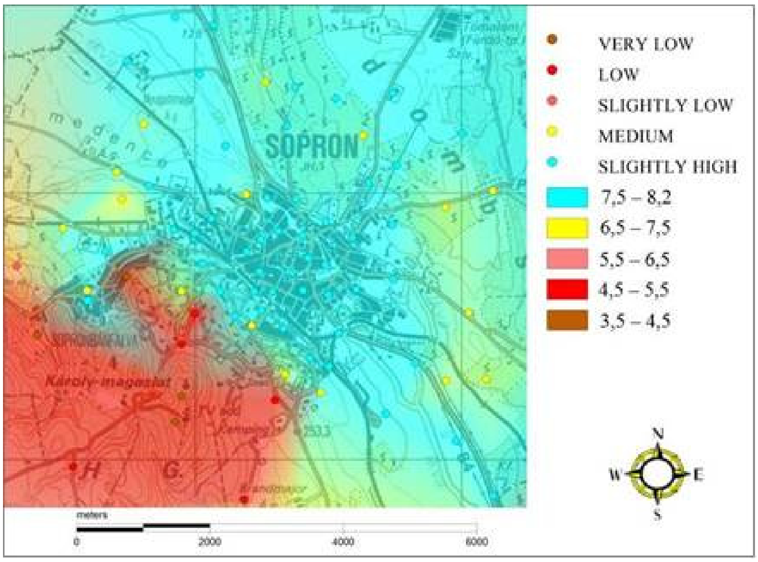

Figure 1. The pH values (pH_{H_2O}) in the upper soil layer (in 0-10 cm depth)

The acidity analysis is the most important one in the soil science, because this serves as a basis to the rest of the examinations. The acidity is determined largely by the bedrock. The city area is covered with sediment (introduced in sect. 1), which is derived from the geologic circumstances and from the anthropogenic effects. This sediment is calcareous (CRAUL 1992), therefore the largest part of the samples originating from there are alkaline or weakly alkaline (STEFANOVITS 1992). All of the samples collected in the downtown are alkaline. The highest alkaline values have been measured in the downtown in the Deák square (pH 8.1), and in the suburban area of Fertőboz (pH 8.3). The samples from the Sopron-hills belonged to the acidic categories according to the bedrock, while the samples from the downtown shows a pH of 4.5. The most acid character has been found on the road to the heroic cemetery in Bánfalva suburb (pH 4.0). In this area the other samples also showed similar acidity (*Figure 1*).

3.2 Calcium-carbonate content

The lime content showed a strong correlation with the acidity. In both layers we measured the maximum value (72.2 %) in the sampling plot between Piusz and Sopronpuszta and near to the Ipar boulevard at the GYSEV railway station (51.9%). Here, we do not find any calcium-carbonate in the samples. In spite of this in the Sopron-hills it is a dominating character of the soils. In the downtown area the calcareous (20.3%) soil sample came from the Kölcsey street, which may indicate the presence of substances used in the building operations. The samples in the downtown can be characterized by high calcium-carbonate ($CaCO_3$) content (BELLÉR 1997). One third of the samples of the suburban area show the same result. In the city centre, the calcium-carbonate content of the soil may originate from the debris and waste of the previous building operations.

3.3 The physical assortment of the soils

The physical assortment of the soil has been determined based on the particle size distribution and the Arany-type compactness restriction analysis (SZODFRIDT 1993). In 80% of the samples the physical assortment of the upper soil layer belongs to the clay category. These kinds of soils can be characterized by medium water management. Their water absorbing capacity is low, therefore they can store the water quite well, but this water is hardly available for the vegetation. On the South-western part of Sopron the Arany-type compactness is often high in both levels.

For many samples the joint analysis of the soil properties shows, that the high compactness values occurs together with hight humus and hight nitrogen content. We observed this phenomenon in all of the soil samples in the suburban forests. A possible reason for it is, that these forest soils the substantial litter layer and the moisture content are seldom affected by human disturbance. Thus the decomposition processes are quick, which can result in good fertilized soils. The other reason for it can be, that the humus content increase the water storage capacity of the soils, which is followed by the rise of the Arany-type compactness index.

3.4 Humus investigations

Based on the analysis of the integral substance content of the soils, 94% of the samples contained more than 2% humus, which is a favorable characteristic. The humus content shows large differences between the city center and the suburban area. In the downtown no extreme values have been measured. Here, less than 10% humus has been found in each of the plots. But in the suburban forests we detected much more extreme values. This is the reason why we found more than 10% humus in the forest soils near to the TV tower. It has to be mentioned, that not only the upper, but also in the lower soil layer contains more than 10% humus.

3.5 Nutrient content

We have observed that the nitrogen contents were higher proportionally in the places, where we detected high humus values. The reason for it can be, that the organic matter in the soil is rich not only in coal, but also in nitrogen. The upper layer was fully saturated by nitrogen (STEFANOVITS et al. 1999), whereas the lower layer not. Thus the nitrogen values in the upper soil layer were always higher (with a few exceptions). We detected the extreme values near to the TV tower (0.75 N%) and on the neighborhood sampling places in Balf (0.54 N%) (*Figure 2).*

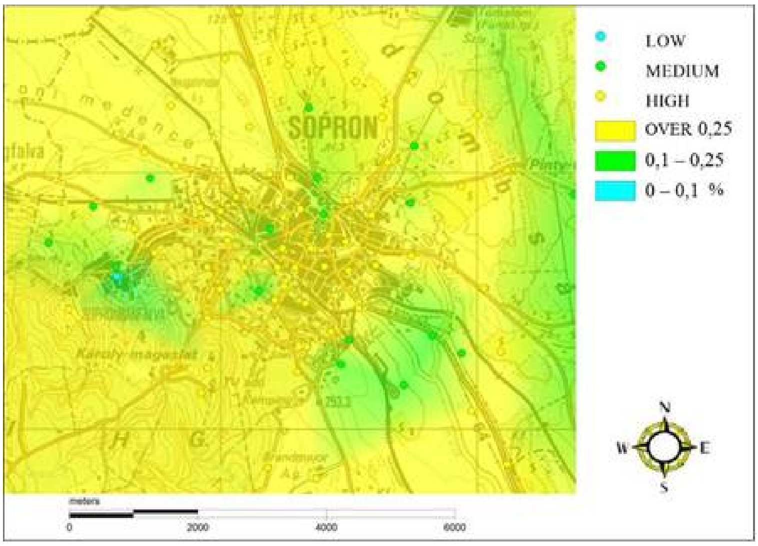

Figure 2. The soil nitrogen content (N%) in the upper layer (in 0-10 cm depth)

The nitrogen content varies in the correlation with the ammonium-lactat-acetous acid (AL) solvent potassium content. This variability may come from the use of the potassium fertilizers, that have been applied on the fields, on the lawns and in the backyards in order to create good fertilized soil. We measured the highest potassium content on the sampling point near to the Sopron-Győr railway (87.2 mg K_2O_5/100g) and in the soils of the Gidai-patak street (94.8 mg K_2O_5/100g) in both layers. The ammonium-lactat-acetous acid (AL) solvent phosphorus results showed, that in 55-65% of the samples 100 grams of soil contained more than 26 mg P_2O_5 in both layers (BELLÉR 1997), what belongs to the class "too much". From the downtown samples, the heavy traffic zones show the highest values, whereas in the suburban samples of the cultivated area the high potassium values 70 and 90 mg K_2O_5/100g. This occurs together with high phosphorus contents.

3.6 Potassium chloride (KCl) solvent calcium and magnesium

We did not find a big difference in the supply of magnesium between the areas of the town. The magnesium content had a similar distribution, 80-90% of the values could be classified into the "below 0.32 g/kg" category. Magnesium deficiency may occur in the soils, which can be characterized by high calcareous and potassium content (KALOCSAI 2006). Naturally the magnesium content (0.79 g Mg/kg) behind the bottler works at Balf was the most significant from the collected samples, because such kind of mineral water can reach the surface, which has been stored in the tortonaian clastic deposit since the formations of the miocene beds. The highest calcium content was measured in the traffic zones, ($CaCl_2$ is often used to de-icing of the roads) and near to the agricultural areas also. The soil samples collected at the Amphitheatre and in Felsőbüki Nagy Pál street can be characterized by high soluble calcium values (6.47 g Ca/kg and 6.17 g Ca/kg, respectivelly). The high value of the Amphitheatre can be explained by the earlier existed residues of limestone building, or by the dog run area.

3.7 EDTA/DTPA solvent nutrient examinations

The highest soluble iron content has been found the samples from the forest areas (Deákkúti street 1526 mg Fe/kg), and along the road to the heroic cemetery in Bánfalva (1497 mg Fe/kg). In the forests area is typical, that the iron oxides compounds accumulate in the soil and may cause discolouration. In 82-84% of the samples the manganese contents are under the 100 mg/kg limit follow the tendencies of the iron values. In the Dudlesz forest (923.1 mg Mn/kg) and in the forest areas extremely high manganese values have been detected in both soil layers, which is the effect of the bedrock. For both layers the highest zinc values were in the downtown area, especially along the busy roads in the centre and near to the bus station (21.6 mg Zn/kg). The zinc can accumulate not only from the traffic, but there are also zinc and its compounds in our household utensils, in industrial and in agricultural use (CSATHÓ 1994). Based on the results of the soil samples of the city, this is a demonstrable and considerable quantity in both levels from Sopron in northwest direction (75.74 mg Zn/kg) and in Festő köz (28.65 mg Zn/kg) (*Figure 3*).

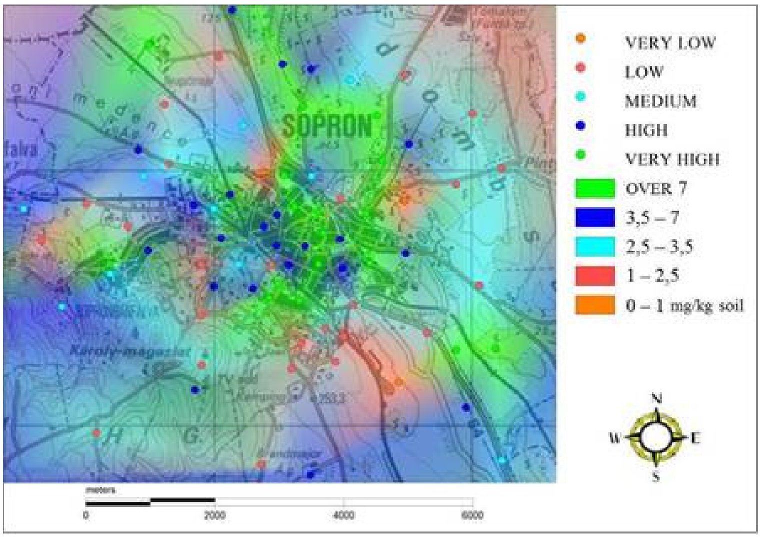

Figure 3. The soil zinc content (Zn mg/kg) in the lower layer (in 10-20 cm depth)

In the Virágvölgy (78.27 mg Cu/kg) and in the suburban district of the town the copper values are significant. In this areas the high copper content can be the result of the grape and cultivation forms – a mix of bluestone and lime – like pesticide. This effect of the crop growth can be explained by the cumulative chlorophyll-formation.

4. FURTHER INVESTIGATIONS

We are planning to continue our researches with further data analyses and evaluations. We would like to interpret our results in broader context, find further connections and correlations as well as explain and reduce the possible inconsistencies. Furthermore, we would like to analyse the heavy metal content of the collected soil samples, to get a whole picture about the industrial and the anthropogenic effects. The information about the heavy metal content is important, because these elements accumulate not only in the soils and in the environment, but they may have serious effects on the human health. We would like to model our results and applying the introduced GIS methods to find the connection between the characteristics of the soils and the other environmental factors (e.g. air pollution, vegetation).

Acknowledgement: This work was funded by the TÁMOP-4.2.2.B-10/1-2010-0018 and TÁMOP 4.2.1.B-09/1/KONV-2010-0006. We thank Zsófia Varga, Mrs. Miklósné Stark and György Pulger for their assistance in carrying out the field and laboratory examinations, as well as Gábor Brolly for his assistance in carrying out the Digiterra Map working and Borbála Gálos for the language check.

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