# THE MAPPING OF SOILS AS RENEWABLE ENERGY SOURCES AND THE VALUATION OF THEIR FUNCTIONS ON THE REGIONAL PLANNING. CASE STUDY: EGERSZALÓK, NORTH HUNGARY

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A TALAJOK, MINT MEGÚJULÓ ENERGIAFORRÁSOK TÉRKÉPEZÉSE ÉS AZOK TERÜLETI TERVEZÉSBEN JÁTSZOTT SZEREPÜK ÉRTÉKELÉSE. ESETTANULMÁNY: EGERSZALÓK, ÉSZAK-MAGYARORSZÁG

## Abstract

As is well-known, soils belong to renewable energy sources, which play an important part of the continuous operation and rejuvenation of economic systems and settlements. The status, quality and optimal utilization of soils could be the basic element for the long-term regional planning. We have investigated the spatial distribution and classification of different main soil types, their physical properties and their importance on regional planning in Egerszalók located in North Hungary. Egerszalók is a part of the Eger Micro region in Heves County and its territory is 23.11 km$^2$. We have deepened 15 soil profiles and soil drills in the study area and we have classified different soil types using HS 1398/1998 and WRB soil classification system. Based on our results, main soil types were determined in the study area and soil erosion map, land-use map and map of thickness of A horizon were drawn. We could point out such territories which are important for the development of the settlement's economic system.

Keywords: soil mapping, renewable energy sources, soil erosion, regional planning, Egerszalók

## Introduction

The investigation of soils, land-use and settlement or regional planning systems is an actual scientific task nowadays because our living space narrows down. That is why, we have to attach importance to mapping of renewable energy sources, land-use systems and possibility of sustainable development. The mapping method of soils were changed over the world in 2006, the FAO worked out the WRB soil classification system (FAO 2006, IUSS WORKING GROUP WRB. 2007) and this method is used in Hungary (NOVÁK T. J. 2013) as well. Numerous scientists deal with land-use changes in different study areas in historic time (KOSMAS, C. et al. 1997, BAKKER et al. 2005, JORDÁN GY. et al. 2005, BANDI E. – RUSSU T. 2005, CEBECAUER, T. – HOFIERKA, J. 2008, SZILASSI P. et al. 2010, DEMÉNY K. – CENTERI CS. 2012) and the investigation of soil

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erosion caused by land-use changes or interference of different landscape factors is focus on scientists' attention as well (STEFANOVITS P. 1981, KERTÉSZ Á. 2004, KERTÉSZ Á. 2008, KERTÉSZ Á. 2009, JAKAB G. et al. 2009, KERTÉSZ Á. et al. 2009, FARSANG A. et al. 2011, BORCSIK Z. et al. 2011, SZALAI Z. – JAKAB G. 2011, KERTÉSZ Á. et al. 2012). Our main task is to reduce soil erosion, work out some methods for protection against soil erosion and plan optimal land-use systems in settlements and micro regions.

## Materials and Methods

We have investigated the spatial distribution and classification of different soil types, their physical properties, thickness of humus layer (A horizon), soil erosion and their importance on regional planning in Egerszalók. This settlement is located in Northern Hungary. Egerszalók is a part of Eger Micro region in Heves County and it is situated 5 km far away from Eger, along the valley of the Laskó Stream (*Fig.1*). Its territory is 23.11 km$^2$.

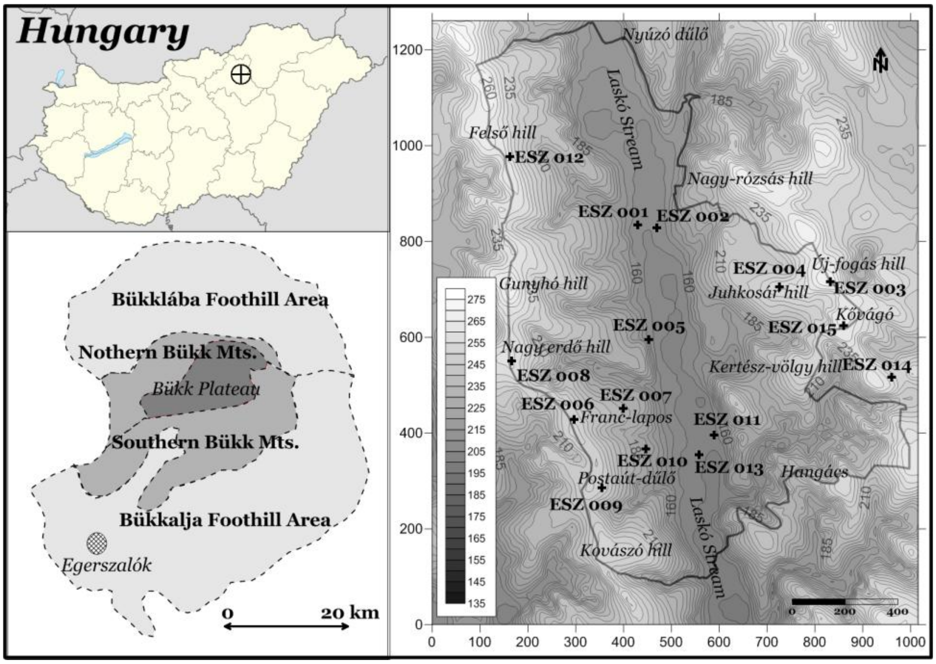


Fig.1. The topographical map of the study area and sites of soil profiles

Firstly, we did some research work on soil mapping in scale of 1:10 000 in this settlement from April of 2013 to July of 2013. We have deepened 15 soil profiles and soil drills in the study area and we have classified different soil types using HS 1398/1998 and WRB soil classification system (IUSS WORKING

GROUP WRB. 2007, NOVÁK T. J. 2013) (*Table 1.*). During our surveying, we defined the soil colour, genetically soil horizons, soil texture, soil structure, consistence, soil-water status, the appearance of carbonates and different materials inside soil horizons, carbonate contents and other biological features

Table 1. Investigated soil types of the study area and their location

| **GPS data** | **Number of soil profiles** | **Soil types** (Hungarian soil classification system) | **Soil types** (WRB soil classification system) |
|---|---|---|---|
| N 47°53'106''<br>E 20°18'506'' | **ESZ 001**<br>(153 m) | Meadow soils:<br>*alluvial meadow soil* | Fluvisols |
| N 47°53'108''<br>E 20°19'020'' | **ESZ 002**<br>(152 m) | Alluvial and slope soils:<br>*alluvial soil with humus content* | Fluvisols |
| N 47°52'499''<br>E 20°20'529'' | **ESZ 003**<br>(259 m) | Brown forest soils: *non-podzolic brown forest soil with clay illuvation* | Luvisols |
| N 47°52'476''<br>E 20°20'179'' | **ESZ 004**<br>(235 m) | Soils based on rocks:<br>*erubase soil* | Umbrisols |
| N 47°52'245''<br>E 20°18'583'' | **ESZ 005**<br>(157 m) | Meadow soils:<br>*carboniferous alluvial meadow soil* | Fluvisols |
| N 47°51'482''<br>E 20°18'082'' | **ESZ 006**<br>(224 m) | Brown forest soils: *brown forest soil with carbonate content* | Cambisols |
| N 47°51'532''<br>E 20°18'423'' | **ESZ 007**<br>(190 m) | Brown forest soils: *brown forest soil with carbonate content* | Cambisols |
| N 47°52'137''<br>E 20°17'271'' | **ESZ 008**<br>(243 m) | Brown forest soils: *brown forest soil with carbonate content* | Cambisols |
| N 47°51'192''<br>E 20°18'265'' | **ESZ 009**<br>(220 m) | Brown forest soils: *non-podzolic brown forest soil with clay illuvation* | Luvisols |
| N 47°51'359''<br>E 20°18'518'' | **ESZ 010**<br>(181 m) | Brown forest soils: *non-podzolic brown forest soil with clay illuvation* | Luvisols |
| N 47°51'311''<br>E 20°19'447'' | **ESZ 011**<br>(146 m) | Meadow soils:<br>*alluvial meadow soil* | Fluvisols |
| N 47°53'431''<br>E 20°17'251'' | **ESZ 012**<br>(246 m) | Brown forest soils: *brown forest soil with carbonate content* | Cambisols |
| N 47°51'292''<br>E 20°19'295'' | **ESZ 013**<br>(144 m) | Alluvial and slope soils:<br>*alluvial soil* | Fluvisols |
| N 47°52'084''<br>E 20°21'327'' | **ESZ 014**<br>(235 m) | Soils based on rocks:<br>*erubase soil* | Umbrisols |
| N 47°52'307''<br>E 20°21'088'' | **ESZ 015**<br>(250 m) | Soils based on rocks:<br>*erubase soil* | Umbrisols |

and human-made materials of soil horizons. After that, we created topographical map, land-use map, soil erosion map and map of thickness of humus layer using by SURFER 9.0 software.

## Results of the investigation

We have deepened 15 soil sections and soil drills in Egerszalók to do some research work on possibility of using and planning of soils as renewable energy sources. Miocene rhyolite tuffs (Felnémet Rhyolite Tuff Formation) build up the eastern and southeastern territory of the settlement, where *erubase soils (Umbrisols)* were developed in the Juh-kosar hill and Kővágó hill. *Non-podzolic brown forest soil with clay illuvation (Luvisols)* was found in the Új-fogás hill, at the highest top of the young pediment surface (*Table 1., Fig. 1.*). *Alluvial soils and alluvial soils with humus content (Fluvisols)* were developed along the Laskó Stream, while *alluvial meadow soils (Fluvisols)* were appeared at the edge of the alluvium. The territory dissected by erosional valleys is located west of the Laskó Stream and it is built up with Pannonian sediments (*Fig. 5.*). That is why, *brown forest soil with carbonate content (Cambisols)* was appeared in the Franc-lapos and in the Felső hill. *Non-podzolic brown forest soil with clay illuvation (Luvisols)* could be discovered in the south-western part of the settlement, in the Postaút-dűlő at the boundary of the rhyolite tuffs and Pannonian sediments.
The upper horizon of soils being rich in humified organic matter (A horizon) has important part in case of the economic point of view because it can provide for the cultivated plants with nutritive material.

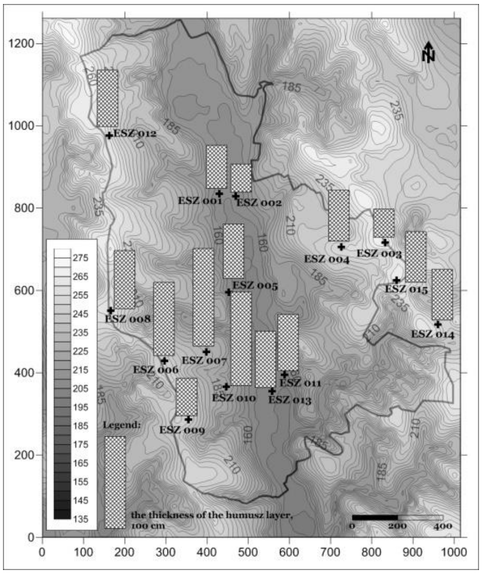


Fig. 2. The map of thickness of A horizon in the study area

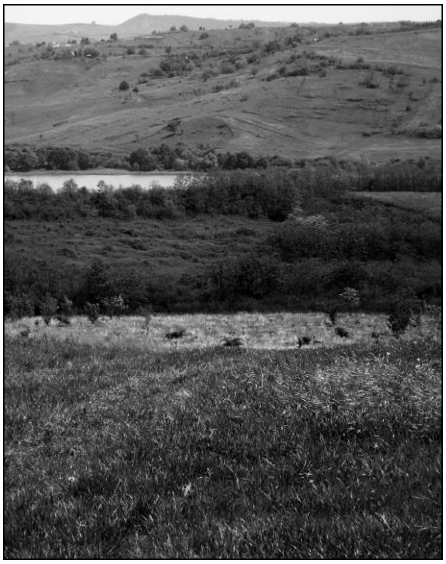

Fig. 3. Landfroms in Egerszalók

(photo: ZELEI Z. 2013)

That is why, after classifying soil types, we investigated A horizon, the layer of accumulated humified organic matters inside soil profiles (*Fig. 2.*). Based on our results, we could classified our soil profiles into four categories in the study area. Soil drill numbered ESZ 003 was deepened in the Új-fogás hill and we could find 30 cm thick A horizon inside the profile. The thickness of humus layer was 41-52-63 cm thick in case of soil profiles depeened at the top of the young pediment surface (ESZ 004, ESZ 008, ESZ 009, ESZ 012 és ESZ 015). The A horizon showed *weakly eroded* character in these soil profiles. The accumulation of *transported and redeposited surface soil* (soil profile numbered ESZ 007) could be seen in the surface of Pleistocene fluvial terraces located along the slopes of the Laskó Stream. The thickness of the A horizon is more than 117 cm. The thickness of the surface soil is 56-97 cm (ESZ 005, ESZ 011, ESZ 013) *in the accumulation zone* of the Laskó Stream, in the Holocene alluvium. Because of the Egerszalók reservoir, we could find 31-48 cm thick A horizon (ESZ 001, ESZ 002) in the alluvium.

Based on data of A horizon (*Fig. 2.*), we could find soil erosion in the study area. To point out the surface erosion, we have used KERÉNYI A. – MARTONNÉ ERDŐS K.' scientific method (1994) and we denoted the ratio of soil erosion in the thickness of the soil profile (%) (*Fig. 4.*).

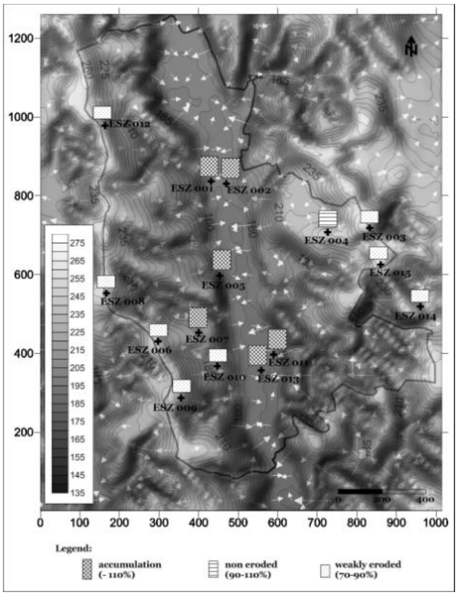


Fig. 4. The ratio of the surface erosion and the accumulation in Egerszalók

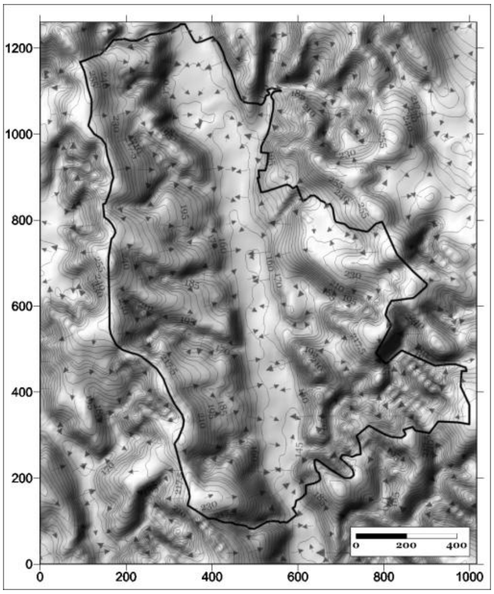

Fig. 5. The linear erosion in Egerszalókon

We have separated three categories in case of surface erosion in the study area. Most of soil profiles (ESZ 003, ESZ 006, ESZ 008, ESZ 009, ESZ 010, ESZ 012, ESZ 014, ESZ 015) could be classified into the *weakly eroded soil category* (70-90%). We could *not observe soil erosion* in the soil profile numbered ESZ 004., but other profiles could be classified into the accumulation category (> 110%). There are intensive surface and linear erosion in Egerszalók. The dissection of western area by north-western – south-eastern and south-western – north-eastern tributary valleys is more intensive (*Fig. 5.*). This territory is built up with more crumbly sediments: Pannonian clays and sands; gravels, sands, clay marls (Sajóvölgy Formation, Zagyva Formation) and Quaternary proluvial clays.

The Tőkés Valley and Maklány Valley caused intensive sediment and soil erosion east of the Laskó Stream. More resistant layers of the Hasány-Felnémet Rhyolite Tuff Formation are built up the base rock of these valleys. The valley dissection is lessened northeast and east of the reservoir in Egerszalók, because the territory of Nyúzó-dűlő and Nagy-rózsás is built up with sediments of the Zagyva Formation. It can be seen (*Fig. 4-5.*) that there is *an accumulation zone* in the middle and southern parts of the alluvium of the Laskó Stream. The accumulation of redeposited sediments moved along slopes was intensive here so that alluvial fans appeared at the edge of the valley.

## Discussion

In the second phase of the investigation, we would like to discover reasons of soil erosion in Egerszalók. The soil erosion was determined by various geological conditions, changing climatic and geomorphologic conditions, changing of surface cover rate and land-use system during the Quaternary period. The drainage system of the Laskó Stream was developed during the Pleistocene and Holocene periods. The changing of land-use system was important in the historic times (FIRST, SECOND AND THIRD MILITARY SURVEY MAPS). That is why, we have made a comparison between the optimal and applied land-use systems in the territory of the settlement (ÁDÁM L. – PÉCSI M. 1985). During our investigation, it is turned out that the territory of Egerszalók is suitable for forestry mainly based on the optimal land-use possibilities. The territory classified with steeper slopes than 25.1% are characteristic in the lowering ridge of the younger pediment surface and at the top of Pleistocene fluvial terraces. Areas that were suitable for vineyards (17.1-25%) originally can be found in fluvial terraces in smaller patches. Intensive agricultural land use could be appeared in the alluvium of the Laskó Stream and in surroundings of Buk hill and Templom hill. The land-use system in Egerszalók is more diverse nowadays. Forests were driven out from the higher pediment surface and they cover steeper slopes, the central zone of erosion valleys and steep valley sides (19%). At the top of younger pediment surface and Pleistocene fluvial terraces, vineyards are the most characteristic land-use category (13.5%). The ratio of intensive cultivated arable lands is 57% in the settlement. Built up territories (4.84%) are only inside the centre of the settlement. The water basin covers 5.3% of the study area. Because we do not use optimal land-use categories and methods in Egerszalók today, the surface and linear erosion is intensive in this settlement.

## Conclusion

According to valuating and planning, we could classify different soil types found in Egerszalók into four categories. (1) *Alluvial meadow soils, carboniferous alluvial meadow soils and alluvial soils with humus content* (*Fluvisols*) have the most productivity in the study area. Every soil type appear in the alluvium of the Laskó Stream, their base rocks are Holocene fluvial sediments and their mean humus content is 2.95% or 2.31% (STEFANOVITS P. 1991, SZENDREI G. 1998). Their water supplies and organic material content are good. (2) The *erubase soils* were developed on rhyolite tuffs located at the top of the younger pediment surface and higher Pleistocene fluvial terraces. Their local mean humus content value shows medium rate, 2.18% (SZENDREI G. 1998). They are shallow soils and they have acid pH value, their water supply is immoderate and their amount of humified organic matter content is unfavourable. (3) The *non-podzolic brown forest soil with clay illuvation and brown forest soil with carbonate content* are mountain and foothill types of soils. Their development based on Pannonian clays, sands and aleurites contained higher carbonate content. These soils appear on volcanic rhyolite tuffs at the south-western boundary of the settlement. Their mean humus content is 1.75-1.67% (SZENDREI G. 1998) and their organic matter content is medium rate. The brown forest soils have favourable conditions for vine-growing in Egerszalók. (4) *Alluvial soils* developed in the alluvium next to the channel bed have 1% humus content value and they contain mineral matters mainly. Because of the continuous sedimentation, they are lack of fertility and organic matter content, but their water management is favourable. Their productiveness is low and they can use for agricultural cultivation (arable lands) austerely. In many respects, different soil types open the doors to various economic possibilities for inhabitants based on the settlement planning aspects.

The most valuable soils being suitable for intensive agricultural cultivation are *alluvial meadow soils and alluvial soils* (*Fluvisols*) in the alluvium of Laskó Stream. The economic utilization of these soils is endangered because new buildings and large projects affect the alluvium nowadays. The soil protection and optimal land-use system are recommended here. Vineyards and arable lands can be found at the top of lower Pleistocene fluvial terraces cultivated from the

1700s. The *erubase soils and brown forest soils with different varieties* have medium rate of organic matter content here. As these areas located under the higher pediment surface, there are intensive sediment and top soil transportation along slopes. These areas were affected by higher foods too so that the thickness of top soil shows advantageous conditions. Vine-growing can be allowed here with such agricultural methods that cause moderate soil erosion (for example: terraced cultivation, sustainable agricultural methods, etc.). We advise the decreasing of arable lands in fluvial terraces because of the soil erosion.
We could map brown forest soils with medium rate of productiveness at the top of the younger pediment surface. In case of these soils, we could observe weak surface erosion. This process indicates the degradation of soil productiveness and the erosion of top soils with high organic matter content. These areas are suitable for vine-growing. These areas were covered by forests originally, but the vegetation cover is low nowadays. That is why, we need to calculate with soil erosion along steeper slopes. We do not suggest intensive, large agricultural cultivation here but small-scale production is allowable here. It is worthily to increase and plan terraced vineyards or energy plants in hilltop and fluvial terraces for the future.

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