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GIS ZHODNOCENÍ REGIONÁLNĚ NEJVÝZNAMNĚJŠÍCH INŽENÝRSKOGEOLOGICKÝCH RAJONŮ SLEZSKÉ OSTRAVY, VÍTKOVIC A RADVANICE

THE GIS ASSESSMENT OF ENGINEERING-GEOLOGICAL ZONES OF GREATEST REGIONAL IMPORTANCE SLEZSKÉ OSTRAVY, VÍTKOVIC A RADVANICE

Abstrakt

Předložený článek je součásti širší studie, která má za cíl hodnocení inženýrskogeologických poměru na vybraném území města Ostravy pro potřeby územního plánování, stavebních úřadů a potencionálních stavebníků především pomocí Geografických informačních systémů. Výzkum má cíl uvedený přístup ověřit, aby byl využitelný i pro jiné oblasti pro zhodnocení této problematiky. Hodnocených geofaktorů je více, avšak publikace se zabývá prvním a nejdůležitějším z nich a to je rozšíření inženýrskogeologických rajonů a jejich kvantifikace ve vztahu k zástavbě a dalším krajinným prvkům v čase od roku 1946 po současnost. Zjištěná situace umožní získat reálný přehled o hodnoceném území Slezské Ostravy, Vítkovic a Radvanice omezeném mapovým listem 15-43-10 v měřítku 1:10 000. Rajony představují území s podobnými, či stejnorodými modely inženýrskogeologického prostředí, které z hlediska orientačního hodnocení základových poměrů budoucích staveb jsou klíčová mimo jiné proto, že mají podobný typ základové půdy, těžitelnosti a podobně.

Abstract

The paper makes part of a larger study, the objective of which is to evaluate engineering-geological conditions in a selected area of the City of Ostrava for the needs of land-use planning, building offices and potential developers, mainly by means of Geographic Information Systems. The research aims to verify the mentioned approach to make it useful for other areas as well. There are a number of evaluated geofactors, but the publication deals with the first and most important one, i.e. expansion of engineering-geological zones and their quantification in relation to the built-up area and other landscape elements in time since 1946 to date. The identified situation will provide a real overview of the evaluated districts of Slezská Ostrava, Vítkovice and Radvanice, defined by the map sheet 15-43-10 in 1:10 000 scale. As they have a similar type of foundation soil, workability, etc., the zones represent an area with similar or homogenous models of engineering-geological environment, which are of a key importance from the point of view of a preliminary evaluation of foundation conditions for any future structures.

1 INTRODUCTION

The basic precondition for land planning or building the foundations of construction works in a certain area is the integrated knowledge of engineering-geological conditions that are a decisive factor of high-quality and effective building the foundations of potential construction works. The main reason for the studyl is the insufficient use of engineering-geological data for land planning and designing activity by competent authorities. The overall project deals with an analysis of engineering-geological zones, workability of rocks, type of preQuarternary bedrock, floodlands, subsidence caused by undermining, slope movements and radon hazard, while the presented paper rates only first of those geofactors - engineering-geological zones. The applied method makes use of the possibilities of Geographical Information Systems, terrain research, documentation and study of archives. The

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research is localized in the selected area of the city of Ostrava, which has been affected by former mining of black coal. In terms of foundation engineering it has various conditions, and thus it is suitable for the above-mentioned research. The overall project was divided into five model areas (1-5), while this paper evaluates a partial model area of no.1, which is defined by topographical map in drawing scale 1:10 1000 (topographic sheet No. 15-43-10). Namely they are Slezské, Moravské Ostravy, Vítkovic a Radvanice. The mentioned methodology was applied in the interest area for the first time.

The geological structure of the interest locality can be characterized by the Brunovistulicum basement, which is overlapped with Devonian and Carbonian sediments. In the Upper-Silesian Basin, the Upper-Carbonian deposits are stratigraphically divided into Ostrava (paralic coal molase) and overlying Karviná strata series (continental coal molase). The roof is formed by thick Badenian deposits, the sedimentation of which caused the formation of the Carpathian Foredeep in the foreland of the Outer Flysch Carpathians.

Quaternary sediments represent Holocene fluvial deposits of lower and upper alluvium plane and anthropogenic deposits such as backfills and dumps. Quaternary deposits represent glaci-fluvial, fluvial, deluvial deposits, loess loam, and Tertiary eluvia (Chlupáč et al, 2002).

2 METHODS APPLIED

The methodological procedures for solving the study were primarily based on three methodological approaches with using geographic information systems, the study and evaluation of archive basic data and field engineering-geological research.

The methodological procedure for the study and evaluation of archive materials was aimed at introductory assessing the engineering-geological conditions and factors.

In the framework of geographic information systems, the registration of relevant map bases, or aerial photographs was realized. Subsequently, the registration and digitising of maps of engineering-geological zoning was carried out. In the next stage, intelligent digitising of built-up areas in the chosen model area of part of the Ostrava Basin was performed.

At the same time, field engineering-geological research was done with the aim to specify better engineering-geological conditions of model areas.

Subsequently, the overlap analysis of built-up areas and relevant engineering-geological zones and subzones was made. The result of this process was the identification and areal quantification making it possible to distinguish between more significant and less significant engineering-geological zones. The overall evaluation proposed newly was reflect all performed works and results.

3 EVALUATION OF ENGINEERING-GEOLOGICAL ZONES

This chapter deals with selected analyses of engineering-geological conditions, namely with the representation of the individual engineering-geological zones, workability of rocks and types of soils and solid rocks of preQuaternary surface. The analyses were carried out for the whole interest area, current built-up area and changes in the built-up area since 1946 to date.

The largest zone in the interest area No. 1 is the *zone of polygenetic loess sediments* (39.9% - fig.1,2). The dominant landscape element of this zone is built-up area (75.5%), where in this zone there is 50.7% of the total current built-up area (Figure 3). Since 1946 there have been most intensive building activities; almost 55.7% of new housing development was built there (Figure 4). Apart from built-up area, there are also landscape elements of fields and meadows (10.8%), forests (10.3%), anthropogenic shapes (3.4%) and water areas (0.1% out of the total zone area) in this zone (Figure 5).

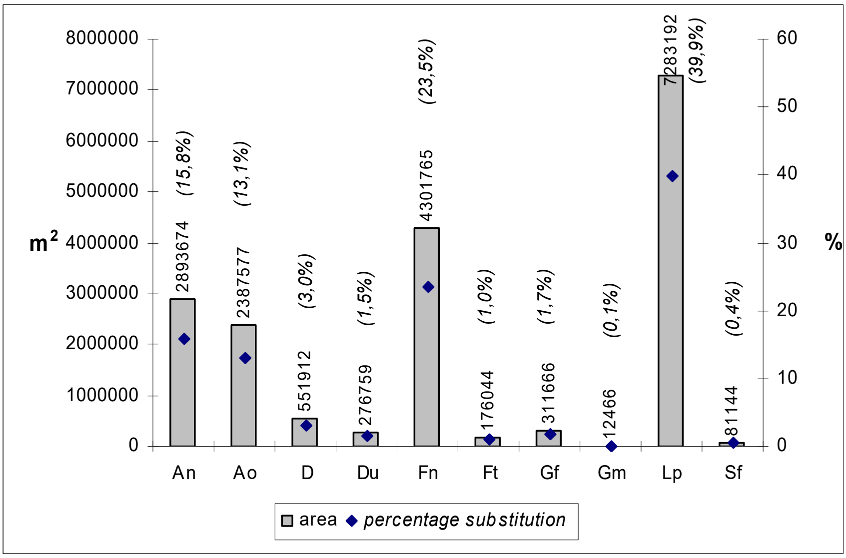

Fig. 1: Areal and percentage representation of zones within the whole interest area

Glossary:

An	*Spoil banks, stock piles and dumps zone*	*Ft*	*Zone of Pleistocene river terraces*
Ao	*Zone of settling basins and waste dumps*	*Gm*	*Predominantly cohesive drift zone*
D	*Deluvial sediments zone*	*Gf*	*Predominantly noncoherent glaciofluvial and glacial lake sediments zone*
Du	*Deluvial-fluvial sediments zone*	*Lp*	*Zone of polygenetic loess sediments*
Fn	*Lowland stream deposits zone*	*Sf*	*Undiscriminated flysch sediments zone*

It is characterized as a zone of intermediate bearing foundation soils, predominantly of firm consistency, of low to medium plasticity. They are medium permeable. This rock material is, for example, potentially usable in the brickware production and is also suitable as agricultural land. As foundation soils there are clays with low to medium plasticity.

In the monitored period since 1946, in the interest area the zone of polygenetic loess sediments was built up by a development complex in the surroundings of the existing Regional Council, Vítkovice Community Centre, Central Bus Station in the district of Moravská Ostrava and Přívoz, Settlement Míru in the district of Slezská Ostrava, Central Cemetery right off the confluence of the Ostravice and Lučina Rivers, and development of family houses in the districts of Radvanice and Bartovice, north of Těšínská Street.

The second largest zone in the interest area is the *zone of alluviums lowland streams* (23.5% out of the interest area - fig.1,2). Also in this zone built-up area prevails over other landscape elements (61.2% of the zone area). The percentage of the total development is not negligible as up to 24.2% of the built-up area is situated in this zone (Figure 3). The trend of development since 1946 comes second with 17.7% of newly built-up area (Figure 4). The representation of other landscape elements in this zone is similar to the zone of polygenetic loess sediments; the landscape element of fields and meadows takes up 14.7 % of the zone area, forests take up 13.1 %, anthropogenic shapes take up 7% of the area and water courses along with water areas form 4 % out of the total zone area (Figure 6).

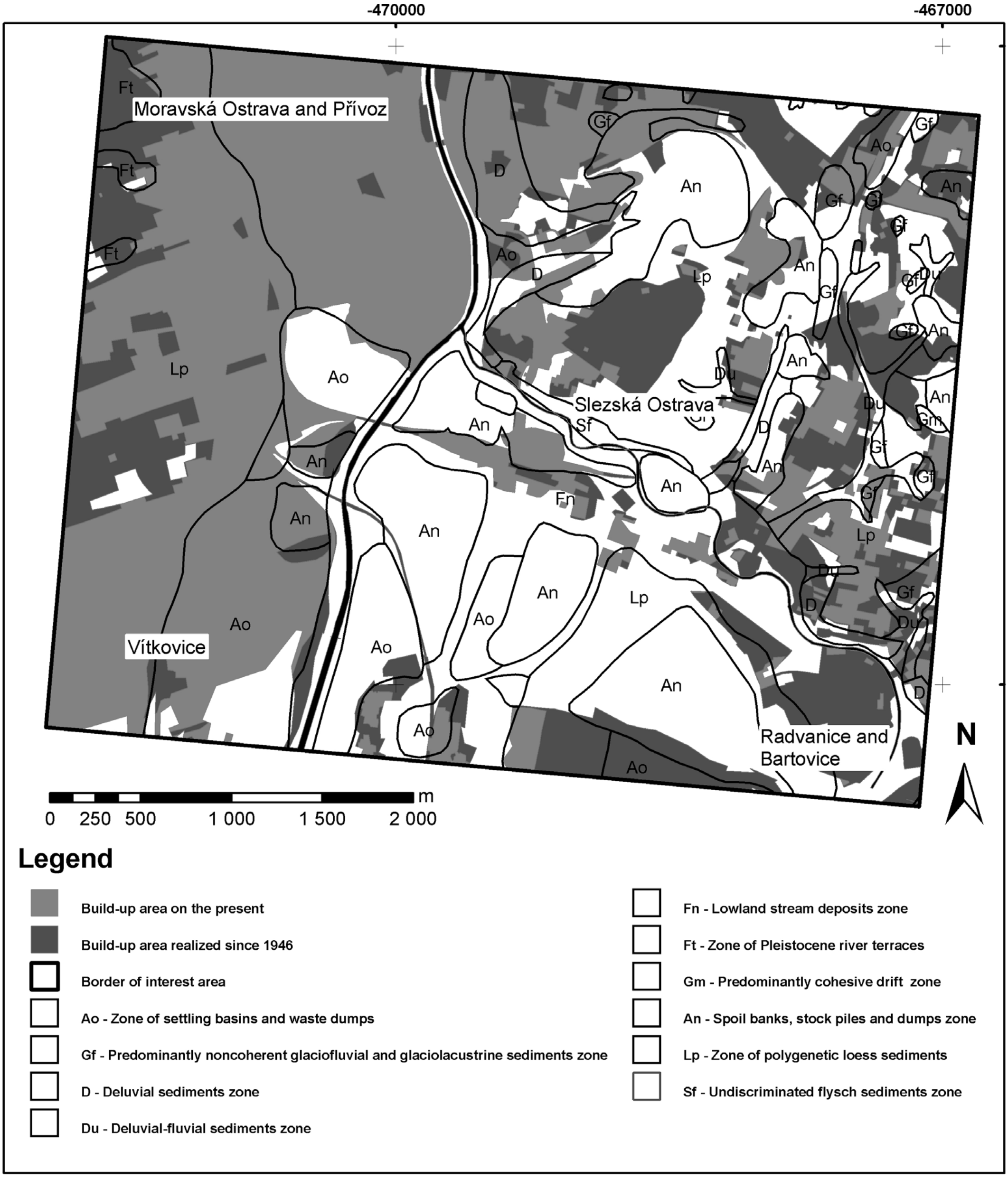

Fig. 2: Engineering-geological zones in the built-up area

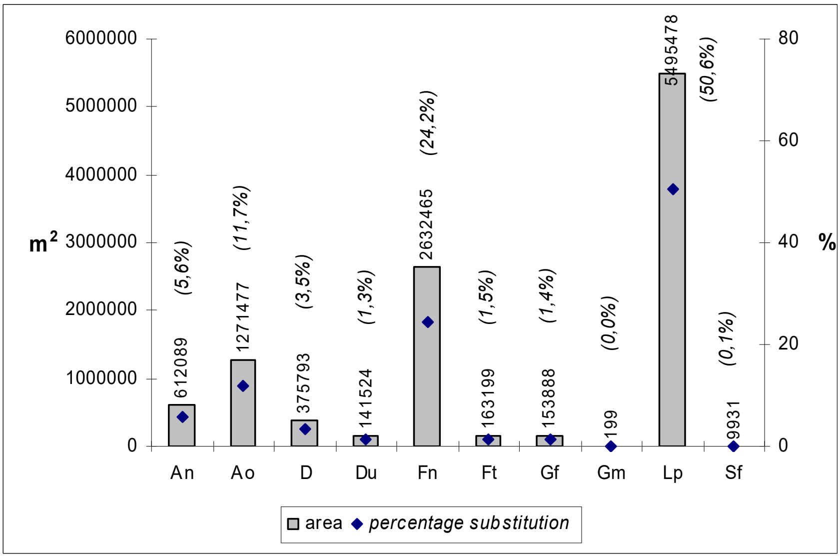

Fig. 3: Areal and percentage representation of zones within the current built-up area (legend - fig.1)

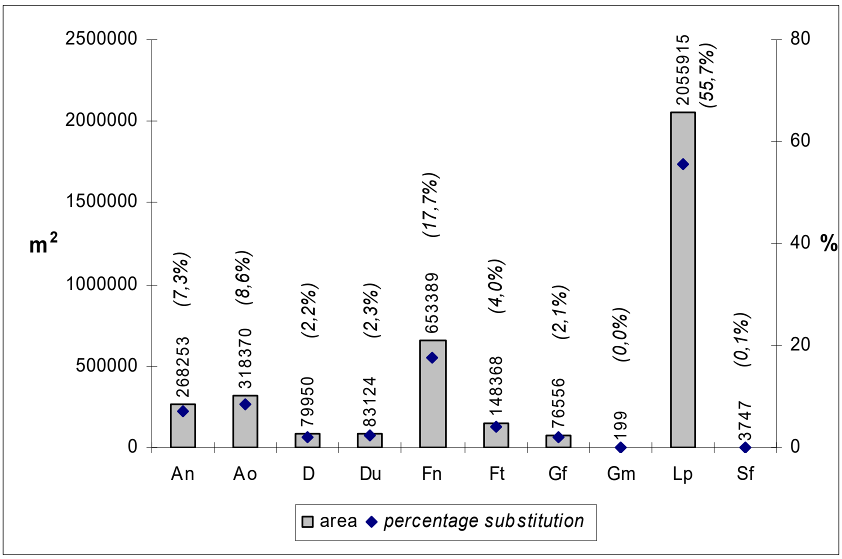

Fig. 4: Areal and percentage representation of zones (legend - fig.1)within the newly built-up area (1946 – present)

The zone is characteristic for inhomogeneous, low bearing and unevenly compressible foundation soils and soils of soft-firm consistency. The ground-water level in this zone is often as shallow as 2 m. In the zone in question there are the following foundation soils: badly graded gravel (G2), gravel with fine soil ingredients (G3) and dirty gravel (G4), next there is sand with fine soil ingredients (S3), loamy sand (S4) and clayey sand (S5). Moreover, there is sandy loam (F3), sandy clay (F4) and clay with low to medium plasticity (F6).

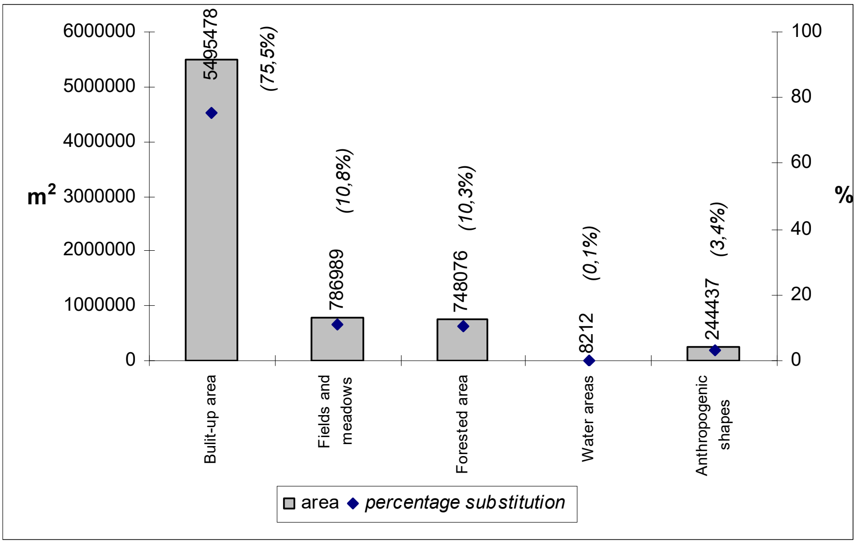

Fig. 5: Areal and percentage representation of selected landscape elements at the present in the zone of polygenetic loess sediments

In the zone of alluviums lowland streams of the interest area there are the majority of constructions of the Ostrava City Centre, despite the fact the development was realized before the monitored period of 1946. In the course of the monitored period, for example the complex of the former OKR - Báňské strojírny and Main Central Mine Rescue Station (the districts of Radvanice and Bartovice) and the Teplotechna complex (the city district of Slezská Ostrava) were established in this zone.

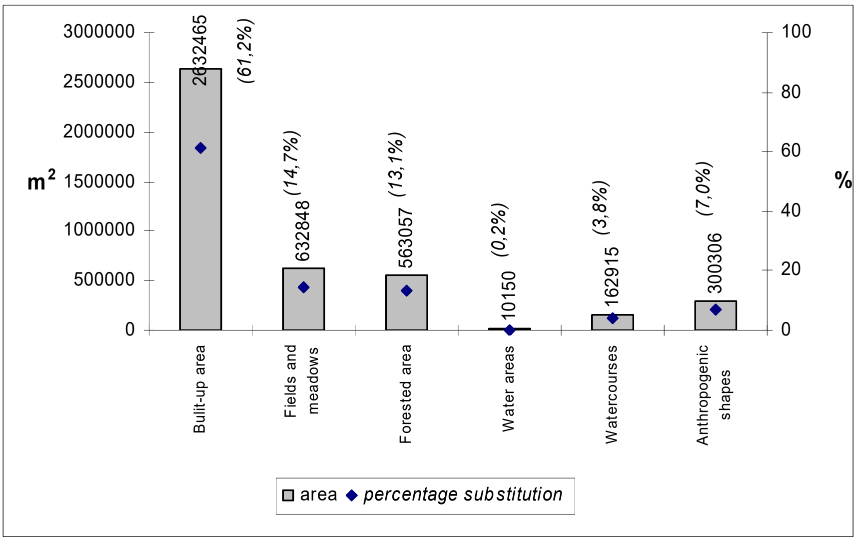

Fig. 6: Areal and percentage representation of selected landscape elements at the present in the zone of alluviums lowland streams

An important part of the interest area is taken up by two similar zones, the *zone of spoil banks, stock piles and dumps* (15.8% of the area - fig.1,2) and the *zone of settling basins and waste dumps* (13.1%). Their share on the total development in the interest area is also very significant; in the zone of spoil banks, stock piles and dumps it is 5.6% out of the total built-up area, and in the zone of settling basins and waste dumps it is 11.7% of the area. The most substantial differences between the two zones are in the representation of the landscape elements; in case of the spoil banks, stock piles and dumps zone forests prevail (36.1%), followed by anthropogenic shapes (28%), built-up area (21.2%) and fields and meadows (14.6%), while in case of the settling basins and waste dumps zone built-up area dominates (53.3% of the zone area), followed by anthropogenic shapes (29.6%), fields and meadows (9.3%) and forests (7.9%). Water areas and water courses are negligible in both zones (Figures 7 and 8). The trend of development in those zones since 1946 is not high; in the zone of spoil banks, stock piles and dumps only 7.3% of development out of the newly built-up area was realized there and in the zone of settling basins and waste dumps it was 8.6% of the built-up area (Figure 4).

Without a detailed engineering-geological survey those zones are not suitable for development, while their local conditions and compaction of loose ground materials are important. Foundation soils are spoil banks (Y) and waste dumps (Z) there.

The zone of spoil banks, stock piles and dumps was predominantly built up in Slezská Ostrava, south of the interest area, down of Lihovarská Street, where Bytostav is situated. Otherwise, the landscape element of forests is dominant there, which is the result of forestry reclamation of dumps. The zone of settling basins and waste dumps was built-up more in the monitored period, which was caused by the construction of houses in Kunčičky (between Lihovarská and Rudná Streets).

Other zones of the interest area cover a very small area and therefore, their analyses will not be as extensive.

The *zone of deluvial sediments covers* 3% of the interest area (fig.1,2). The soils in this zone are represented by medium bearing, mostly dry, inhomogeneous foundation soils with various content of clastic fraction. There is a wide range of geotechnical properties values, in particular. The suitability of a building plot must be assessed on an individual basis with regard to morphology, composition of slope and bedrock rocks. The foundation soils here are very varied, from gravel loam to clays with low to medium plasticity (F1 to F6), gravel with fine soil ingredient (G3), dirty gravel (G4) and clayey gravel (G5). The most dominant landscape element in this zone is built-up area (51.1%), followed by fields and meadows (23.5%). Since 1946 the area in this zone has been primarily built up in the city district of Slezská Ostrava, on the right bank of the Ostravice River. In the district of Radvanice and Bartovice the right bank of the Lučina River was built up in this zone.

The *predominantly cohensionless glaciofluvial and glacial sediments zone* takes up 1.7% of the interest area (fig.1,2). In this zone there are mostly sands, gravels and less sandy loams. Dense sediments form medium to high bearing foundation soils, in case of which the ground-water level must be taken into consideration. The sands and gravels are largely well permeable and act as a significant Quarternary ground water aquifer. The sediments above the ground-water level are of slight to intermediate getting characteristic; quicksands fall in the getting characteristic class 4. This zone is characteristic for a wide range of foundation soils; there is badly graded sand (S2), sand with fine soil ingredient (S3), loamy sand (S4) and clayey sand (S5). Next, there is badly graded gravel (G2), gravel with fine soil ingredient (G3), sandy loam (F3) and sandy clay (F4). Almost a half of the zone is built up (49.4% of the interest area), the second largest landscape element are forests (34.3%), followed by fields and meadows. The built-up area mostly concerns houses in the districts of Radvanice and Bartovice.

The *deluvial-fluvial sediments zone* covers only 1.5% of the interest area (fig.1,2). The largest landscape element in this zone is again built-up area (49.8%), fields and meadows cover 35.1% of the area and forests cover 15.1%. The zone is characteristic for inhomogenous, medium to low bearing foundation soils that fill shallow wash-depressions. For foundation engineering they are low suitable to unsuitable, of slight to medium getting characteristic. The foundation soils in this zone are sandy loam (F3), sandy clay (F4), soils with low to medium plasticity (F5) and clays with low to medium plasticity (F6). In addition, there is loamy sand (S4) and clayey sand (S5). The majority of the built-up area situated in this zone is formed by a railroad, which is considered a built-up area landscape element for the purposes of this analysis.

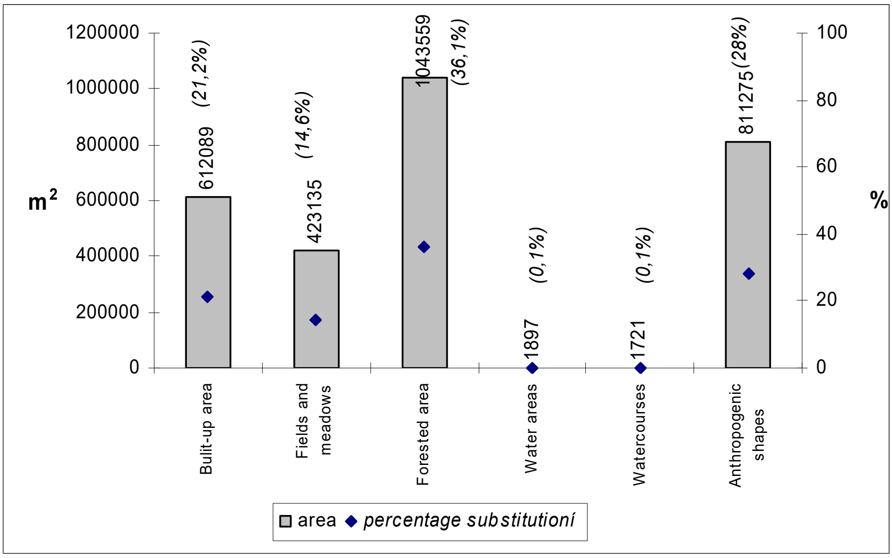

Fig. 7: Areal and percentage representation of selected landscape elements in the zone of spoil banks, stock piles and dumps at the present

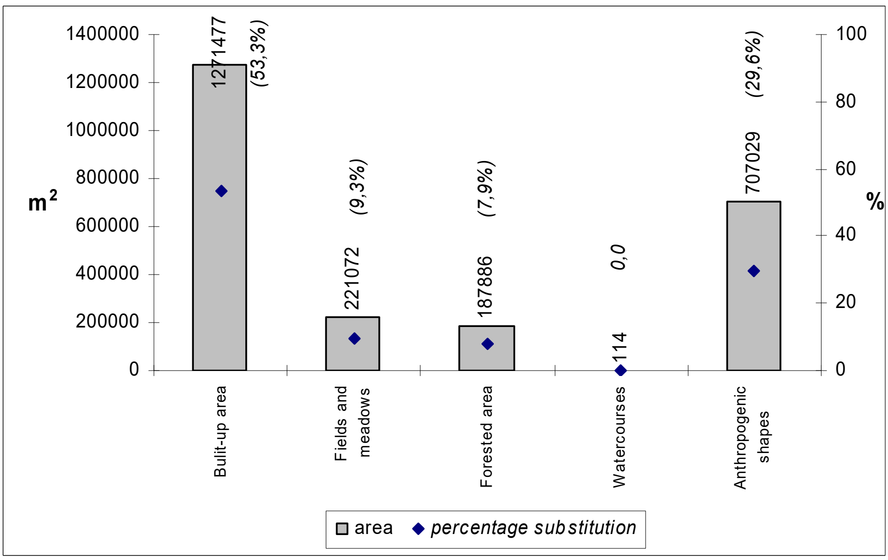

Fig. 8: Areal and percentage representation of selected landscape elements in the zone of settling basins and waste dumps at the present

The *zone of Pleistocene river terraces* takes up 1% of the area (fig.1,2)., while built-up area with its 92.7% of area prevails over other landscape elements The soils of this zone are bearing, stable and little compressible foundation soils. They are predominantly compact, with the ground-water level under the foundation engineering level. The gravels and sands are well permeable and form an important ground water aquifer. With regard to the compactness and granularity, they are of medium to hard getting characteristic. As foundation soils there is sand with fine soil ingredient (S3) and loamy sand (S4), badly-graded gravel (G2), gravel with fine soil ingredient (G3) and dirty gravel (G4). The zone, therefore the built-up area too, is located in the north-west end of the interest area.

The last two zones cover a negligible area, the *undiscriminated flysch sediments zone* (0.4%) is largely covered with forests (80.9% of the area), the *predominantly cohesive drift zone* takes up only 0.4% of the interest area. The most dominant landscape element of this zone are fields and meadows (60.1%), followed by forests (38.3%). The built-up area is very small in those zones; in case of the undiscriminated flysch sediments zone it is 12.2%, etc.

4 CONCLUSION

The most important characteristics of the area in terms of engineering-geological conditions for the needs of foundation engineering and landscape planning are the engineering-geological zones in which the area is divided into territories with similar engineering-geological characteristics and conditions for foundation engineering.

From this point of view, in the interest area the largest is the zone of polygenetic loess sediments (39.9% of the area) and the zone of alluviums lowland streams (23.5% of the area). In addition, more than a quarter of the interest area is formed by similar zones of spoil banks, stock piles and dumps and the zone of settling basins and waste dumps. Those two zones are not suitable for development without a detailed engineering-geological survey.

Other zones in the interest area cover very small areas. As for their suitability or unsuitability for foundation engineering their localization is important, for which maps have been created.

As for the needs of landscape planning the extent of landscape elements such as built-up area, forests, fields and meadows, anthropogenic shapes and water areas must be known.

In both zones (the zone of polygenetic loess sediments zone and the zone of alluviums lowland streams) the most dominant landscape element is built-up area, which represents a considerable part of all the built-up area in the interest area (74.8%).

In case of the zone of settling basins and waste dumps built-up area also prevails and in the spoil banks, stock piles and dumps zone dominant are reclaimed forests.

In terms of research, it was necessary to monitor the landscape elements also in time in order to be able to recognize trends and be able to influence them in the future. As for the past, changes have been monitored since 1946 to date.

It was discovered that since 1946 the most intense development has been in the zone of polygenetic loess sediments (55.7% of newly built-up area), followed by the zone of alluviums lowland streams (17.7% of the area) and in both of the anthropogenic zones (together 15.9% of new development is situated there).

The realized evaluation of the selected engineering-geological conditions by means of geographic information systems on an interest area can be generally applied on any other area. However, it is most useful for conurbations.

5 ACKNOWLEDGEMENT

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Since 1.11.2004 replace:

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