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Marian MARSCHALKO[1], Tomáš PEŇÁZ[2], Lucie FOJTOVÁ[3]

THE IMPORTANCE OF IMPLEMENTING TRANSPARENT GEOLOGICAL STRUCTURE INTO LAND-USE PLANNING DOCUMENTATION

DŮLEŽITOST IMPLEMENTACE PŘEHLEDNÉ GEOLOGICKÉ STAVBY PRO ÚZEMNĚ-PLÁNOVACÍ DOKUMENTACI

Abstract

Land-use planning is an activity that permits rational utilization of the landscape on the basis of certain natural connections. It is a system that develops in time and brings new information and experience gained from a number of fields. This better helps to reflect the needs of the landscape and at the same time to improve this sophisticated process. There is no doubt that it is the information on the geological environment that belongs among information which limits the utilization of landscape in terms of its exploitation. Talking of human activities, even more important are details on the engineering-geological environment focused on the research of such part of the environment that interacts with anthropogenic activities, engineering structures in particular. The geological structure is a very complex environment changing in space and thus the elementary need for its exploitation in land-use planning are simplified models with similar characteristics. Those needs are met by expansion of engineering-geological zones. In land-use planning there is a significant deficit in this issue not only in the Czech Republic but world-wide. An example of a possible solution is drawn in this paper applied in a researched part of the city of Ostrava with its exceptional anthropogenic changes in the geological environment in the city districts of Slezská Ostrava (Koblov, Antošovice) and outside Ostrava, in Šilheřovice, Vrbice and Pudlov, defined by a map sheet 15-41-25 in 1:10 000 scale.

Abstrakt

Uzemní plánování je lidskou činností, která umožňuje využívání krajiny na základě určitých zákonitostí. Je to systém, který se vyvíjí v čase a přináší nové informace a zkušenosti získávané z řady oborů. Umožňuje to více reflektovat potřeby krajiny a zároveň zkvalitnit tento sofistikovaný proces. Zcela jednoznačně do typu informací, které limitují možnosti krajiny z hlediska jeho využívání patří informace o geologickém prostředí. Ještě vyšší formou zaměřeno na lidskou činnost jsou údaje o inženýrskogeologickém prostředí zaměřené na zkoumání té časti prostředí, která přichází do interakce s antropogenní činností, zejména však s inženýrskými díly. Geologická stavba je velice složité a v prostoru se měnící systém, proto elementární potřebou jeho využívání v územním plánování jsou zjednodušené modely s podobnými charakteristikami. Tyto potřeby splňuje rozšíření inženýrskogeologických rajonů. V uzemním plánování ve vztahu k této problematice existuje v

[1] Doc. Ing. Marian Marschalko, Ph.D., Institut inženýrské geologie, Fakulta hornicko-geologická, VŠB-Technická univerzita Ostrava, 17. listopadu 15, 708 33 Ostrava - Poruba, tel.: (+420) 597 323 505, e-mail: marian.marschalko@vsb.cz.

[2] Ing. Tomáš Peňáz, Ph.D. Institut geoinformatiky, Fakulta hornicko-geologická, VŠB-Technická univerzita Ostrava, 17. listopadu 15, 708 33 Ostrava - Poruba, tel.: (+420) 597 325 478, e-mail: tomas.penaz@vsb.cz.

[3] Ing. Lucie Fojtová, Institut inženýrské geologie, Fakulta hornicko-geologická, VŠB-Technická univerzita Ostrava, 17. listopadu 15, 708 33 Ostrava - Poruba, tel.: (+420) 597 323 505, e-mail: lucie.fojtova@vsb.cz.

České republice, ale také ve světě značný deficit. Příklad možného řešení přináší publikace s aplikací ve výzkumném území města Ostravy s výjimečnými antropogenními změnami geologického prostředí v městských obvodech Slezská Ostrava (Koblov, Antošovice) a vně Ostravy zasahuje do Šilheřovic, Vrbic a Pudlova, vymezeném mapovým listem 15-41-25 v měřítku 1:10 000.

1 INTRODUCTION

The objective of the paper is to point out the necessary application of information sources on the geological structure within decision-making and information processes in land-use planning and procedures granting building permits at the building offices by means of geographic information system technologies. The geological structure is an environment in which constructions are founded, water is gained and simultaneously we prevent its effects on the constructions, we need it as a source of building materials, etc. It is a great drawback not to make use of the information within land-use planning. At the same time, however, we need certain generalization of geological structure in relation to future foundation engineering. This requirement is met by expansion of engineering-geological zones in the interest areas in relation to the landscape element, etc.

The studied area (model area 3, determined by a topographic map 15-41-25 in 1:10 000 scale) is located in Ostrava, the third largest city agglomeration, in the north-east of the Czech Republic (city districts of Slezská Ostrava - Koblov, Antošovice and outside Ostrava it reaches to Šilheřovice, Vrbice and Pudlov), which is however most affected by anthropogenic industrial and mining activities among Czech cities as well as in the European scale.

2 EVALUATION OF ENGINEERING-GEOLOGICAL ZONES

In terms of land-use planning, design of constructions and operation of engineering work as well as from the point of view of environmental protection it is necessary to study such components of the geological environment and geodynamic phenomena which are important from the point of view of protection from undesirable geological processes. These are called *components of engineering geological conditions* and they for example include rocks quality as foundation soils, depth and ground water aggressive action, relief gradient and division, slope deformation, internal erosion phenomena, etc.

We must not forget the evaluation of possible realization of a specific engineering plan, including consideration of expected interaction of the planned engineering work with the geological environment, which is dealt with within the study of *engineering geological conditions.*

A practical solution of this situation in terms of land-use planning is application of *engineering geological zoning* based on the evaluation of spreading the zones on the examined interest area. It is the case of singling out regions differing in character and degree of uniformity of the above stated engineering geological conditions and reference degree of suitability for certain ways of economic use. The degree of the expressed uniformity or suitability depends on taxonomic level of singling out a zoning unit selecting the evaluation according to the engineering geological zones.

On the basis of the study it was discovered that in the interest area the largest zone is the *lowland stream deposits zone*, which takes up 42.3 % (7.72 km^2 - Fig.1,2*)*. In terms of the evaluation of development it is interesting that even if only 12.5 % of the built-up area is situated in the zone, this represents up to 63.9 % of the total built-up area (Fig. 3) to be found in the interest area. The percentage of the new development is also high, up to 72.7 %, which is apparent from the point of view of the evaluated period since 1946 (Fig. 4). The distribution of landscape elements in this zone (Fig. 5) shows that the most pronounced is fields and meadows (61.3 %), followed by forests (15.1 %), built-up area (12.5 %) and water areas (8.1 %). 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). An example of the development in the zone is the new development in the municipalities of Vrbice, Pudlov, Antošovice, new highrway D47, etc.

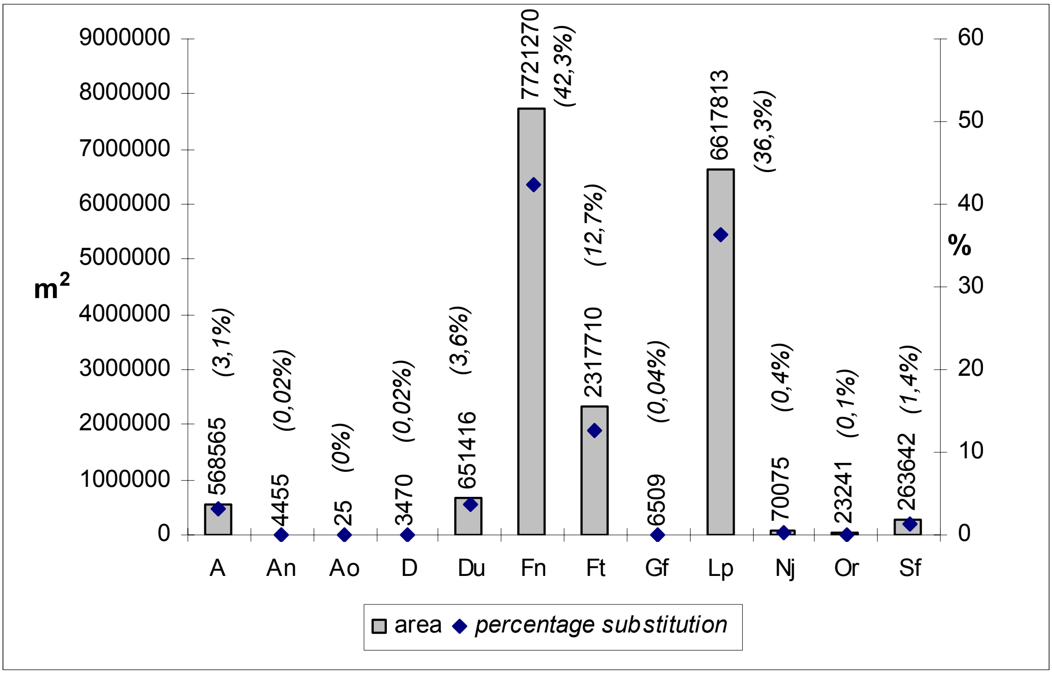

Figure 1: Areal and percentage representation of zones within the whole interest area.

Glossary:			
A	*Zone of spoil banks and waste dumps*	Ft	*Zone of Pleistocene river terraces*
An	*Spoil banks, stock piles and dumps zone*	Gf	*Predominantly noncoherent glaciofluvial and glacial lake sediments zone*
Ao	*Zone of settling basins and waste dumps*	Lp	*Zone of polygenetic loess sediments*
D	*Deluvial sediments zone*	Nj	*Zone of Miocene sediments*
Du	*Deluvial-fluvial sediments zone*	Or	*Zone of organic soil*
Fn	*Lowland stream deposits zone*	Sf	*Undiscriminated flysch sediments zone*

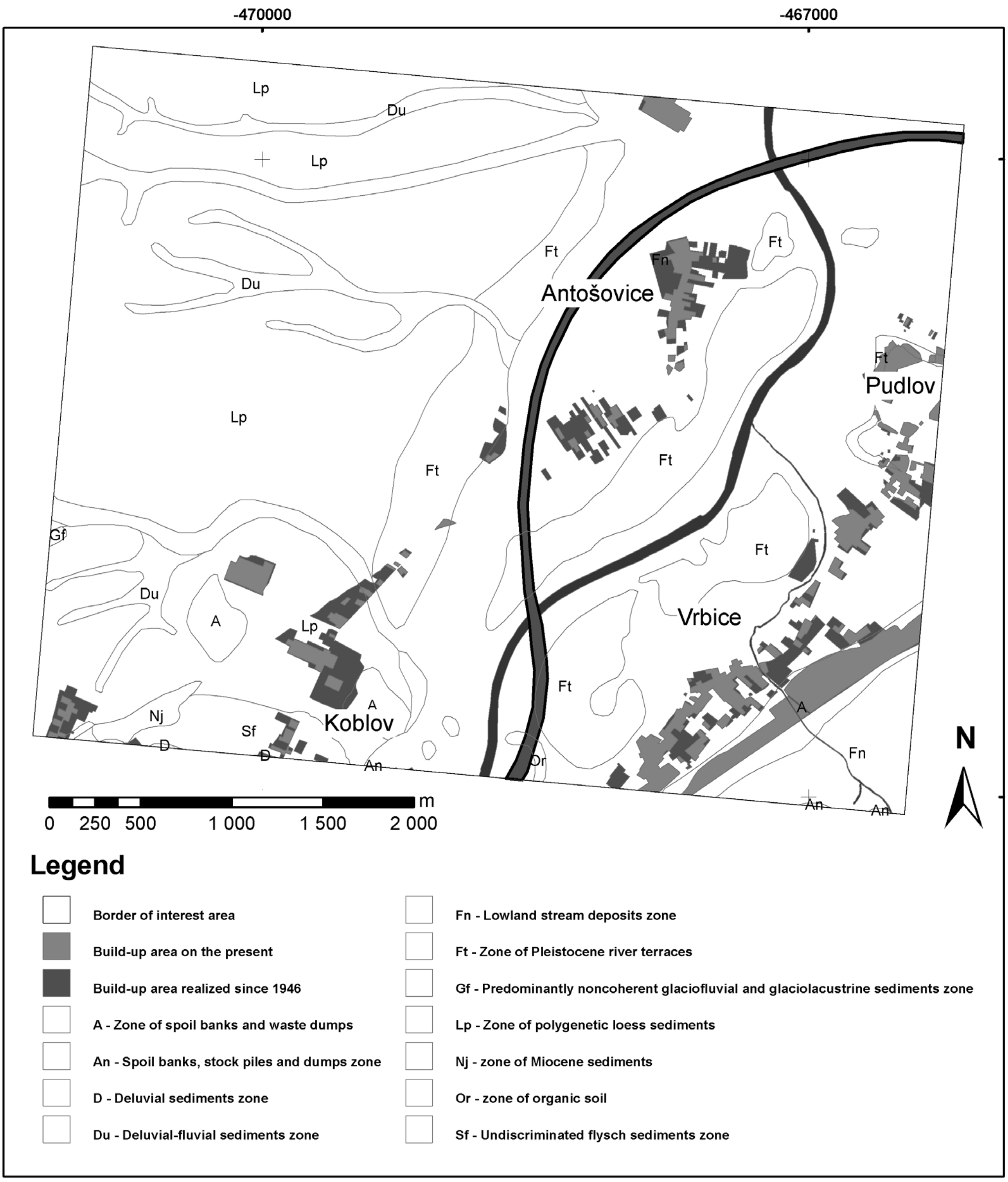

Figure 2: Engineering-geological zones in the built-up area.

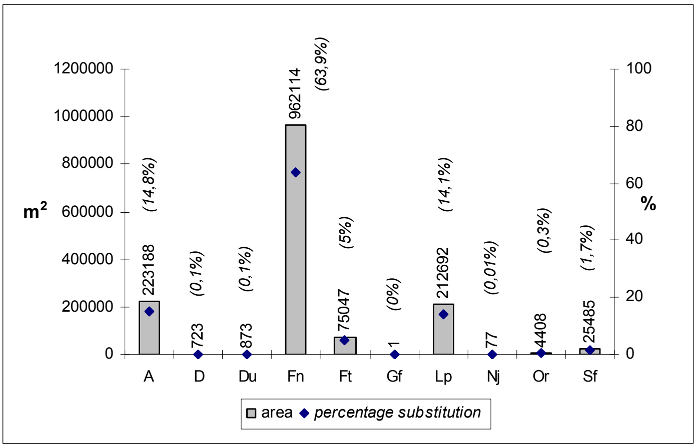

Figure 3: Areal and percentage representation of zones within the current built-up area (legend - fig.1).

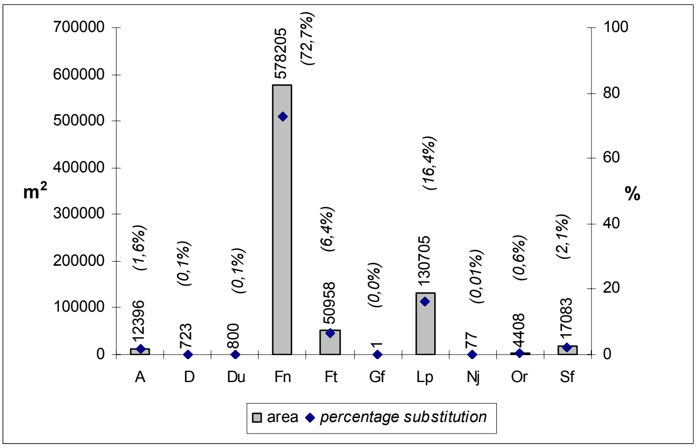

Figure 4: Areal and percentage representation of zones (legend - fig.1) within the newly built-up area (1946 – present).

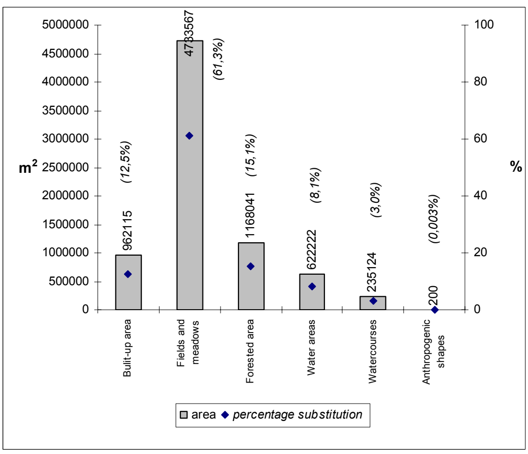

Figure 5: Areal and percentage representation of selected landscape elements at the present in the zone of alluviums lowland streams.

The second largest zone in the interest area is the *zone of polygenetic loess sediments* with 36.3 %. (Fig. 1, 2). Despite the fact only 3.2 % of the development is built there (Fig. 6), this makes up 14.1 % (Fig. 3) of the total built-up area and 16.4 % of the new development built after 1946 (Fig. 4). The reason for this distribution is, apart others, low development in the interest area. This is also the reason why the most spread landscape element in this zone is forests (68.5 %) and fields and meadows (28 % - Fig. 6). In other studies of the surroundings the built-up area was dominant in the zone of polygenetic loess sediments. 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.

An example of the implemented development belonging to this zone is the premises of the former Koblov Mine (south of the interest area) and part of the development on the periphery of Petřkovice (south-west of the interest area).

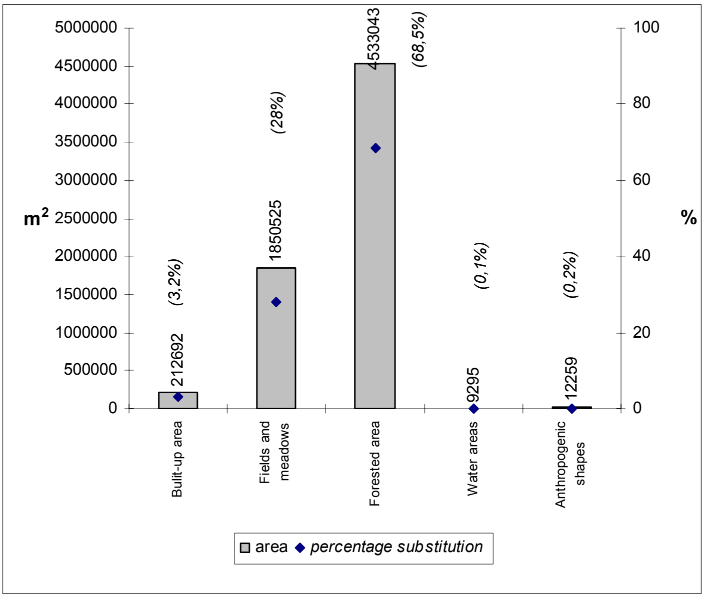

Figure 6: Areal and percentage representation of selected landscape elements at the present in the zone of polygenetic loess sediments.

As for the third largest *zone of Pleistocene river terraces* (12.7 %), the biggest landscape element (Fig. 7) is water areas (42.8 %), followed by forests (30.9 %) and fields and meadows (22.8 %). The built-up area takes up only 3.2 % of the zone area, while the development represents 5 % of the total built-up area. 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). As mentioned above, the majority of the zone is covered by water areas, it is mainly Lake Vrbické; the built-up area means houses in the east border of the Černý Forest.

The *deluvial-fluvial sediments zone* (3.6 % of the total area) is largely made up by forests (80.6 %), followed by fields and meadows (18.4 %). The built-up area (Fig. 8) there ranges in negligible areal values (0.1 %), and thus a further analysis of the built-up area is not required. The zone is characteristic for inhomogeneous, 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).

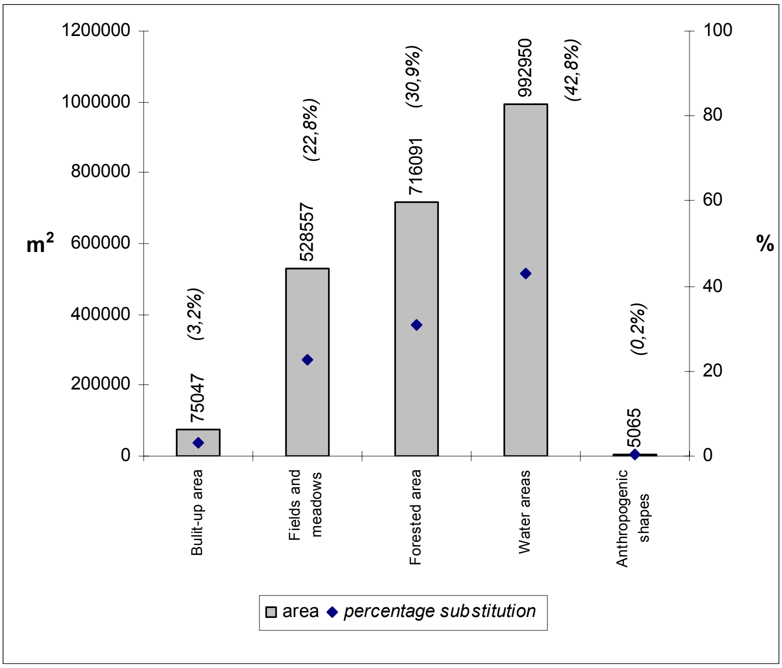

Figure 7: Areal and percentage representation of selected landscape elements in the zone of Pleistocene River terraces at the present.

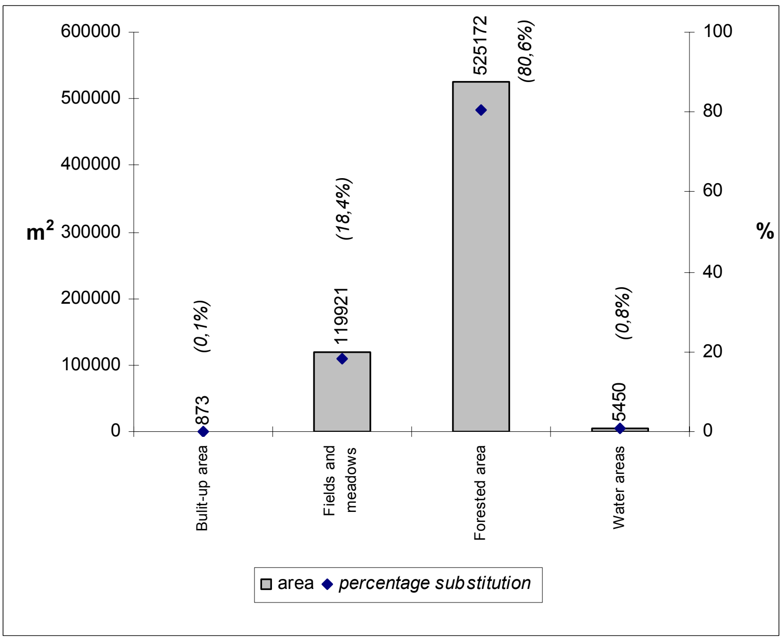

Figure 8: Areal and percentage representation of selected landscape elements in the zone of deluvial-fluvial sediments at the present.

From the engineering-geological point of view and future development it is necessary to be careful with anthropogenic zones – *the zone of spoil banks, dumps and waste* (3.1 % of the area) (Fig. 9) and the *spoil banks, stock piles and dumps zone* (0.2 %). There is also the *zone of settling basins and waste dumps,* but as it covers a very small area in the interest area (25 m^2) its further evaluation is unnecessary. With the first zone the most spread landscape element is built-up area (39.3 %), fields and meadows (39.2 %), anthropogenic shapes (14.6 %) and forests (14.6 %). In this zone 14.8 % of the present built-up area is located, which places this zone on the second place, directly after the lowland stream deposits zone, while the majority of the mentioned development was built before 1946 (since 1946 only 1.6 % of the area has been built over). 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 built-up area there comprises of a railway (Ostrava – Bohumín), on the periphery of the municipality Vrbice, in the south-east of the interest area.

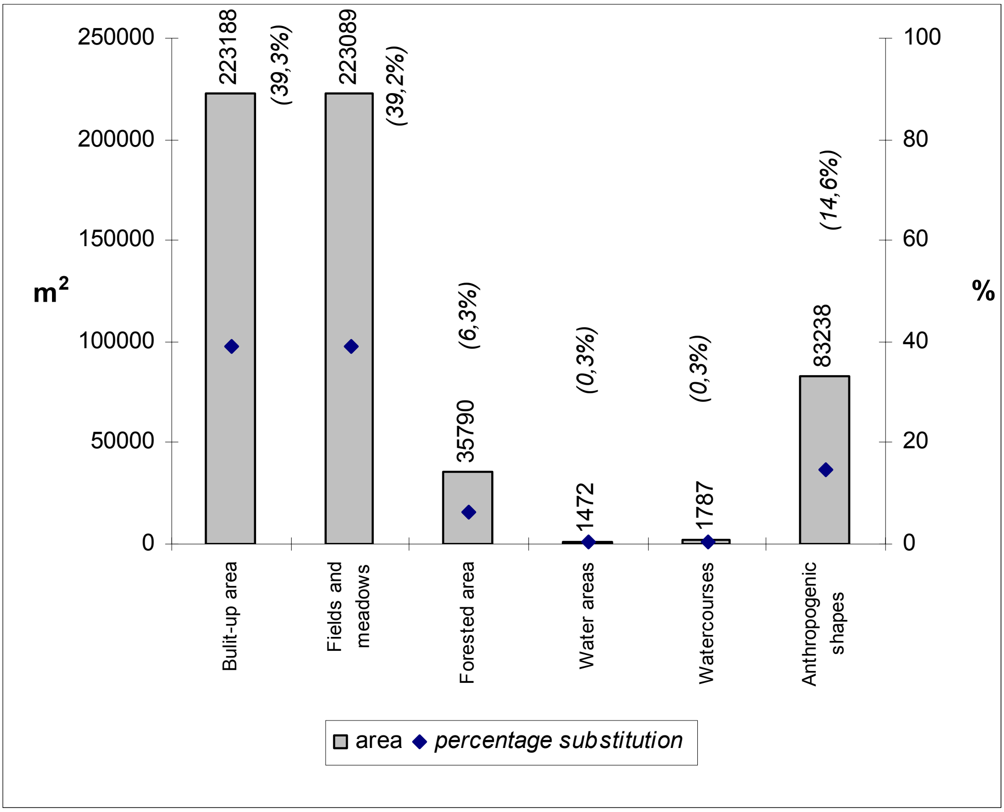

Figure 9: Areal and percentage representation of selected landscape elements in the zone of spoil banks and waste dumps at the present.

The undiscriminated flysch sediments zone takes up 1.4 % of the interest area (Fig. 1, 2), which is mainly formed by fields and meadows (85.9 %), followed by built-up area (9.7 %) and forests (4.4 %). For foundation engineering this zone is potentially less suitable for engineering-geological conditions and thus it is necessary to define it clearly in the map documentation for land-use planning. This zone interferes with the housing development in the northern part of Koblov (south of the interest area).

Other zones are very sparse in the interest area, below one per cent of the total area, thus they are only mentioned shortly.

The *zone of Miocene sediments* covers only 0.4 % of the interest area (Fig. 1, 2). It is predominantly afforested (69.9 %), the rest of the area is formed by fields and meadows (30 %). The sediments of this zone provide good, but relatively sensitive foundation soil (volume changes). The environment is susceptible to sliding at natural or artificial intervention. The ground water of low water yield is in more permeable positions and various depths, usually aggressive.

The remaining engineering-geological environment in the interest area is made up by the *zone of organogenous and organic soils* (0.1 % of the area - Fig. 1, 2), *predominantly noncoherent glaciofluvial and glacial lake sediments zone* (0.04 %) and *deluvial sediments zone* (0.02 %).

3 CONCLUSION

The study deals with a geometric representation of engineering-geological zones in the interest area. It also deals with their quantification in relation to landscape elements in order to identify the percentage of the given geological environment on its utilization and requirement in the interest area in question. The next studied criterion is the situation in time, which means that it focuses on the current state and next, on the state since 1946 to date in order to identify change trends. All this is related either to the overall interest area or to built-up area which is the most important subject of interest of land-use planning and engineering geology.

The carried out study identified the largest zone in the interest area being the lowland stream deposits zone (42.3 %), followed by the zone of polygenetic loess sediments (36.3 %) and the zone of Pleistocene river terraces (12.7 %). The remaining zones occur on relatively small areas in the interest area, while their localization during the area evaluation in relation to future foundation engineering is significant as they have different suitability from this point of view.

An important criterion for land-use planning is to learn about the future engineering-geological environment but also the character of landscape elements which are to be found there. This points several interesting facts, such as the typical geological structure for development in the studied area or for other use of the landscape. According to the rate of development it is possible to identify the free potential for future construction. Last but not least, when there is an identical landscape element and different geological environment we can choose the one with more suitable conditions as for the implementation of the future engineering structure, etc. The next studied criterion was changes in time which were assessed from the point of view of the present state and we also monitored the so-called realized built-up area since 1946 to date, based on aerial photos. Comparing both states, experience can be gained from this perspective and on its basis we can positively influence the future state by means of land-use planning.

In terms of areal quantification, the most pronounced landscape elements of the largest lowland stream deposits zone were fields and meadows (61.3 %), forests (15.1 %) and built-up area (12.5 %), which represents up to 63.9 % of the total built-up area found in the interest area. Simultaneously, this represents big potential for the future from the point of view of future development. With the zone of polygenetic loess sediments, forests dominated (68.5 %); the built-up area is minimum (3.2 %), which also indicates a similar trend in the future.

In terms of chronological changes it was discovered that since 1946 the most intense development has occurred on the lowland stream deposits zone (72.7 % of the newly built-up area), followed by the zone of polygenetic loess sediments (16.4 % of the area).

4 ACKNOWLEDGEMENT

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Oponentní posudek vypracoval:

Ing. Vratislav Bradáč, ALGOMAN, s.r.o., Hlavní 316, 747 81 Otice