An environmental investigation scheme used in Lithuanian urban areas

KASTYTIS DUNDULIS[1], SAULIUS GADEIKIS[2] & SONATA GADEIKYTE[3]

[1] *Engineering Geology, Vilnius University, M.K.Ciurlionio 21, Vilnius, Lithuania. (e-mail: kastytis.dundulis@gf.vu.lt)*
[2] *Engineering Geology, Vilnius University, M.K.Ciurlionio 21, Vilnius, Lithuania. (e-mail: saulius.gadeikis@gf.vu.lt)*
[3] *Engineering Geology, Vilnius University, M.K.Ciurlionio 21, Vilnius, Lithuania (e-mail: sonata.gadeikyte@gf.vu.lt)*

Abstract: Many questions arise when trying to estimate the interaction between the geological environment and the infrastructure of urban areas. This interaction is very complicated in terms of the various interrelations and complexities. On the other hand, other specialists, whose fields of interest are quite distant, need this kind of information. Consequently, the estimation of the engineering geological conditions of urban areas by traditional components of the geological environment: geological structure, relief, hydrogeological conditions, geotechnical parameters of soil as well as geological phenomena and processes, would be incomplete. It is also necessary to present information about an area's historical development, chemical and physical pollution peculiarities, technological load intensity, groundwater protection and stability of soils.

Our experience in the research of urban areas in Lithuania has enabled us to build up a complex geological and infrastructure based environmental investigation scheme. The composite parts of the investigations are presented in the scheme.

A database was compiled and several special maps reflecting geotechnical system peculiarities were made from the available datasets.

Finally, the division of areas (based not only on the geological information but also on the infrastructure load influence) was used to evaluate the urban areas and to forecast a dynamic area development.

Résumé: Etude de liaison entre les conditions géologiques et l'infrastructure du territoire urbain s'est posée beaucoup de questions sciétifiques. Cette liaison est assez compliquée et il est exprimée par différent rélations complexes. D'autre par, pour les spécialistes qui n'est l'ingénieur géologue, cette information est aussi nécessaire. Estimation des composants traditionnels de condition ingénieur géologique du territoire urbain comme: le structure géologique, le reljef, les conditions hydrogéologiques, les paramétres géotechnique des sols, les procéssus géologiques n'est pas suffisante. Il est nécessaire d'avoir information en supplément pour estimer le territoire urbain: l'evolution historique, la contamination chimique et physique, l'intensité de la charge technologique, la protection des eaux souterraines, la stabilité de sols et .

Notre expérience d'estimation des territoires urbains de Lithuanie à nous permet faire le schèma complèxe des conditions géologiques et l'infrastructure de territoire urbain. Les composentes d'étude on soumis cet schèma.

On était construit la base des données, les cartes qui on expressent singularité de système géotechnique, appliquant tous les données.

Finalement, division de territoire étudié, appiquant n'est pas seulement d'information géologique, mais aussi la charge d'infrastructure, on donnait la possibilité estimer prévision d'évolution dinamique des territoires urbains.

Keywords: environmental geology maps, engineering geology maps, loading, urban geosciences.

INTRODUCTION

The human impact on the geological environment of urban areas has increased to the present day. Thus the estimation of the consequences of economic activities must be evaluated. Urban territory is a representative example of a natural technical system, and it is an area of study with constantly arising questions (Sergejev 1979; Bondarik 1981; Bonani et al. 1997; Kleb 1997). It is necessary to evaluate the research and estimation of each territory's data for features of historical development, summary technogenic load and stability of physical and chemical influences. In such cases the estimation and prognosis of technogenic changes in geological environments is essential for the structural definition, functioning and dynamics of natural technical systems in certain territories (Shubin 1985).

NATURAL TECHNICAL SYSTEM STRUCTURE

Depending on the purposes of research, the natural technical system of urban territories should be broken into subsystems and elements. First of all, a given system can be divided in two interacting subsystems - technical and geological.

As a technical subsystem is made up of the different enterprises of residential-public buildings and structures of communications, further decomposition into complexes of engineering structure elements is possible. The complexes are different in the sphere of the activity. Thus in urban territories it is obviously possible to allocate the following basic complexes: industrial, residential-public, linear-transport and underground.

The influences of technogenic complexes on the geological environment have a rather different character, however, in terms of summary influence they can be generalised as physical, chemical and biological. Former studies have shown that physical influences including gravity, temperature, vibration, electromagnetism and material transportation are the most important (Zigalin 1984; Kotlov 1977). The summary influence of these factors is higher than the chemical and biological influences.

The decomposition of a geological subsystem can be different and depends on the tasks to be solved – starting from large geological structures and ending with rocks and soils. As technogenic complexes and their influence on the geological environment are generally localised, the essence of the geological environment of urban territories could possibly be replaced by the concept "engineering-geological conditions". In this case, under the standard scheme, the division into smaller elements becomes simpler. It is possible to allocate the following basic elements: soils, groundwater and relief.

If technical and geological subsystems for the same urban territory are taken in two-dimensional space the separation of territory composition and subsequent division is possible at the same time (Figure 1).

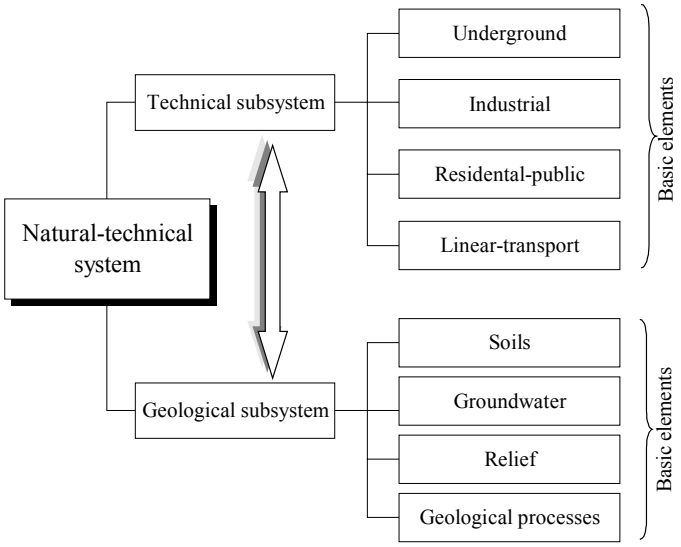


Figure 1. Natural technical system structure

FUNCTIONING AND DYNAMICS OF A NATURAL TECHNICAL SYSTEM

The construction of a matrix for this analysis enables the prediction of reversible processes of the geological environment in more detail (Figure 2).

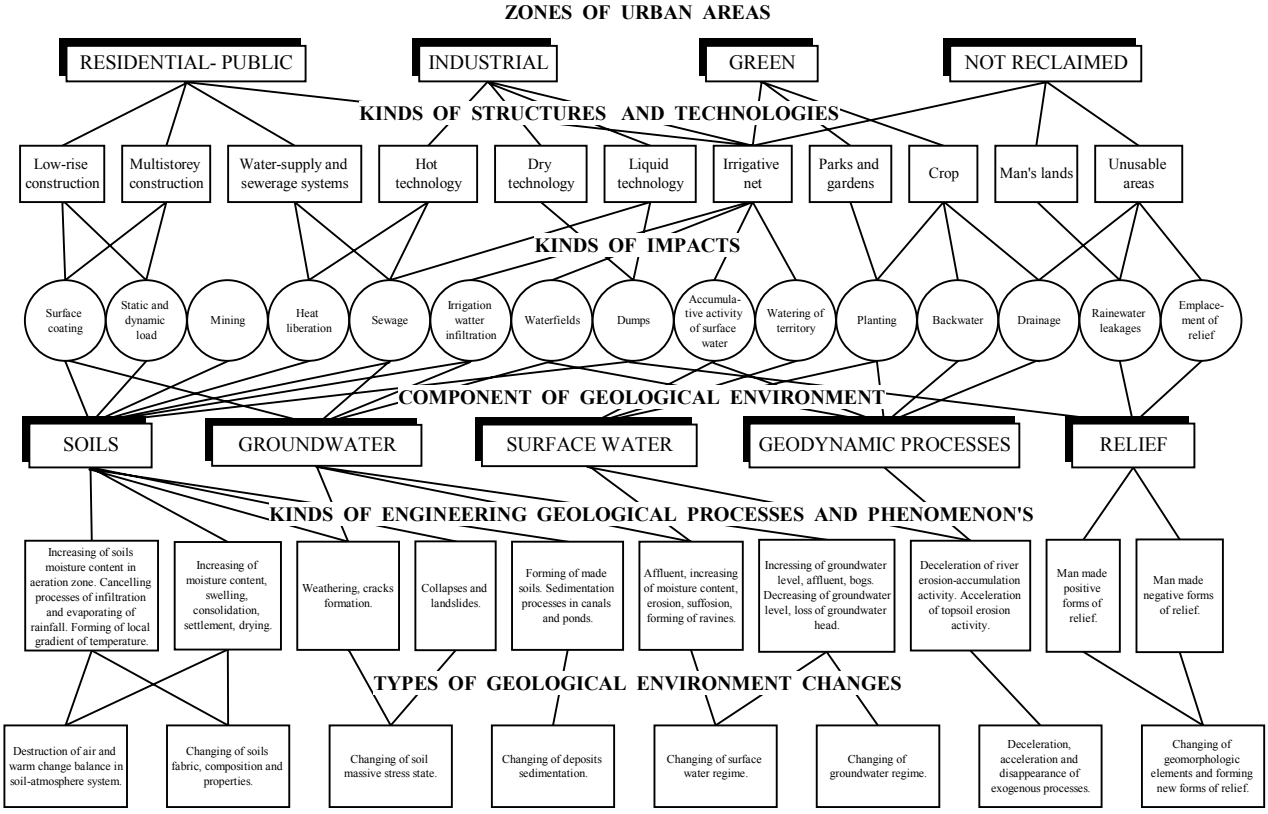


Figure 2. Interaction model between urban area and geological environment (Chudaibergenov 2001)

Any natural technical system is a function of the change in its condition, with interaction of both technical and natural influences. The engineering geological processes determining dynamics of the given system are presented in Table 1.

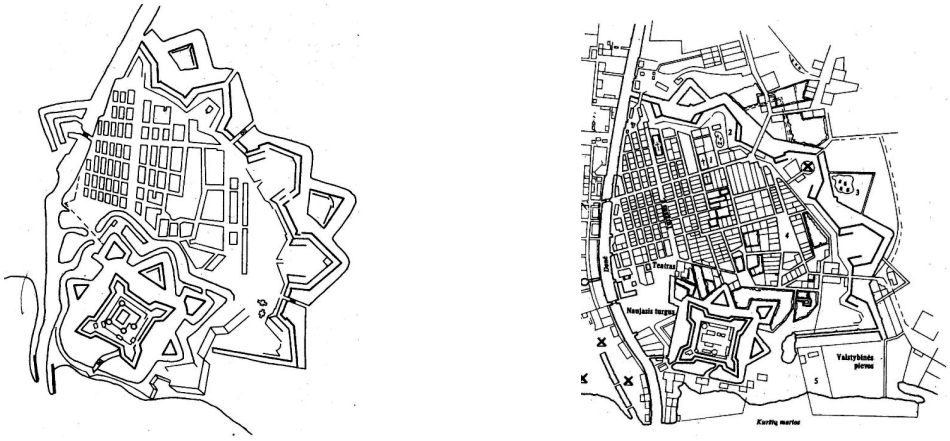
Table 1.Classification of technogenic changes in the geological environment

Parts of the geological surrounding	Changes of geological surrounding	Technogenic complexes			
		Industrial	Residential-public	Linear-transport	Underground
Soils	Soils compacting	+	+	+	-
	Soils decompacting	-	-	+	+
	Soils swelling	+	+	+	-
	Gravitation deformation of slope	+	+	+	-
	Technogenic karst process and suffosion	+	-	-	+
Ground water	Groundwater flooding	+	+	-	-
	Groundwater drawdown	+	+	+	+
Relief	Settlement of ground surface	+	+	-	+
	Artificially negative forms	+	+	+	-
	Artificially positive forms	+	+	+	-

The basic changes in elements of the engineering geological conditions are expressed above and are specified by the engineering geological processes, which have been considered by other researchers (Zolotarev 1983; Kotlov 1977; Shubin 1985). The most frequent changes of the geological environment in urban areas are shown in Table 1, which does not reflect all sets of all possible changes, but it is the most vivid example of interaction between two subsystems.

It should be noted that the submitted list of changes in geological environment specifies that all of them can be reduced to two basic groups: 1) processes which change conditions of geological environment "in situ"; 2) processes which influence the transportation of material.

The changes occurring in the geological environment under the influence of technogenic load playback have influence on the technogenic complexes or their separate parts. Non-uniform settlement, deformation and destruction are examples of the given influences.



A B

Figure 3. Schemes of Klaipeda city in the 18th century (A) and 19th century (B) (Tatoris 1994)

On the other hand, any natural technical system has its own history of development. In most cases evolution of urban territories and the development of technogenic complexes take place over centuries and even thousands of years. In this case it is important to consider the peculiarities of natural technical system development in its historical aspect. The study of archaeological and historical materials, especially of maps, images of urban territories, old pictures, photos and descriptions allows establishment not only of the place of former buildings, structures and records of building foundations, but also enables the measurement and restoration of paleogeographic conditions. An example of such research in Lithuania is the studies carried out during 1994-1999 in the territory of Klaipeda city (Gadeikis 1999). The historical documents of the studied territory helped not only to establish the site of a number of old structures (Figure 3), foundations and the prediction of human capacity, but also the recreation of a former hydrographical network, an arrangement of large bogs and a change in relief (Figure 4).

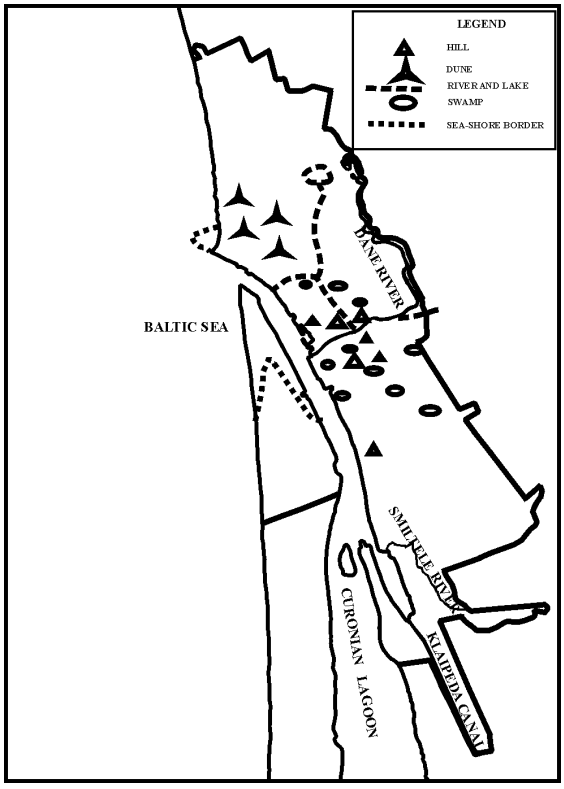


Figure 4. Scheme of the paleogeographic conditions of Klaipeda city (Gadeikis 1999)

Taking into account paleogeographic conditions of urban territories and their changing dynamics, historical development of town-planning is an important part of the engineering geological estimation of urban territories, as well as the reconstruction and development of separate structures and development of general city planning.

THE BASIC RULES OF COMPLEX ENVIRONMENTAL INVESTIGATION FOR URBAN TERRITORIES ESTIMATION

The systematic approach to environmental estimation of urban territories allows the definition of the main components to be employed.

The main document in this case is the map of engineering geological conditions which displays all basic elements. The map must be simple and clear for users from other professions. In this case the map must reflect: the geological structure of the upper part of the lithosphere, petrology, geotechnical properties of rocks and soils, hydrogeological conditions and geological processes.

The legend of the engineering geological map of Lithuanian urban areas was prepared according to the data from the analysis of geological, geomorphological and geotechnical information. This legend possesses information about the composition, physical state and features of geological bodies and predicts their stability and deformability.

The second element used for the estimation of conditions of urban territories is the map of technogenic load, which reflects modern conditions of that load. The main principles of its formation are based on a parametric estimation of its activity. The most suitable for study are the indirect parameters such as the area of building, length of transport highways and length of underground communications per unit area. All possible existing items and pollution should be shown on the map of technogenic load. The total degree of intensity of technogenic load on a map is represented by an integrated vector.

The additional information of the capacity of a bulk layer, the maximum and minimum level of groundwater, the degree of protection from pollution and paleogeographical data is presented on the maps.

Using the aforementioned maps, a survey of the interaction of natural and technical systems enables the division of territory. Typology of areas is made taking into account the following factors: relief, physical condition and geotechnical properties of soils, hydrogeological conditions, intensity of development of geological processes and intensity of technogenic load. It also offers a structure and method of prospective works and a forecast of possible changes of geological environment with development or intensity of technogenic load.

CONCLUCIONS

Environmental estimation of urban territories is possible on the basis of surveying as it is a natural technical system.

Decomposition of a system is essential not on elements of engineering geological conditions alone but also on the intensity of technogenic load.

It is inevitable to consider the historical development of urban territory and the reconstruction of paleogeographic conditions, chemical and physical pollutions and groundwater protection. The final result of the investigation is division of territory taking into account both natural conditions and intensity of technogenic load.

The approach presented in this article allows the prediction of possible changes in the given system.

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