THE RESTRICTIONS IMPOSED UPON THE URBAN DEVELOPMENT BY THE PIEZOMETRIC LEVEL. CASE STUDY: OTOPENI-TUNARI-CORBEANCA

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Abstract. The objective of the study is to identify the urban development pressure exerted upon the limits imposed by the depth
of the phreatic level. The territorial systems from the vicinity of Bucharest registered a momentous dynamics and it enabled the expanding of urbanized areas beyond the limits imposed by the natural conditions. The present research involved the creation of a database concerning the depth of the phreatic level, as well as the identification of the expansion stages undertaken by the urbanized areas. There were applied questionnaires concerning the degree of knowledge regarding the development restrictions for the beneficiaries of built spaces. The spatial layout of the indicators which were used in the research permitted the discovery of some areas where the decision to build something had been taken without analyzing the low depth of piezometric level.

Key words: piezometric level, urban development, territorial management, emerging territorial systems

1. Introduction

Residential buildings produce significant changes upon the natural environment and these are also affected by its components’ action, groundwater, both through their chemical composition, as well as through piezometric level position, creating limits for the urbanized spaces expansion. In these circumstances there appears the necessity of drawing risk maps, which have the role to highlight dynamic piezometric level restrictions. The increase in the groundwater recharge will determine a rise in the grand water level (Boukhemacha et al., 2015a, b).

The comprehension of complex relationships between the components of this system by the decision-makers (decision factors, property developers, customers), will lead both to quantitative and qualitative protection of aquifers and to the minimization of the exploiting costs and to the improvement of the buildings lifetime. The spectacular dynamics of the emerging areas causes an increasing power of the pressure upon the development limits (Dobrea et al., 2012a, b; Peptenatu et al., 2012a, b; Pintilii et al., 2014, 2015). The features of the emerging territorial systems are illustrated in the specialized literature, which insists on the need for a specific approach upon the complex relation between major cities and the functional structured areas surrounding them (Kavaliauskas, 2008; Rutkauskas, 2008; Zelenakova and Jakubikova, 2014; Romanescu et al., 2015).

The continuous dynamics of the relationships leads to a permanent restructure of the space and it becomes possible to push forward the limits of the development (Basbas and Nikolaou, 2009; Popescu et al., 2009). The pressure exerted upon the natural environment surrounding major cities is analyzed in the studies about metropolitan areas expansion (Bassand et al., 2000; Wust et al., 2005; Krátke, 2007). The creation of some territorial management systems, designed to support and guide the natural evolution of the complex relationships between major cities and surrounding spaces will lead to a multiplication of imbalances in the natural environment (Peptenatu et al., 2014; Szymanska et al., 2015).
The building of some specific management models for the emerging structures, resulted from the interactions between the polarizing center and the influence area, are determined by the way in which it is perceived the imbalance between the economic compound and the environmental one, as well as at the institutional level and at the demographic composition level (Alam et al., 2007; Giri et al., 2007; Sjöberg, 2007; Braadbaart et al., 2008).

The highly dynamics of the relationships between the components of the emerging territorial systems needs territorial management models in which there should be paid a special attention for the decisional part, because the decisional impulses have to be guided in order to lead to the results expected by the decision makers (Skeaff et al., 2007; Velasco et al., 2013; Nandi et al., 2015; Petrişor, 2015).

2. Background and research methodology

The research aims to highlight the relationship between the groundwater system and the constructions implemented during the time in these areas. On the basis of piezometric level data collected, bearing in mind the validation of the data resulted from the field research, as well as on the analysis of the cartographic database of the buildings within Corbeanca, Otopeni and Tunari, we managed to elaborate: the territorial distribution of piezometric level position; the spatial evolution of the areas built from 1940 to 2015; and to define the vulnerability of the areas with a high groundwater level upon constructions.

In order to achieve the spatio-temporal data evolution and interpolation concerning the piezometric level of the studied area there was used ArcGIS 9.3 platform. In order to create the digital piezometric level model, there was used Inverse Distance Weighted (IDW) interpolation method, which is the most relevant for obtaining this one, while for extracting hydroizohipses there was used the Contour function. The data concerning the building area was obtained from two historical cartographic materials, Directories Drawing Plans and topographical map at the scale 1:25,000 (first two stages) and two orthophoto plans dated from 2005 and 2015.

Starting from the four cartographic funds, there was extracted the vector database which illustrates the area built for the three towns.

The pressure exerted upon the limits of the natural environment was analyzed through the evolution of the following indicators: the number of dwellings by type of ownership, the number of finished dwellings classified concerning their categories, the number of building permissions, the authorized area for building, the number of inhabitants, the number of firms, the employee number.

The research took place in Corbeanca-Otopeni-Tunari area (Fig. 1), a representative area for the quick expansion of public spaces and their selling prices.

3. Results

The expansion of buildings areas is a phenomenon that Romania has been explosively facing for the past 25 years, the urban peripheries of major cities are struggling with momentous dynamics.

Otopeni Town registered the highest growth rate of the built areas (Fig. 1), compared to Corbeanca and Tunari, due
to its position on the transport axis of Bucharest - Ploiești, as well as due to the plans for territorial development advanced since 1950, when the town has been included in the “30 Decembrie” district of the regional city of Bucharest. Since 1968 Bucharest, Otopeni town was ascribed as suburban community of Bucharest city (Parliament of Romania, 1981), subsequently being subordinated to Ilfov Agricultural Sector since 1981 and declared a city since 2000 (Parliament of Romania, 2000).

The localities of Corbeanca and Tunari recorded significant increases after 2005, beginning with the major investments in infrastructure, which improved accessibility to the polarization center of Bucharest. Thus, there are expanded residential areas, new residential areas being developed outside the central hearth, on the land of the old farms. The evolution of the spatial areas built on the emerging territorial system from Bucharest was generated by the new living conditions need of the population from the polarizing center of Bucharest.

The maximization of property developers’ profit, but also the lack of information concerning the geotechnical design conditions (SR EN 1997-1: 2004 SR EN 1997-2: 2008), the constructions founding on lands susceptible to humidity (NP 125: 2010), as well as the general principles of checking the safety of constructions (STAS 10100 and STAS 10101), all these led to the development of several residential neighborhoods within completely inadequate areas, where the beneficiaries have noticed very lately their shortcomings (roads of poor quality, deficiencies in power supply, lack of access to a sewerage system or water supply).

Less noticeable is, unfortunately, the piezometric level position, which negatively affects the structure and the lifetime of the buildings due to its great importance illustrated throughout all this studied area.

![Fig. 1. Spatial evolution of Corbeanca, Otopeni and Tunari localities, within 1940 – 2015](image)
The measured level oscillations in the hydrogeological observation drilling within the network of “A.N. Romanian Waters”, on a range of about 40-50 years, indicates the average level of groundwater, as well as the maximum and minimum rates of oscillation, depending on climatic variations. They occur at depths ranging generally between -2 m and -7 m (Fig. 2).

In the area of Bucharest and Ilfov county, Fratesti Aquifer is the main collector of groundwater. This aquifer layer is characterized by three levels, which have a huge flow potential, hydraulic conductivity with values between 4 and 24 m/day, according to specific flow rates of 1.5 - 10 l/s/m. In the area of Bucharest, hydrochemical profile (facies) ranges from sodium bicarbonate with calcium poignancy, in layers A and B, and sodium bicarbonate dominant, with a significant chlorinated calcic ball in the depth, in case of layer C.

From the analyses of the hydroizohipses drawn within the northern area of Bucharest city emerging area, based on the hydrogeological data available in the period 2000-2016, there could be noticed that most of the area built in Corbeanca village overlaps the area bounded by the hydroizohypse of 2 m, and only partially over the 3 m and 4 m ones. This is a humidity sensitive field that requires special foundations. Also, the same situation we can find in the case of Tunari locality, where only the southern part of the built land, located in the close proximity of the ring road surrounding Bucharest city, is built over areas with a groundwater level ranking 4 – 5 m depth, while the rest is situated in areas with values of 2 – 3 m.
The only built area, within the analyzed space, where groundwater lies at depths of 4 - 6 m, is the town of Otopeni where, only to a small extent (in the southern part of the locality), we may encounter a humidity sensitive area with position of groundwater at about 2 m depth.
This area is positioned partially over the construction of Otopeni International Airport, which can become a limiting factor for its development in the future. Detailed analyses upon the economic and social context of the area studied have shown growth tendencies for the analyzed indicators. The most dramatic growth has been recorded by the number of dwellings (Fig. 3), which has been really increasing after 2005.

The three territorial systems analyzed become tempting for the tenants arrived
from urban areas in search of modern living conditions. The highest values are recorded in Corbeanca and Otopeni where exclusive real estate projects have been initiated. The attractiveness of the analyzed space regarding real estate projects, is highlighted by the number of buildings built during the each analyzed year (Fig. 4). The most significant increases have been registered by real estate and housing projects funded by population (Fig. 4 C, D). The same tendency is evidenced by the number of permissions issued in the specified period (Fig. 5 A, B, C, D) and the approved area to be built (Fig. 6 A, B, C, D), bearing in mind that the economic crisis led to the reduction of requests number.

The tendency to increase pressure upon the limitations imposed by the groundwater level, is proved by the evolution of the number of inhabitants, the three analyzed localities having recorded significant development during this period (Fig. 7). The concentration of economic activities in the three localities is another specificity issue that helps the raise of the built areas. The dynamics of the companies (Fig. 8) and the dynamics of the number of employees (Fig. 9), show an increase of the economic complexity.

4. Conclusion

Groundwater is a vector of development for the new residential areas offering a low cost water supply, but it illustrates also critical issues, less known, which will increase maintenance and service costs of the new constructions.

In the city of Bucharest and its emerging space, most likely due to waterproofing riverbeds of Dambovita and Colentina Rivers and due to the construction of underground transport network, of the underground passages and parking, as well as due to the water loss from the running water distribution and waste water draining system, there can be noticed a growth of the piezometric level in the first groundwater layer.

In this moment many of these buildings require drainage or epuisment works for the groundwater which involves higher operating costs, but also additional risks concerning their safety in operation.

Drainage or epuisment works can generate hydrodynamic phenomena such as hydrodynamic training, hydraulic breaking of the excavation base or differential settling.

Within the researched area, there worked up, between the years 1990 and 1995, hydroameliorative drainage works organized in systems larger than 1,000 ha (ISPIF -1995), which had the role of maintaining the optimum level of groundwater in order not to be affected the buildings and agricultural fields.

The analysis of the main pressure indicators upon the limits the groundwater impose to the development, shows an increasing trend, which requires guided intervention concerning the decision makers in order to lunch works designed to lower the groundwater level for the entire studied area.

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phenomena from the territorial systems” - Project Manager Assistant Professor Daniel Peptenatu.

REFERENCES


Parliament of Romania (2000), Law 220 for Low for declaring Otopeni commune, Ilfov County, as city [in Romanian], Official Gazette 617.


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