SANITARY PROTECTION OF THE GROUNDWATER TAPPING – LEGISLATIVE ISSUES, PRINCIPLES AND PARTICULARS. CASE STUDY – TAPPING FOR THE WATER SUPPLY OF SAPOCA VILLAGE, BUZĂU COUNTY

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ABSTRACT. – Sanitary protection of the groundwater tapping – legislative issues, principles and particulars. Case study – tapping for the water supply Săpoca village, Buzău county. At European level, water presents a great importance, the Water Framework Directive no. 60/2000/EC and the Directive for the protection of groundwater against pollution and deterioration no. 118/2006/EC, establishing clear objectives that all water, including groundwater, must achieve "good status" by 2015. The legal basis for the concept and size of sanitary protection areas and hydrogeological protection perimeter is given by the "Water Law" (Law no. 107/1996), "The Law regarding the amendment and completion of Water Law no.107/1996" (Law no. 310/2004) and „The Decision for the approval of special rules type and the size of the sanitary and hydrogeological areas (GD no. 930/2005). GD no. 930/2005 sets out that in order to protect the health of groundwater abstraction there are established in the field three areas of protection with various degrees of risk from pollutants, namely sanitary protection area with severe regime, the sanitary protection regime restriction and hydrogeological protection perimeter. The paper presents some legal issues and principles for determining the protection areas of the groundwater tapping, and through the case study (abstraction for water supply of Săpoca village, Buzău county) there are presented some peculiarities (geomorphological, geological, hydrogeological conditions) on how to determine these areas.

Key words: the quality of groundwaters, sanitary protection areas, the hydrogeological protection perimeter.

INTRODUCTION

The groundwaters represent an important source of water supply for lots of human communities both in the urban environment and in the rural one. At European level, water is given a great importance, the Water Framework Directive no. 60/2000/EC and Directive for the groundwater protection against pollution and deterioration no.118/2006/EC, establishing clear objectives that all waters, including groundwater, must achieve "good status" by 2015 so as to ensure their sustainable use. In this context the sanitary protection of the grounwater tapping is very important.

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2. LEGISLATIVE ISSUES FOR THE PROTECTION OF GROUNDWATER TAPPING – PRINCIPLES AND PARTICULARS

The legal basis for the concept and size of sanitary protection areas and geological protection perimeter is given by the "Water Law" [6], by the "The Law regarding the amendment and completion of Water Law no.107/1996 (Law no. 310/2004)" [7], and by the "Decision for the approval of special rules regarding type and size of sanitary and hydrogeological protection areas" (GD no. 930/2005) [8].

In the GD no. 930/2005 there are provided, among others, the following: the sanitary protection of groundwater tapping is achieved by applying water quality protection measures set by the laws in force, and by establishing in the field the following areas of protection with different degrees of risk from pollutants (Article 3), namely:

- **The sanitary protection area with severe regime** includes the terrain around the objectives of Article 2, where is prohibited to use any location or activity that could lead to the contamination of water sources (Article 5);
- **The sanitary protection area with restriction regime** comprises the territory around the sanitary protection area with severe regime delimitated so that through the application of the protection measures, depending on the local conditions, to eliminate the danger of water quality deterioration (Article 6);
- **The hydrogeological protection perimeter** will ensure protection against any kind of readily degradable or non-degradable substances and the regeneration of the yield exploited through the tapping works (Article.7).

The sizing of the protection areas will be made by taking into consideration all the local, natural and anthropogenic factors, that can occur in the water contamination, namely: the geomorphological, geotectonic and geotechnical characteristics of the area, the structures and hydrogeological parameters of the layers situated above the intercepted aquifer, the structure and hydrogeological parameters of the intercepted aquifer, the punctual and diffuse sources of pollution and other aspects observed in the field (Article.11).

At the sizing of the sanitary protection areas with severe regime and with restriction regime, there is usually utilized the criterion of the time transit of a water particle hydrodynamic active using in calculations the aquifer hydrogeological parameters. The size of the sanitary protection area with severe regime of the underground sources is made so that there is ensured a crossing time of minimum 20 days for every drop of water, which is presumed to be contaminated, which would infiltrate at the limit of this area and would reach at the place of the water tapping, and the size of the protection area with restricted regime is achieved taken into consideration a time transit in the underground of minimum 50 days from the infiltration point to the place of tapping (Article 13).

In the case of the wells that exploit the depth aquifers under pressure and which are made so that to achieve the isolation conditions of the tapping layer toward the terrain surface and the superior aquifer layers vulnerable to pollution,

there is established only the sanitary protection area with severe regime which will be circular, with the centre on the well position and the radius of 10 meters; in this case the sanitary protection area with restriction regime coincides with the sanitary protection area with severe regime, and the hydrogeological protection perimeter situated in the supply area of the aquifer, there is simultaneously established for all the tappings that exploit the same regional aquifer structure (Article.14).

The mentioned legislation lays down the areas of health protection with severe regime for pump stations, water quality improvement facilities, buried tanks and distribution networks (Article.30).

3. CASE STUDY – THE ESTABLISHING OF THE SANITARY PROTECTION AREAS AND OF THE HYDROGEOLOGICAL PROTECTION PERIMETER FOR THE SAPOCA TAPPING FRONT WELLS, BUZAU COUNTY

3.1. General data

Săpoca village is situated at approximately 15 km North – West from Buzău town, on the left side of the river with the same name, near the confluence with it's left tributary the Slănic river (Fig.1).

From the geomorphological point of view, Săpoca village area is located in the South - East part of the Buzău Sub-Carpathians, near their contact with the plain area, at the confluence of the Slănic and Buzău rivers [4].

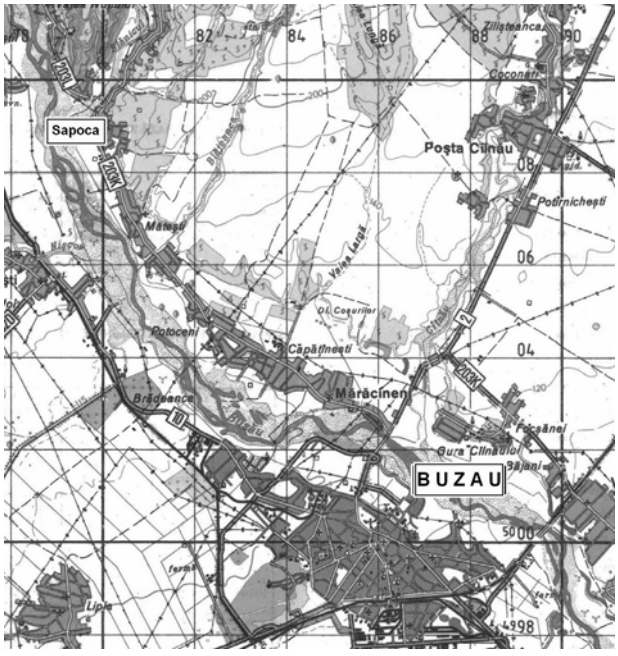

Fig. 1. ***Location of study area***

From the geological point of view, the study area belongs to the North East part of the Wallachian Platform, near the contact with Carpathian Foredeep [2],[3]. The Wallachian Platform consists of two structural floors, the basement composed of crystalline schist, and the cover, made up of deposits belonging to several cycles of sedimentation.

From the hydrogeological point of view, the followings are important for the study area: deposits belonging to the Upper Pliocene and Quaternary. **Middle Romanian - Lower Pleistocene** is represented by the Cândeşti Formation (gravels and sands, gravels with sands and boulders, with intercalations of clays and marls). **The Middle Pleistocene** is represented by an alternation of marls, clays and sands, forming "Marly Complex", as well as through the deposits of the Râmnic Plain, which are directly overly Cândeşti Formation and are covered by loessoid deposits. The alluvial deposits of the Buzău terraces (gravels, sands and boulders) and the loessoid deposits belonging to the terraces are of **Upper Pleistocene – Holocene** time. The loessoid deposits of the low terraces, the alluvial deposits of valleys and the alluvial deposits that make up the alluvial fan of the Buzău River (sands, gravels, boulders) have been attributed to the **Holocene**.

3.2. Hydrogeological considerations

From the hydrogeological point of view, in the study area there are developing two important hydro – structures: the alluvial fan of the Buzău River (Holocene) and the Cândeşti Formation (Middle Romanian – Lower Pleistocene).

Generally, from lithological point of view, the Buzau river alluvial fan deposits, which quarter the phreatic aquifer, consist of sands with gravels and boulders. To these are added subordinate clays, sandy clays, with lenticular development.

The phreatic aquifer supply is made from rainfalls on all its cropping out area, and the general flow direction of the groundwater is from northwest to southeast, with the local change of the direction towards the Buzău river.

The hydrogeological section achieved by the wells of the Săpoca tapping front (Fig. 2) show that, in this area the deposits of the Buzău river alluvial fan are mainly made of sands with gravels and boulders and subordonate, from sands with gravels on which are added clayey interbeds with lenticular development.

Under the deposits of the Buzău river alluvial fan are developing the Cândeşti Formation deposits in which there is located the medium depth aquifer.

From petrographical point of view, the Cândeşti Formation consists in an alternation of sands with gravels and boulders and sands with gravels (Fig. 2). They are separated by clay horizons, some with lenticular development.

The contact between the deposits of the Buzău river alluvial fan and the Cândeti Formation deposits is marked in the study area by a continuous clayey horizon. In other areas the contact is not clearly stated, due to the discontinuous development of the clayey horizons. The piezometric level can be artesian or ascending, and the general flow direction of groundwater is from northwest to southeast.

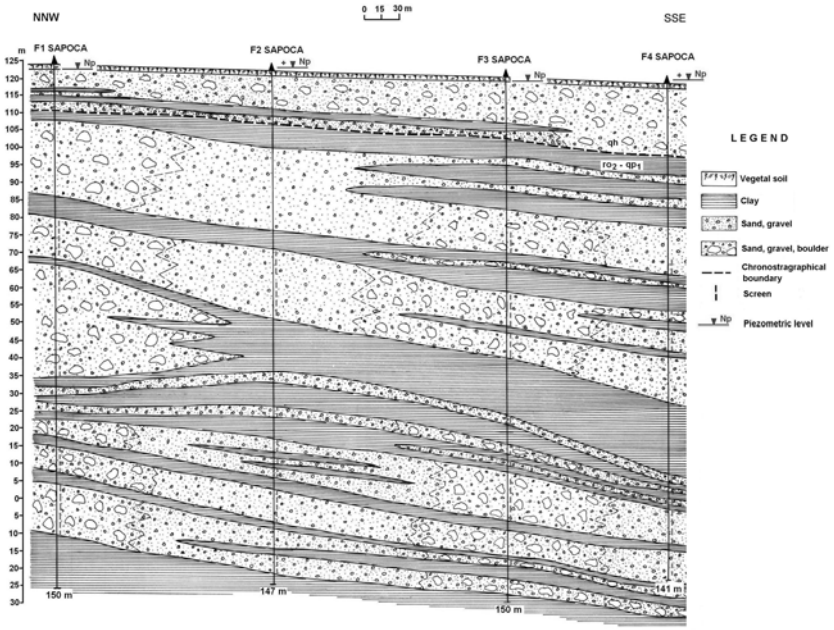

Fig. 2. ***Hydrogeological cross section through the wells of the tapping Săpoca front, Buzău county***

3.3. Data regarding the Săpoca tapping front

The tapping front which ensure the groundwater supply of the localities from Săpoca village is made of 4 wells placed on an alignment with a length of approximately 525 m and is located on Buzău river left side terrace (Fig. 3), downstream of its confluence with the Slănic river.

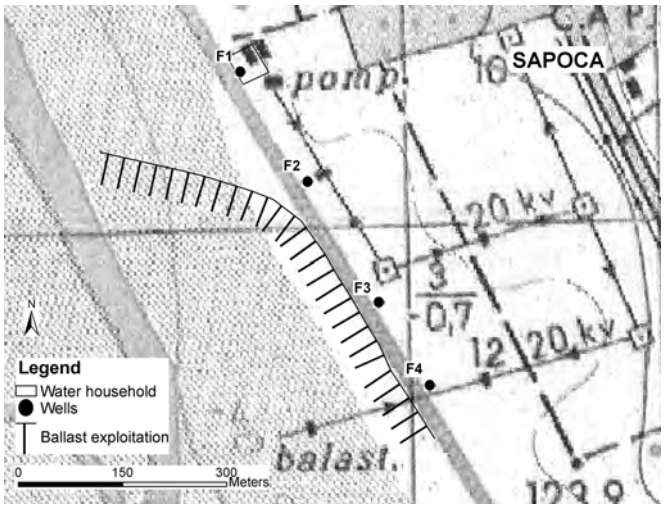

Fig. 3. ***Location of the Săpoca tapping front wells***

All wells have crossed an alternation of sands gravels and boulders, sands with gravels, with clays intercalations and captures the middle depth aquifer located in the Cândeşti Formation (aquifer with pressure level) in the range 45 m – 144 m. Inside the water household along with the F1 well, there is a water storage tank with the capacity of 500 m^3, pump station and staff office. In the western and southwestern side of the tapping front there are currently in progress excavation works for exploiting the mineral aggreagates from the terrace area of the Buzău river left side.

3.4. The dimensions of the sanitary protection areas

The sizing of the sanitary protection areas was made according to the *Government Decision for the approval of the special rules regarding the type and the size of the sanitary and hydrogeological protection area – HG no. 930/2005* and based on the analysis of each well, of the geological and hydrogeological context (based on the achieved hydrogeological cross section) and of their definitization data sheets from the NIHWM archive – Department of Hydrogeology.

Based on the above statements there is considered that the wells tap the middle depth aquifer (aquifer with under pressure level), there are also impermeable or hardly permeable horizons in the cover of the tapped aquifer horizons with continuous development on relatively big distances.

The finalization data show that at the execution of the Săpoca F1 well there was made the isolation of the horizons tapped from the surface by cementing the annular space between the digging hole and the cased column on the depth range of 25–30 m and a plug of clay on the depth range 30–32 m, without a proper isolation of the phreatic aquifer.

In the case of the wells F2 Săpoca, F3 Săpoca and F4 Săpoca, the isolation of the phreatic aquifer was not achieved, the annular space between the digging hole and the cased column being filled with ballast.

Taking into consideration that the proper isolation of the phreatic aquifer is a condition for applying the provisions of the Article 14 from HG no. 930/2005 (one sanitary protection area with severe regime, circular with the radius of 10 meters), condition that is not fulfilled in the case of the Săpoca tapping front, the sizing of the sanitary protection area for these wells cannot be done by applying the provisions of this article.

This raises the possibility of entering a potentially polluting substances from the phreatic aquifer in the middle depth aquifer, through the infiltration through the sand or the ballast between the drilled hole and the cased column.

It is considered that the entering of the phreatic aquifer water in the drilling is made from upstream to downstream but also sidewise, on the general flow direction of the groundwater, and the real flow speed is the one in natural regime, according to the Law of Darcy [1]:

$$v = \frac{K \cdot I}{n_e} \qquad (1),$$

where v = flow speed (m/day)
K = hydraulic conductivity (m/day)
I = hydraulic gradient (dimensionless)
n_e = effective porosity (dimensionless)

Considering the criteria of time transit (art. 13, lit.a,b from HG 930/2005) the distance made by a drop of water in a time t = 20 days, corresponding to the sanitary protection area with severe regime is:

$$D_{20} = v \cdot 20 \text{ days (m)} \quad (2).$$

By analogy, in a time t = 50 days, the corresponding distance of sanitary protection zone with restriction regime is:

$$D_{50} = v \cdot 50 \text{ days} \quad \text{(m)} \quad (3).$$

The sanitary protection areas for the wells F1 Săpoca, F2 Săpoca, F3 Săpoca and F4 Săpoca are established according to the Article 11 and by adapting the provisions of the articles 13 and 14 din HG no. 930/2005, so that:

- the sanitary protection area with severe regime: 10 meters downstream on the groundwater flow direction, sidewise, on both sides of the capture and upstream on the groundwater flow direction, the distance corresponding to the time t=20 days, calculated according the relation (2)
- the sanitary protection area with restriction regime: 10 meters downstream on the groundwater flow direction, sidewise, on both sides of the capture and upstream on the groundwater flow direction, the distance corresponding to the time t=50 days, calculated according the relation (3)

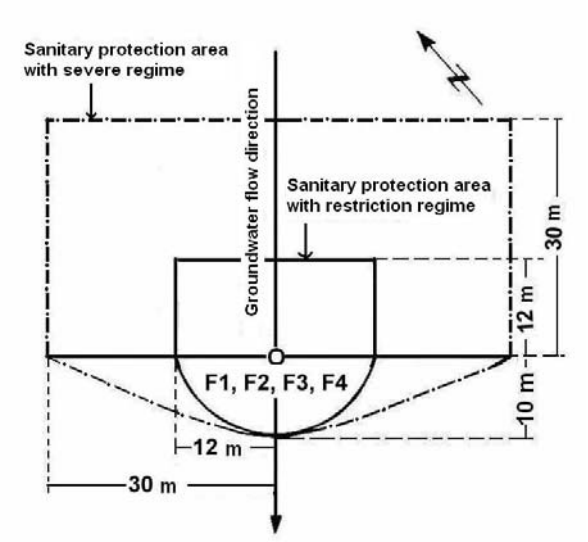

Fig. 4. ***The sanitary protection areas of the Săpoca tapping front wells, Buzău county***

According to relation (1), where K = 60 m/day, I = 0,0015 and n_e = 0,15, [5] of the relations (2) and (3) and of those mentioned above:

- the sanitary protection area with severe regime D_{20} = 12 m
- the sanitary protection area with restricted regime D_{50} = 30 m.

The downstream distances in both sanitary protection areas are of 10 m (Fig. 4).

In Fig. 4 the flow direction of the phreatic groundwater is marked, because the groundwater from this aquifer has a potential pollution risk of the tapped water, through the infiltration in the annular space between the digged hole and the cased column.

3.5. The delimitation of the hydrogeological protection perimeter

The delimitation of the hydrogeological protection perimeter (points 1–19) was made according to the provisions from the articles 7 and 14 from HG no. 930/2005, taking into account the following (Fig.5):

- the supply area of the middle depth aquifer located in the Cândeşti Formation deposits which is situated in the hillside from north and northwest of Buzău, area in which these deposits crop out;
- the general direction of the groundwater flow, from northwest to southeast;
- the placement of the tapping front from the supply area of the quartered aquifer in the Cândeşti Formation and from the main flow direction of the groundwater.

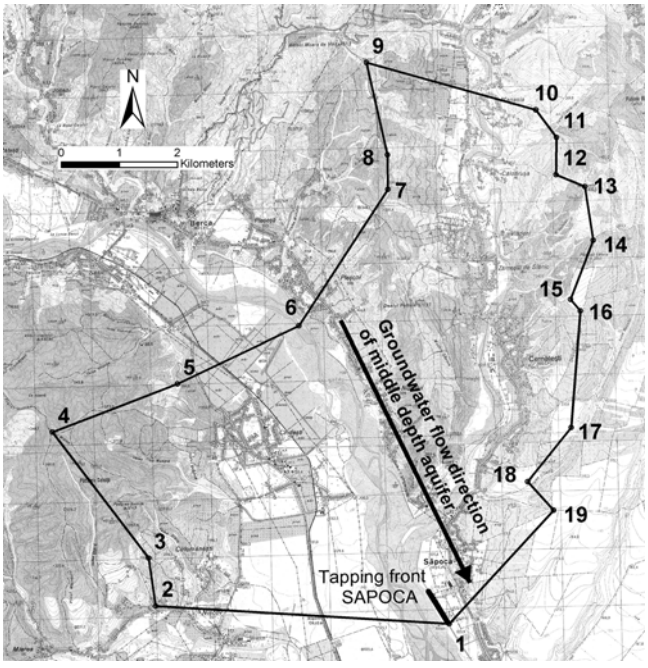

Fig. 5. ***The delimitation of the hydrogeological protection perimeter for the Săpoca tapping front wells, Buzău county***

4. CONCLUSIONS

The tapping front which ensure the underground water supply of the localities from Săpoca village is made of 4 wells placed on an alignment with a length of approximately 525 m and is located on Buzău river left side terrace, downstream of its confluence with Slănic. The wells with depths comprised between 141 and 150 m, exploit the middle depth aquifer quartered in the Cândeti Formation.

The sizing of the sanitary protection areas was made according to the **Decision for the approval of the special rules regarding the type and the size of the sanitary and hydrogeological protection area – HG no. 930/2005** and based on the analysis for each well of the geological and hydrogeological context (based on the achieved hydrogeological cross section) and of their definitization data sheets from the NIHWM archive – Department of Hydrogeology.

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