GROUNDWATER QUALITY IN THE SOUTHERN PART OF DOLJ COUNTY

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Abstract. Groundwater quality in the southern part of Dolj County was determined in 2013 based on the hydrological units which correspond to the geomorphologic units present within Dolj County perimeter; the results of the analyses are presented in the paper as average values. Groundwater has been studied from several localities situated on the Danube terraces and within the Jiu alluvial floodplain. The following indicators were determined: water temperature, pH, dissolved oxygen, chemical oxygen demand determined with potassium permanganate, chemical oxygen demand determined with potassium dichromate, total salts, hardness, chlorides, sulfates, calcium, magnesium, sodium, ammonium, nitrites, nitrates, orthophosphates, total phosphorus, iron, manganese. The groundwater quality depends on their hydrogeological, hydrochemical characteristics and as well as on the anthropogenic characteristics. The groundwater quality is simply the result of the geology and hydrology of the area. Source rock composition, weather in the source area, and final mineral composition of the sediments are the main factors controlling the chemical composition of the studied water.

Keywords: groundwater, quality indicators, Dolj County, physicochemical characteristics.

Rezumat. Calitatea apelor subterane în zona de sud a judeţului Dolj. Calitatea apelor subterane, din partea de sud a judeţului Dolj a fost stabilită în 2013, pe baza unităţilor hidrologice care corespund unităţilor geomorfologice existente în perimetrul judeţului, rezultatele analizelor fiind prezentate în lucrare ca valori medii. A fost studiată apa freatică provenită din mai multe localităţi situate în terasele Dunării şi zonele inundabile din lunca Jiului. Următorii indicatori au fost determinaţi: temperatura apei, pH-ul, oxigenul dizolvat, consumul chimic de oxigen determinat cu permanganat de potasiu, consumul chimic de oxigen determinat cu bicromat de potasiu, săruri totale, duritate, cloruri, sulfaţi, calciu, magneziu, sodiu, amoniu, azotaţi, azotiţi, ortofosfaţi, fosfor total, fier şi mangan. Calitatea apelor subterane depinde de caracteristicile hidrogeologice, hidrochimice, precum şi de caracteristicile antropice. Calitatea apelor subterane este rezultatul geologiei şi hidrologiei zonei. Compoziţia rocilor, microclimatul din zona sursă, şi compoziţia minerală finală a sedimentelor sunt principalii factori care controlează compoziţia chimică a apei studiate.

Cuvinte cheie: ape subterane, indicatori de calitate, judeţul Dolj, caracteristici fizico-chimice.

INTRODUCTION

Groundwater is the biggest fresh water reservoir in the world and it represents more than 97 % of all available fresh water reserve, except for the glaciers. The groundwater is very important for the hydrologic cycle and is vital for wetlands and river flow, acting as a reservoir during drought periods. The groundwater has specific physicochemical properties and may be used as drinking water for population. In Romania, about 83 % of the water used for population comes from underground, and for this reason it is very important to keep the groundwater unpolluted. Water pollution is a process that modifies its specific physicochemical and biological properties, which leads to restriction or special measures of decontamination, so the water may be used for different activities (ŞERBAN & ŞERBAN, 2009).

According to the legislation, the quality of groundwater is protected by European Directives, many of them fully transposed in the Romanian legislation. The most important are: the Water Framework Directive (60/2000 CE), the Directive for the protection of groundwater against pollution and deterioration (2006/118/CE), the Directive for the protection of groundwater against nitrates pollution from agricultural sources (91/676 CE). Through the Directive for the protection of groundwater against pollution and deterioration (2006/118/CE) it is imposed to member states to prevent the direct or indirect discharge of wastewater with dangerous substances in the groundwater and to reduce the discharge of other pollutants, in order to avoid pollution.

The Water Framework Directive (2000/60/CE) regarding the establishment of the framework for European policy in water field has integrated the provisions from the Groundwater Directive in one complex system meant to assure the quality and quantity of all groundwater in the European Union. The Water Framework Directive established environmental objectives for groundwater, surface waters, coastal and transitional waters that must be achieved by the end of 2015. The activity of awareness of groundwater quality is conducted in the major river basins, on the morphological units, and within their structures aquifers (underground) through hydrogeological stations comprising one or more observation wells. To follow the pollution of groundwater supplies due to human activities and to determine the impact of various sources of pollution on the phreatic, measurements and observations are periodic and polluting wells located around major pollution sources in each basin. Given the fact that groundwater is not always used for drinking (a situation which highlights the quality of the indicators set out in law by determining water) and to highlight its quality as a result of various activities carried out to determine, in addition, a number of other quality indicators specific to these activities. Groundwater is an important source of drinking water. Most of the population uses groundwater for fresh supply and agricultural purposes. Unfortunately, many of our wells are already contaminated with nitrates and other industrial and agricultural chemicals (JOSAN N., 2002; TARCEA M., 2006). Composition and quality of underground water supply sources depend on the quality and composition of soil and this is why protection from possible sources of contamination in the area is very important (MĂNESCU et al., 1996; VASILOV & BUŞTIUC, 2000).

MATERIAL AND METHODS

Oltenia Plain is the westernmost subunit of the Romanian Plain and it develops like a W-E strip between the Getic Tableland (N), the Olt River (E) and the Danube River (W and S). Oltenia Plain is crossed from N to S by five perennial rivers: the Blahniţa, the Drincea, the Desnăţui, the Jiu and the Olt. The altitude of Oltenia Plain varies from 200 m near the boundary with the Getic Tableland to 25 m (over sea level) at the entrance of perennial rivers Olt River into the Danube Floodplain (SE corner). Oltenia Plain occupies a surface of 7,985 km^2 (roughly 8,000 sq.km). It is composed of 7 step-like levels of terraces modelled (cut) by the Danube River during the Middle-Upper Pleistocene and of three extended floodplains (the Danube, the Jiu and the Olt perennial rivers) (Fig. 1).

Phreatic aquifer has mutual and hydraulic relationship with some of the underlying confined waters (in the Serravallian - Upper Pliocene formations). Generally, the water table aquifers hosted in the terraces and floodplains recharge from meteoric waters and discharge into the perennial rivers. Only during the great floods, the rivers feed the water table.

Groundwater quality in the southern part of Dolj County was determined in 2013 based on the hydrological units which generally correspond to geomorphologic units present in Dolj County perimeter. There were studied several villages located on the Danube terraces and the floodplains from the Jiu area. The following indicators were determined: water temperature, pH, dissolved oxygen, chemical oxygen demand determined with potassium permanganate, chemical oxygen demand determined with potassium dichromate, total salts, hardness, chlorides, sulfates, calcium, magnesium, sodium, ammonium, nitrites, nitrates, orthophosphates, total phosphorus, iron, manganese. Water samples were collected from distinct bodies of groundwater, as it follows: terraces and floodplains of the Jiu and its tributaries. These waters are subject to geomorphologic division in which they are stationed, creating discontinuities in their regional development. However, in terms of spread, it is the most important unit, approx. 80 km long and 5 km wide, the deposit thickness varying between 3 and 8 m. The studied localities are: Zăval, Malu Mare and Ostroveni; deep groundwater from the Pliocene formations developed both in the Jiu hydrographic basin and the Danube basin, with a large expansion in area and depth. There were studied Sadova and Amărăşti, a deep groundwater body from Pleistocene formations. They are stationed in several aquifer layers, have small thickness of 3-4 m, have a seasonal aquifer layer, with less water, but important for the area because most of the wells tap that aquifer layer. The studied localities are Piscu Sadovei and Dobreşti. These waters were characterized in terms of quality indicators, oxygen regime and indicators of mineralization. Water samples for analysis are presented in the paper as average values. Determinations were performed with the following instruments: water harvesting pump equipped with vacuum, Hanna ph-meter, Hach digital titrator, system Kjeldahl, DR 2010 spectrophotometer.

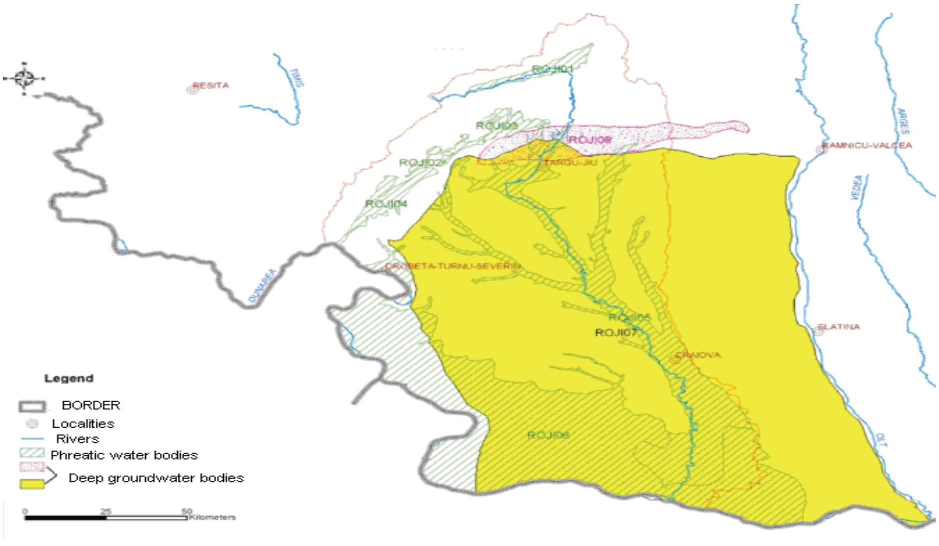

Figure 1. The map of water bodies delimitation (original).

RESULTS AND DISCUSSIONS

The groundwater quality depends on its hydrogeological, hydrochemical characteristics and as well as on the anthropogenic characteristics. The groundwater quality is simply the result of the geology and hydrology of the area. Source rock composition, weathering in the source area, and final mineral composition of the sediments are the main factors controlling the chemical composition of the studied water (STEVANOVIC & IURKIEWICZ, 2009).

In figures 2, 3 and 4, there are presented the physicochemical characteristics of phreatic waters from the Danube and the Jiu terraces and floodplains framed in water body II, namely, Zăval, Malu Mare and Ostroveni, the physicochemical characteristics of phreatic waters from the Pliocene, the Sarmatian and the Pleistocene formations framed in water body V, from Piscu Sadovei and Dobreşti localities and the physicochemical characteristics of phreatic waters from the Pliocene, the Sarmatian and the Pleistocene formations framed in water body III, from Sadova and Amărăşti localities.

The phreatic layers of Zăval, Malu Mare and Ostroveni are intercepted at different depths depending on the terrace level. In the old, higher and upper terraces areas, the aquifers are found commonly below the depth of 10-15 m. In the low terrace and floodplain areas, the phreatic layer was intercepted in most cases between 5 and 20 m depth. The permeable deposits thickness of the phreatic horizon varies between 3 and 8 m. The highest thickness was found in the areas of the lower basin of the Jiu River. In the terrace areas, the thicknesses are smaller, rarely exceeding 10 m. In the phreatic water quality assessment, there was also taken into consideration a number of components, which by their high content, depreciates the water quality. On the underground flow direction, the water is enriched in salts and the fixed residue increases. It is also noted that, in areas with slower hydrodynamic regime (with small slope drainage), and together with the evaporation factor from the layer, when the hydrostatic level is near the surface (under 3 m), waters are more mineralized.

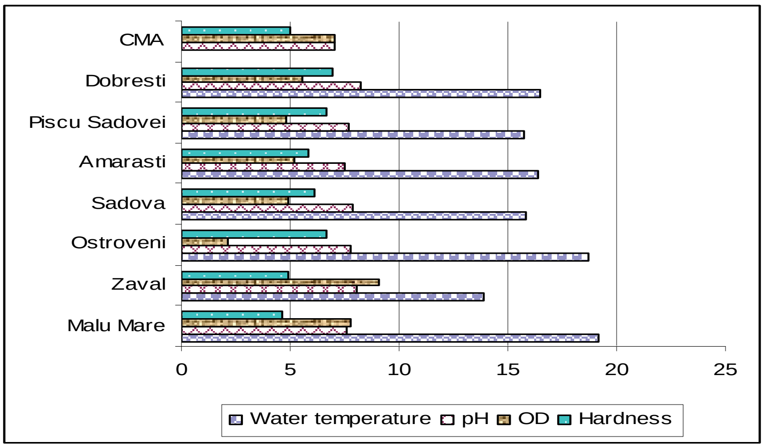

Figure 2. Water temperature, pH, OD and hardness of the analysed phreatic waters.

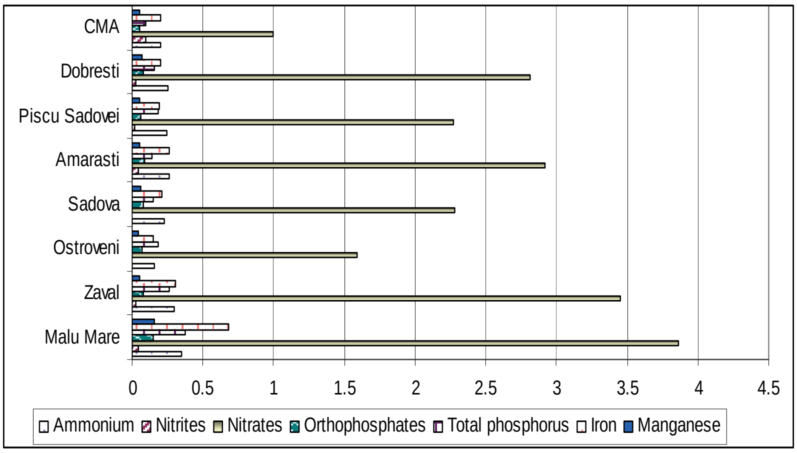

Figure 3. Chemical characteristics of the analysed phreatic waters.

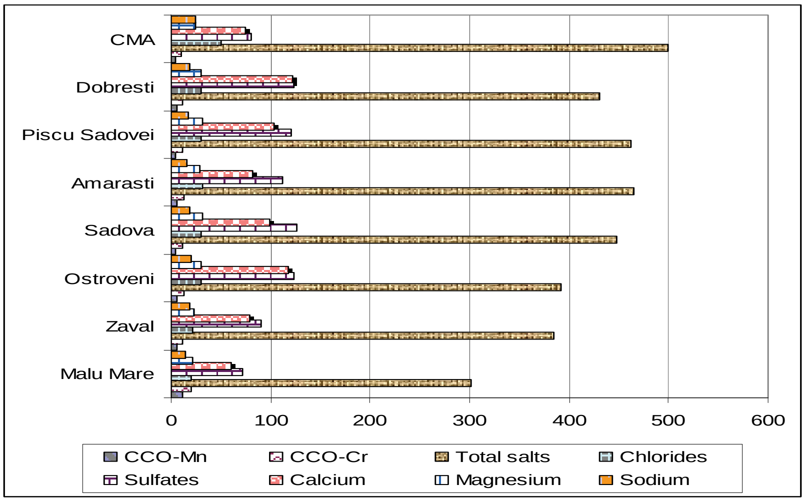

Figure 4. Physicochemical characteristics of the analysed phreatic waters.

From the figures above, it can be observed that, in Malu Mare, Zăval Ostroveni localities, the water pH is neutral and slightly alkaline, the oxygen regime, sulfates, calcium, ammonium, nitrates, orthophosphates, total phosphorus, iron and manganese exceed the limits for drinking. Total salts, chlorides, sodium and nitrites are below the maximum permissible concentration.

The oxygen regime represented by the dissolved oxygen, the consumed oxygen expressed as potassium permanganate and the consumed oxygen expressed as potassium dichromate did not meet the standards for drinking. The total salts, hardness, sulfates, calcium, magnesium, ammonium ion, orthophosphates, total phosphorus, iron and manganese exceed the MPC. The studied waters are of sodium bicarbonate and calcium bicarbonate nature. Occasionally, there are also magnesium bicarbonate waters, being highly mineralized.

Regarding the physicochemical characteristics of the phreatic waters from Piscu Sadovei and Dobreşti, in this case, the situation is similar to the previously presented one, values lower than the maximum permissible concentration being registered for the following indicators: total salts, chlorides, sodium and nitrites. The high amount of ammonium ion, nitrates, orthophosphates and total phosphorus is due to the application of nitrogen and phosphorus fertilizer (complex fertilizer). The other highlighted features depend on the formations that the waters cross.

In the case of the physicochemical characteristics of the phreatic waters from Sadova and Amărăşti, we can conclude that: the waters are neutral and slightly alkaline, the oxygen regime is normal, in the case of OD and CCO-Mn, the waters are mineralized; the water is hard, sulfates, calcium, magnesium, ammonium ions, phosphorus, iron and manganese exceed the maximum permissible concentration.

CONCLUSIONS

The groundwater quality depends on its hydrogeological, hydrochemical characteristics and as well as on the anthropogenic characteristics. The groundwater quality is simply the result of the geology and hydrology of the area. Source rock composition, weathering in the source area, and final mineral composition of the sediments are the main factors controlling the chemical composition of the studied water (STEVANOVIC & IURKIEWICZ, 2009).

The phreatic water from the terraces and floodplains of the Oltenia Plain has a total mineralization between 290 and 600 mg/l, depending on the lithological constitution of the aquifer horizon and store rock granulometry. It appears that where there are sands, the mineralization is higher than in the gravel area. Only some of these waters meet the drinking characteristics, following the tapping of water deep enough so that water to be drinkable. The most common waters are of calcic bicarbonate and sodic bicarbonate type.

The high concentrations of ammonium ion, nitrogen, phosphorus and pH in Malu Mare area is due largely to the weatherproofing of ammoniacal phosphorus water pit, in Craiova area, infiltrated into the phreatic layer. The high amount of ammonium ion, nitrates, orthophosphates and total phosphorus is due to the application of nitrogen and phosphorus fertilizer (complex fertilizer). The other highlighted features depend on the formations that the waters cross.

REFERENCES

JOSAN N. 2002. *Sisteme globale de mediu*. Edit. Universităţii din Oradea. 54 pp.

MĂNESCU S., TĂNĂSESCU G., DUMITRACHE S., CUCU M. 1996. *Igiena*. Edit. Medicală. Bucureşti. 79 pp.

STEVANOVIC Z. & IURKIEWICZ A. 2009. Groundwater management in northern Iraq. *Hydrogeology Journal*. Elsevier. London. **17**(2): 367-378.

ŞERBAN SANDA ADINA & ŞERBAN MARIOARA. 2009. The assessment of groundwater in Doljchim chemical plant are. *Geographica Timisiensis*. Edit. University Press. Timişoara. **18**(1-2): 181-192.

TARCEA M. 2006. *Ecologie medicală*. Edit. University Press. Târgu Mureş. 26 pp.

VASILOV M. & BUŞTIUC M. 2000. *Poluarea apei potabile cu substanţe azotoase – efecte acute şi cronice asupra organismului*. Monografie. Edit. Medicală. Bacău. 121 pp.

*** Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

*** Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration (Daughter to 2000/60/EC).

*** Directive of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources (91/676/EEC).

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