CINQ CONTINENTS

REVUE ROUMAINE ELECTRONIQUE DE GEOGRAPHIE

Volume 1 / Numéro 2
Été 2011
ISSN: 2247 - 2290
p. 160-169

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Cite this document:

Paiu M., Şutea-Drăgan, S., Breabăn, I., G., 2011. Considerations relating to the quality of underground water sources within the city of Barlad. *Cinq Continents* **1** (2): 160-169 [Available online]| URL: http://www.cinqcontinents.lx.ro/1/1_2_Paiu.pdf

Considerations relating to the quality of underground water sources within the city of Barlad

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Considérations sur la qualité des sources d'eau souterraine dans la ville de Bârlad. La ville de Bârlad est alimenté avec l'eau potable qui provienne dans deux sources : souterraines et autres situées au surface. Aux derniers ans, la réduction de la longueur du réseau de distribution de l'eau dans la ville avec ~9%, a mené vers l'augmentation du nombre des utilisateurs de l'eau qui provienne de sources souterraines, c'est-à-dire les fontaines et les pompes, caractérises par une minéralisation haute. L'étude représente la première phase de l'étude qui veut mettre en évidence les variations imposées par la succession des saisons dans la région étudiée avec l'objectif de trouver les meilleures sources pour les habitants. Après récolter les échantillons d'eau, par les 44 sources souterraines, ont été déterminés les indicateurs de qualité de l'eau potable (en utilisant des méthodes électrochimiques, volumétriques et spectophotométriques). Puis les résultats ont été représentés avec ArcGis 9.3; en rélevant des dépassements pour certains indicateurs.

Mots clés: l'eau potable, sources souterraines, les indicateurs de la qualité de l'eau, SIG.

Consideraţii cu privire la calitatea surselor de apă subterane în oraşul Bârlad. Municipiul Bârlad este alimentat cu apă potabilă atat din surse de suprafata cat si din cele subterane. In ultimii ani lungimea retelei municipale de distributie a scazut cu ~9%, ceea ce a condus la cresterea numarului de utilizatori ai surselor subterane de tipul fântânilor şi cişmelelor, caracterizate de o mineralizatie crescuta. Studiul reprezintă o primă fază de analiză sezonieră a calității apei subterane din arealul studiat, în vederea determinarii oportunitatii alimentarii populatiei. În urma prelevării probelor de apă, din cele 44 de surse subterane au fost determinaţi o serie de parametri de calitate ai apei potabile (prin metode electrochimice, volumetrice și optico-spectofotometrice), rezultatele fiind prelucrate cu ajutorul platformei ArcGis 9 și s-au constatat depășiri a unor indicatori de potabilitate a apei.

Cuvinte cheie: apă potabilă, surse subterane, indicatori de calitate a apei, SIG.

1. INTRODUCTION

The city of Bârlad is located in the major river bed Barlad, on an area of 1456 hectares of which 1028 is intravilan land. The values of the highest altitude of the hills near town are in the Dealul Crang, 311 meters (in the west) and in the Dealul Mare, 264 meters (in east).

The city is geographically situated in the eastern part of Romania, in the physical-geographical unit of the Moldavian Plateau, and in the contact area between the Falciu Hills in the east, and the Tutova Hillocks in the west. It is placed on the consequent river valley of Barlad, in the area there are several valleys in confluence: from the east, the river valleys of Popeni, Trestiana, and Jaravat; from the north the river valleys of Horoiata and Simila; and from north-west the Tutova river.

The annual average temperature is 9,8°C. The maximum average temperature is in July, 21,4°C, and the minimum of -3,6°C is in January. The average annual precipitation recorded at the Bârlad weather station is 472,2 mm, being the lowest recorded rainfall in the Bârlad river basin. The maximum rainfall was 712,8 mm in 1968, while the minimum of 388 was recorded in 1967.

The first historical evidence of the existence of a trade fair in Bârlad was made by Prince Alexander the Good, in 1401. Early appearance of the city is due to its placement at the crossroads of trade routes linking central and northern Moldavia with oriental world.

Relatively small spatial development has led to the existence of a very high population density. „Bârlad is the only city in Vaslui county whose urban built area has stagnated between 1993-2008. The value of population density was 6346 inhabitants / km^2 in 2009. Bârlad is the most crowded urban settlement municipal type in North-Eastern Region. Moreover, the city ranks second nationally, being preceded only by the Bucharest municipality (12,015 inhabitants / km^2)[1]".

In recent years the length of municipal water distribution network has decreased by ~ 9%, correlated with a high population density, has increased the number of users of underground water sources such as wells and pumps, characterized by an increased mineralization. (Figure 1).

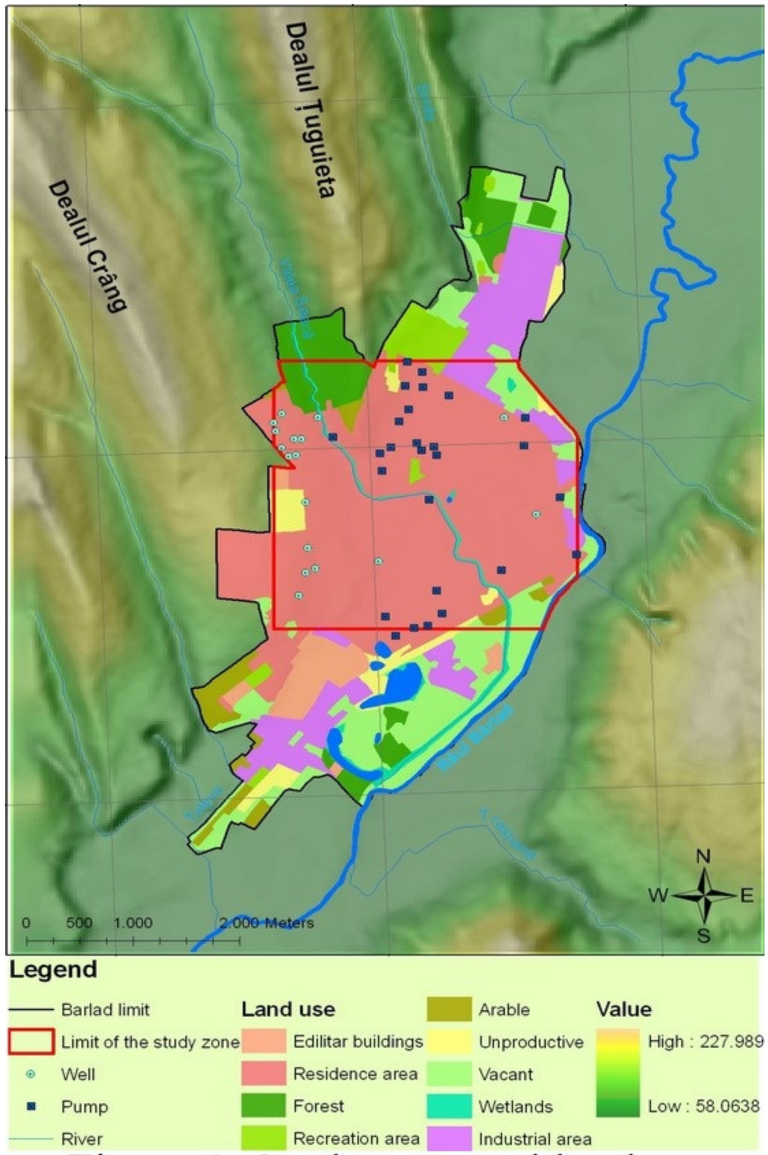


Figure 1. Study area and land use

Groundwaters have relatively constant parameters. The waters are characterized by high mineralization, high content of carbon dioxide and low oxygen concentration.

In terms of quality, ground water is considered clean and enrolls in the standards for drinking or industrial uses less demanding.

Water pollution is, as a general definition, directly or indirectly change of the normal composition due to human activity, in such an extent that they affect all other uses to which water could be used in its natural state. Water pollution involves biological, physical and chemical pollution and leads, ultimately, to the alteration of the ecological balance.

2. GEOLOGY

Bârlad is located at the contact of two geotecture areas in the north the Moldavian Platform and in south the Depression of (Platform of) Bârlad. These structural units shows two levels: foundation (crystalline and folded) and sedimentary consisting of Paleozoic, Mesozoic, and Neozoic formations. „The border between the two structural units is merely conventional (the Bârlad-Pogonesti-Murgeni line), because has no counterpart in the present relief [2]”.

The foundation of the Moldavian Platform began to form even since the Proterozoic (being one of the oldest land in Europe), and is the result of significant geosyncline orogenic movements, and of the pronounced metamorphic and magmatic processes. Geodynamic processes specific to the period of geosyncline lasted until Middle Proterozoic, later setting up as a stage of tectonic stability, being favorable for denudation and sedimentary processes.

The Bârlad Depression foundation is more complex and is considered by most experts as part of the Dobrogean Depression, showing a mixed character: Hercynic origin charachteristics in the south the same as Northen Dobrogea and in the north, the foundation is the same origin as the Moldavian Platform. The Bârlad Depression foundation is not uniform, being marked by numerous geodynamic processes, and formed at different stages, sunking in the depths gradually becoming larger towards the south and west.

A second important step in the genesis of the area, is the denudational-sedimentary phase, which occurred during marine transgressions and regressions,giving birth to the second stage of The Barlad Plateau: sedimentary (presenting stratigraphycal discordance over the surface foundation).

Unlike the foundation, the sedimentary shows many common characteristics between the Moldavian Paltform and the

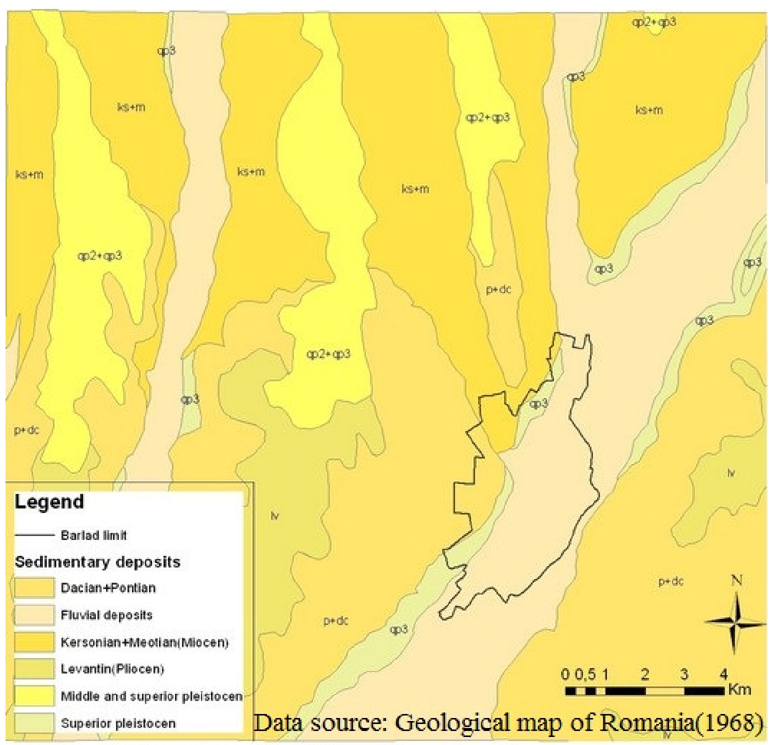


Figure 2. Geological map

Depression of Bârlad, especially begining from Cretaceous and the Neogene.

The deposits specific to the area of Bârlad belong to the Superior Sarmatian (Chersonian deposits) and to the Pliocene (Meotian, Pontian-Dacian structures), the last ones showing maximum development at the latitude of the city Barlad (Figure 2).

„Meotian deposits consist of two distinct horizons: a lower horizon cinerite called the "Nutasca-Ruseni horizon "and a loamy top horizon much thicker than the first. " The "Nutasca-Ruseni horizon " consists of three banks cinerite separated by andesitic volcanic deposits of sand and clay marls. Volcanic material gradually decreases eastwards crossing to sand and sandy cinerite. Total thickness of the "Nutasca-Ruseni horizon" is increasing from 10 to 20 m in the east of the river of Bârlad, to 30-40 m in the central area of the Tutova Hills. The upper Meotian horizon is composed of sand, clayish sand and clay with intercalations of sandstone slabs. The upper horizon reaches thicknesses of up to 180 m [3]".

In the hydrographic river basin of Bârlad the deep aquifer structures are taking shape since the Lower Sarmatian, especially in the north-central part of the basin, while the regressive nature of the Middle Sarmatian deposits is making that the Chersonian and Meotian-Pontian hydrostructures to individualize in south-central part of the basin. Also in the south-central part of the basin, Pliocene formations occur in stationed structures (Dacian-Romanian)[4].

Figure 3. Taking water sample from a pump

Groundwater aquifers are located in structures belonging to the Quaternary formations. Pleistocene deposits consist of rough sand with gravel in the base, sheltering underground terrace aquifers and Holocene alluvial deposits shelter floodplain aquifers.

3. METHODOLOGY

The field stage, consisted in the the GPS mapping of all water sources in the intravilan area of the city. During this stage, 17 wells have been mapped and 27 pumps (44 groundwater sources) located on public land. On 10 December 2010, we conducted water sampling from all 44 previously mapped sources (Figure 3).

Figure 4. The use of spectrophotometric method in analizing the nitrates

The containers used for sampling had been previously washed out with distilled water and on the field were washed with water that was to be sampled. On the field the water was sampled in two containers: 100 ml water used for fixing dissolved oxygen adding 2 ml of 50% manganese chloride mixture and 2 ml 15% KI and 35% NaOH and 2000 ml water used for laboratory analyzes. Also on the field we made measurements for the parameters pH, conductivity and temperature.

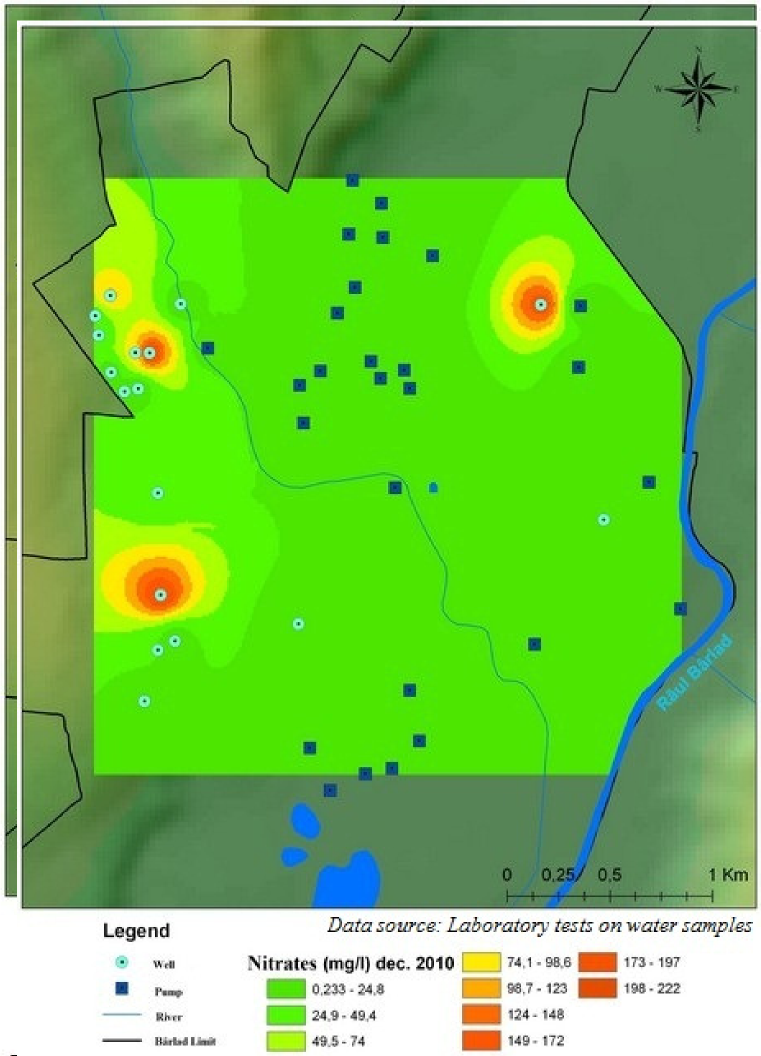
The laboratory stage consisted in the chemical analysis of the water samples and data interpretation using GIS software.

The determination of the oxidisable substances from the water was conducted using the potassium permanganate method. The potassium permanganate oxidizes the organic substances from the water, in acidic and warm environment, and the remains of the potassium permanganate is determined with oxalic acid.

Phosphate determination is made through a spectrophotometric method. Phosphate ion reacts with ammonium molybdate in strongly acidic environment, forming fosfomolibdenic acid and in the presence of reducers (ascorbic acid) forms a blue molybdenum with λ max = 650nm.

The determination of nitrates is made through a spectophotometric method. The fenoldisulfonic acid reacts with the nitrates, from the reaction forming nitro-fenol-disulfonic, of a yellow colour with λ max= 410nm (Figure 4).

Interpretation of the data obtained following chemical analysis, was performed using GIS software, TNT Mips 6.9 and ArcGIS 9.3. The maps were made by interpolating the data using the „inverse distance weighted" method.



] Figure 6. The nitrates concentration spread in the study area

4. RESULTS OBTAINED

Chemical oxygen demand (COD) or the water oxidisable substances are substances that can oxidise under the influence of an oxidant. Increased amount of organic substances in water or their appearance at some point is synonymous with water pollution with germs that usually accompanies the organic substances. Of the 44 water sources, 8 of them were recorded exceeding the maximum admissible concentration limit for drinking water (5 mg O_2/l) with organic substances, most of which are located in the floodplain area of the city (Figure 5). High concentration of organic substances is due to the correlation between location in the floodplain, and thus implicitly in an area with geological permeable alluvial deposits, and high infiltration of wastewater loaded in organic substances originating from areas without sewage (eastern town) or a old leaking drainage.

In the case of the nitrate (NO_3) parameter the results of chemical analysis have revealed nitrate in all the city water wells on the other hand we got only 5 values above the maximum admissible concentration for drinking water (50 mg/l) reaching a value of 165 mg/l in the case of well 21 (Figure 6). High values of nitrate concentration in drinking water wells in the area is due to the heavy use of fertilizers in agriculture, the affected area being situated near agricultural land. Also in the area where the infected wells are located the sewage system is missing which causes infiltration of wastewater loaded in organic compounds in the groundwater.

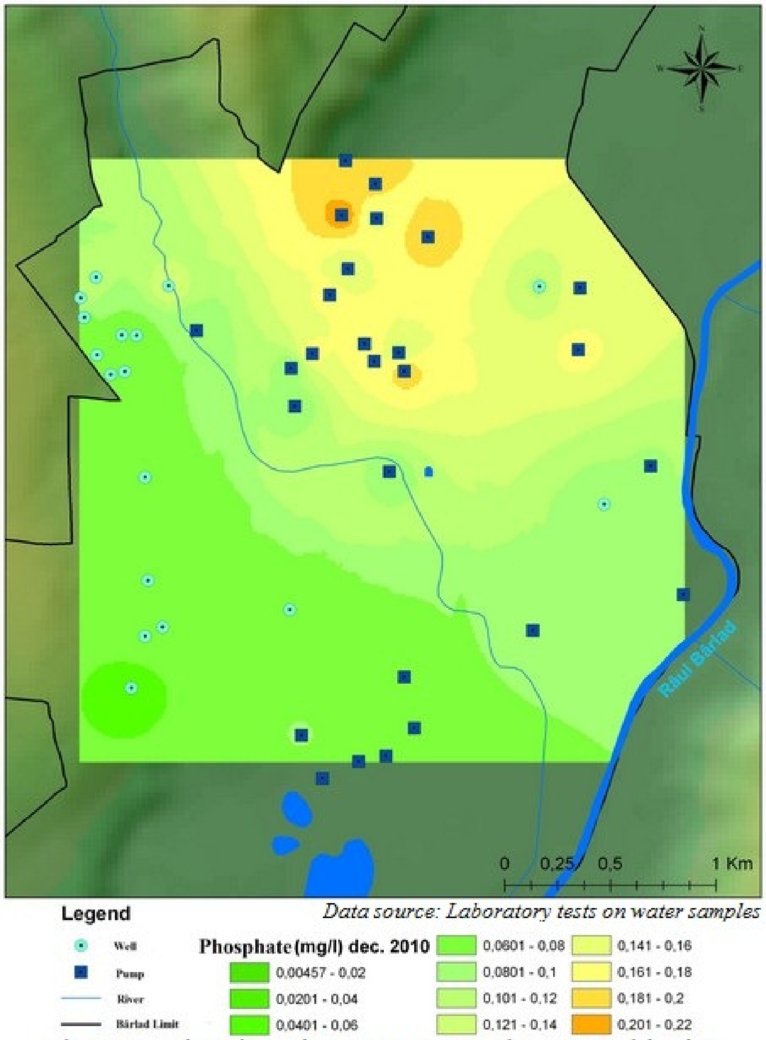


Figure 7. The phosphates concentration spread in the study area

For the water quality parameter, phosphate (PO_4) exceedings of the maximum admissible value for drinking water (0.5 mg/l) is recorded with 12 of the 44 water sources on the public domain. (Figure 7) The exceeding of the phosphate concentration is due to pollution of groundwater by sewage, detergents, as well as substances used in agriculture (pesticides, fertilizers), infiltrated into groundwater. The high values in north of the city may be due to industrial water infiltration from SC Rulmenti SA Barlad factory, industrial unit known for exceeding the concentrations of pollutants discharged into the river Barlad, but also due to the city's old sewage system.

5. CONCLUSIONS

In this paper we presented the results of tests carried out on underground water sources within the territory of the city Bârlad. Considering that in some cases the local population uses groundwater as the only source of drinking water, the results of this study are alarming. Thus, in areas lacking centralized water supply and sewage system, high values were recorded in the case of COD and nitrate parameters, while high levels of phosphates parameter were recorded as a result of industrial and domestic waste water infiltration in northern city groundwater.

Exceeding the maximum admissible concentrations of the studied parameters can have serious effects on human health, sometimes even fatal. High levels of nitrates in drinking water can quickly lead to fetal damage, miscarriage and the syndrome of "blue disease" in babies. Nitrates in the digestive tract are converted into nitrites, these decrease the O_2 figing in the hemoglobin, in time causing a decrease in red blood cells, causing anemia. A dirty water with organic substances can cause diarrheal diseases, hepatitis and intestinal parasites.

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