

PHREATIC WATERS POLLUTION IN THE SOMEȘ PLAIN

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ABSTRACT. – The pollution of underground waters may determine restrictions in the water supplying of the inhabitants. In the Someș Plain, the three analyzed underground water bodies are characterized from a chemical point of view, being situated in the bicarbonate – calcic class, with various subclasses. In this study were used environment reports issued by the Counties Agencies for Environment Protection, respectively the Water management plans for Someș – Tisa and Crișuri water basins. The chronological analysis of the events that determined phreatic waters pollution, respectively, cases incidence and exceeding quantity, were made for the period 2002 – 2014, according to the available data.

Keywords: pollution, chemical tracers, underground water bodies, nitrates, phosphates

1. INTRODUCTION

The knowledge activity of phreatic waters quality takes place in the large hydrographic basins, on morphological units and within those structures, on aquifers (groundwaters) via hydrogeological stations comprising one or more observing drillings.

The Someș Plain is located in the north-western part of the country, representing the northern subunit of the Western Plain, occupying an area of over 3600 square kilometers with an elevation between 100-220 m. From a regional perspective, the Someș Plain comprises **five hilly plains** (Ardud and Tășnad, of glacia and terraces nature, Buduslău and Pir, of low plateau nature, with big glacia along the valleys), a piedmont-tabulated plain with loess and windy sand (Carei – Valea lui Mihai) and **two divagation plains** (the Low Someș Plain and Ier Plain) (Pop, 2005).

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The phreatic waters from Someș Plain are settled in the terrace, flood plain and low plain sedimentary deposits. Their supplying is made through surface waters that come from rainfalls or main river valleys, and through ascensional infiltrations from deep aquifer layers. Depending on climatic oscillations, the upper aquifer layer represents a hydrostatic level situated at approximately 3-4 m below the topographic surface in dry periods, respectively 1-2 m in rainy periods. When rainfalls are extremely heavily, the aquifer level reaches the surface, determining puddly processes or even temporary swamps.

The variety of factors intervening at the level of underground water resources can be seen in the phreatic waters' quantitative and qualitative parameters that show numerous regional differences.

If we talk about **phreatic water pollution**, this can be determined by a series of different causes (V., Sorocovschi, Gh., Șerban, 2008):

- Pollution due to infiltration of polluted rainfall water, especially of streaming water that brings polluting substances from soil surface to the underground aquifer;
- Pollution due to water infiltration from polluted aquatic bodies or with different physical – chemical characteristics (rivers, lakes);
- Pollution of a captive aquifer with contaminated waters that come from the upper phreatic aquifer level;
- Aquifers' pollution following some works (drillings, underground pipes and channels, underground reservoirs, gravel pits, etc.);
- Aquifers' pollution through surface liquid residue infiltrations that come from different human activities into the underground waters through percolation processes (industrial waste waters, landfills or manure, chemical fertilizers and pesticides used in agriculture, etc.).

2. PHREATIC WATER BODIES IN THE SOMEȘ PLAIN

The delineation of groundwater bodies was made only for areas with significant important aquifers for water supply, especially with discharges greater than 10 m³ / day. The rest of the area, even if there are local underground water accumulation conditions, they do not constitute bodies of water, according to the Framework Directive 60/2000. In the Someș Plain there were identified three groundwater bodies in areas with floodplains and terraces of the Somes, Crasna and Homorod rivers. According to Somes-Tisa Management Plan, they were coded as follows: ROSO01 – Someș cone, Holocene and Upper Pleistocene, ROSO06 – Carei Plain, and ROS007 - Crasna River, meadow and terraces. Their characteristics are given in Table 1.

Table 1. Characteristics of phreatic water bodies in the Someș Plain*

Code/name	Surface. (km ²)	Type	Layers' thickness (m)	Water use	Pollutants
ROSO01/ Someș Alluvial Cone	1380	P	5.0 – 15.0	WS, I, Z	I, A
ROSO06/ Carei Plain	633	P	0.0 – 15.0	WS, Z, P	I
ROSO07/ R. Crasna, meadow and terraces	191	P	0.5 – 5.0	WS, I, Z	I, A, G

* *Water management pla for Someș-Tisa hydrographic basin - 2010*

Water use: WS- water supplies; I - industry; P - pisciculture; Z - zootehnichs.
Polutants: I-industrial; A-agricultural; G-garbage.

ROSO01 groundwater body consists of phreatic waters, stationed in the development area of Someș River alluvial cone located in the northern part of Someș Plain. From a hydro – chemical point of view, the waters belong to the hydro-carbonated class, with a total mineralization of approx. 350 - 550 mg / l. ROSO06 body of groundwater body, associated with Carei Plain, contains phreatic waters accumulated in permeable alluvial deposits, and hydro-chemically they are included in the bicarbonate - calcium category, especially in the sulfate-magnesium subordination. Sometimes the ammonium concentrations are exceeded, indicating certain sensitivity to pollution. In the central – southern part of Someș Plain develops the ROS007 water body, associated with Crasna River. This is a porous and permeable phreatic water body type, located in Crasna River valley and its tributaries. From a hydro-chemical point of view, we can identify a variety of classes and groups. Thus notice, the bicarbonated-calcium class, subordination magnesium – sulphate, or calcium – sulphate class, subordination salt.

3. PHREATIC WATER BODIES POLLUTION. GENERAL CHARACTERISTICS

In the Someș Plain, the determination of the contamination degree is achieved by monitoring boreholes using the hydro-geological observations network. This has not revealed critical situations, except in isolated cases, where the concentration of nitrite was higher. The results of chemical analysis obtained in specialized laboratories of the Romanian Waters National Administration (2010) on the quality situation of groundwater in Someș alluvial cone led to local overruns of the threshold values for the following indicators: NH₄ (Oar, SC FLORISOL SA atu Mare - monitoring drillings, Apa - well, Chereușa - well, Andrid - fountain and Satu Mare Odoreu - well), NO₃ (Satu Mare Odoreu - 2 wells), NO₂ (well

Ghereușa), PO₄ (Moftinu Small, SC FLORISOL SA Satu Mare - pollution monitoring drillings, APASERV Satu Mare - operation drilling), Pb (Doba, Satu Mare, Micula) and As (Lipău). The exceedings of Pb and As indicators are due to higher values of natural background.

In Carei Plain, the analyzes showed exceeding of threshold values for the indicators NO₃ and NH₄ in the pollutants tracking drillings of SC ABOMIX SA Moftinu, the Pb indicator for F4 Moftinu Mic drilling (belonging to the National Hydrogeological Network) and NH₄ indicator in the pollution tracking drilling from the Carei waste landfill.

Given the distribution of monitoring points and that exceeding values for the NH₄ and NO₃ indicators correspond to punctual sources of pollution, and the Pb exceeding is due to higher values of natural background, for this indicator in the Moftinu Mic area, it was taken into consideration that this underground water body is, in terms of quality, in good condition.

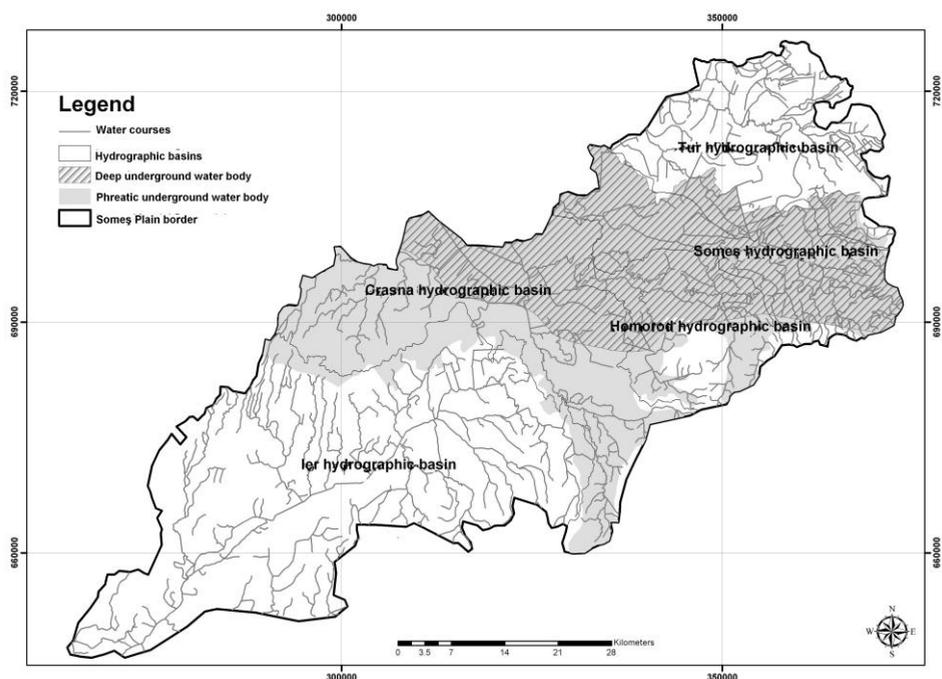


Figure. 1. Expansion of underground water bodies in Someș Plain .

The underground water body associated with Crasna River is in a generally good quality state, with isolated overruns for the indicators Pb, NO₃ and PO₄ only external, peripheral area of Someș Plain, namely in the development area of urban

centers like Zalău and Șimleul Silvaniei. The same favorable situation is recorded for the underground water body associated with the Livada Plain (Lower Tur River). An overview of the expansion of underground water bodies (phreatic and deep), is shown in Figure 1.

4. CHRONOLOGICAL ANALYSIS OF POLLUTION PROCESSES

The monitoring of underground water quality in the period 2002 - 2013 revealed distinct situations that were individually analyzed for each year. Available data were taken from *The Annual reports of the Satu Mare and Bihor counties Environment Protection Agency*.

In the **year 2002** appeared a significant deterioration of water quality in aquifers, showing high values of nitrate due to irrational use of chemical fertilizers, improper storage of vegetable and animal (manure), sludge treatment stations, of other waste.

In the related area of Satu Mare, nitrate pollution affects primarily rural population. The study analyzes conducted by the Public Health Direction, Division Sanitary – Veterinary Direction, The Water Management System and Agency of Environmental Protection on water samples from countryside wells or on pastures belonging to various agricultural companies and livestock farms have shown these results: Satu Mare area stands out with the highest load of nitrates into the underground water, with the multiannual average over 100 mg / l (CMA = 45 mg / l). Note that the Halmeu municipality has a population of 7688 inhabitants, of which 3,250 people are likely to be affected; Botiz and Ardud.

On the other side, there were registered the following nitrates values in drinking water from wells: Mădăraș - 250 mg / l; Drăgușeni - 250 mg / l; Halmeu - 250 mg / l; Mihăieni - 250 mg / l; Upper Supuru - 150 mg / l; Turulung - 150 mg / l; Cehăluț - 125 mg / l; Hurezu Mare - 100 mg / l; Beltiug - 100 mg / l; Micula Nouă - 100 mg / l; Medieșu Aurit - 100 mg / l. Examples of places where the nitrate concentration ranged from 50-100 mg / l: Socond, Adrian, Agriș, Hodod, Băbășești. At some sources from Botiz in the year 1994 were recorded values of 500 mg / l nitrates.

Excessive recorded values and their variation in leaps can be explained by the fact that in the area under consideration are located vegetable and livestock farms, today no longer working at design capacity or operating intermittently (SC Avicola SA Satu Mare, farms Ciuperceni and Botiz, SC AGROZOOOTEHNICA SA Ardud).

The nitrates pollution of phreatic layers has a remnant nature due to the pollutant accumulation in time. Such contaminated aquifers has insularity character

and goes to the use of pumped water exploitation for domestic and agricultural use has helped keep contaminated surfaces generally in the limits of the localities (Figure 2).

The areas most susceptible are those located in the vicinity of waste landfill from the municipalities Satu Mare and Carei, where exceedances were found to nitrite and nitrate.

In the **year 2003** there were noted 86 cases of exceeding the admitted limits for general chemical indicators (pH, conductivity, Cl, SO₄, Ca, Mg, total hardness and fixed residue) and those undesirables (CCOMn, NO₂, NO₃, NH₄, phenols, Fe, Mn, Cu, Zn and PO₄). The drills which recorded such situations are those from Lipău, Odoreu, Lucăceni, Urziceni, Atea, Carei and Doba.

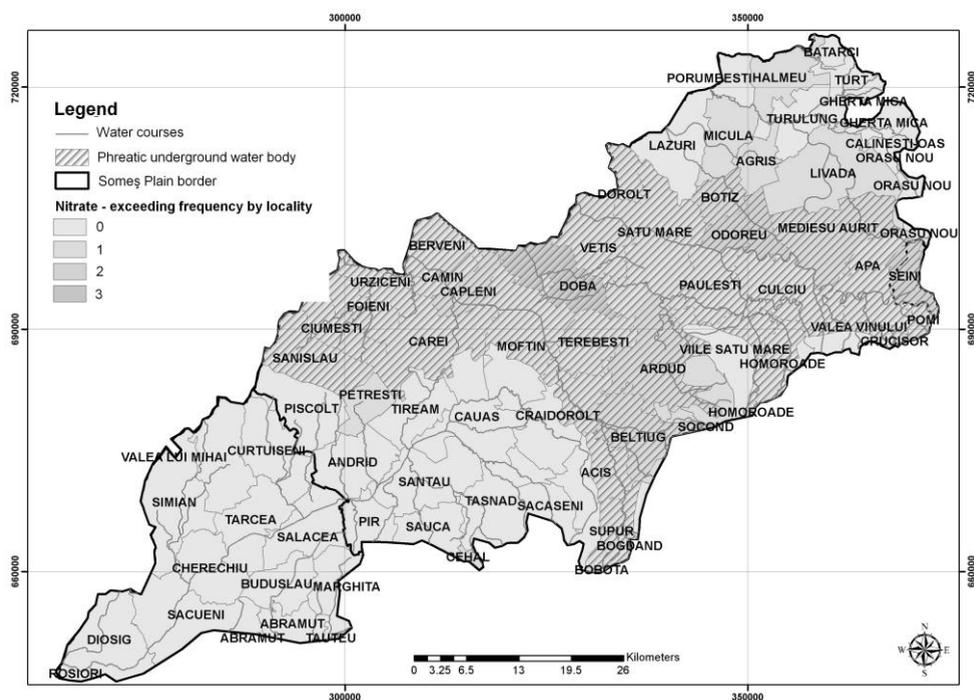


Figure. 2. Exceeding frequency for nitrate in phreatic underground waters in Someș Plain

In the **year 2004** they were found values: below the permissible limit for dissolved oxygen (Odoreu F5), with slightly acid pH (Lipău F6, Odoreu F4, Odoreu F5, Odoreu F6, Livada F1 and Tămășeni F1). Ammonium presented elevated values at Oar (F3), while phosphates had higher CMA values (according to STAS 1342/1991) at drilling Lipău F6, Acas F3, Rusen F1 and Botiz F1. Iron values were high at Livada F1 (10 times exceeding CMA values) and manganese

values were high at Someș Odorhei F2 (exceeding 75 times the permissible concentration). Regarding heavy metals, there have been found overruns for lead (Dumbrava F1 -150 mg / l, which is 15 times higher than the CMA value), nickel (Lipău F3 - 77 mg / l, being nearly 4 times higher than the CMA value), cadmium (Agris and Dumbrava drilling).

In the **year 2005** there were 45 cases of exceeding admitted limits. In most cases the quality parameters were classified within the authorized limits, with exceptions regarding some exceeding values for pH - slightly acid at F3 Lipău drilling, CCOMn for 11 drillings with a maximum value at F3 Oar drilling (12.6 mg / l), and sporadic exceeding for iron and manganese, respectively lead (Atea F1 drilling).

In the **year 2006** there were several critical situations of overcoming current regulations to certain parameters at the drillings from Crasna and Someș river basins. Thus, there were identified 13 exceeding cases for pH, 33 cases for CCOMn, iron and manganese (two cases), NO₃ (3 cases) and NH₄ (5 cases).

In the **year 2007** there were situations of overcoming current regulations at the drillings from Crasna and Someș river basins for pH (9 cases), CCOMn (39 cases), dissolved oxygen (53 cases). The indicator for ammonium presented exceeded values of the maximum permissible limits in 13 cases, total hardness - 2 exceeding cases under permissible limits.

In the year 2008, hydrogeologic measurements on water quality parameters have generally demonstrated a classification into the drinkable criteria, but there were cases of exceeding the CMA values. Thus, there were identified 13 cases of exceeding for pH. CCOMn indicator presented exceeding in 27 cases, and dissolved oxygen - 50 cases of exceeding the limits. Ammonium presented of the exceeded values over the maximum permissible limits in 19 cases, and for total hardness there were 3 cases. Due to the natural background, the values were exceeded for Fe (9 cases) and Mn (in 26 cases). Exceeding cases appeared for the metals: lead - 13 cases, and one case for Cd (Micula F1 / II drilling). There were no exceeding for NO₂, but appeared one case for NO₃ (Dumbrava F1 AD drilling) and a case for orthophosphates (Livada Vii F1 drilling).

In the **year 2009** the drillings in the analyzed area revealed cases of exceeding the limits for pH, CCOMn, dissolved oxygen, total hardness, nitrites, nitrates and metals.

There were recorded 9 exceeding cases for pH, 34 cases for CCOMn and 40 cases for dissolved oxygen. Because of the natural background, there were more values exceeded for the indicator Fe (in 951 cases) and Mn (in 56 cases). For chemical parameters there were recorded exceedings for heavy metals: Pb (1 case), Cd (1 case), As (7 cases) and Ni (1 case); for the remaining metals, the obtained values were classified into the admitted limits. There were exceeding for NO₂ (1 case) and NO₃ (Lucăceni F1 / II drilling, one case) and four cases for orthophosphate.

Since **year 2010**, the authorities moved to ground water quality assessment, according to the methodology of the Framework Directive 60/2000, with frequent use of the term underground water body. In this regard, the delineation was done on separate hydrogeological units, with the results being:

- in the Someș alluvial cone were identified four drillings where were exceeded local threshold values for nitrates and phosphates: Seini F1 for NO_3 (61.5615 mg / l); Moftinu Mic F6 for PO_4 (0.663 mg / l); Micula F1 / II for PO_4 (0.5150 mg / l) and Viile Satu Mare F1 / II for PO_4 (0.648 mg / l) - Figure 3.
- within the water body from Carei Plain there were designated three drillings with exceeding values of CMA for nitrates, nitrites, ammonia and lead: Lucăceni F1 / II NO_3 (96,535 mg / l) and NO_2 (0.606 mg / l); Căpleni F6 to NH_4 (2.39 mg / l) and Scărișoara Nouă F1 / II Pb (0.03925 mg / l).

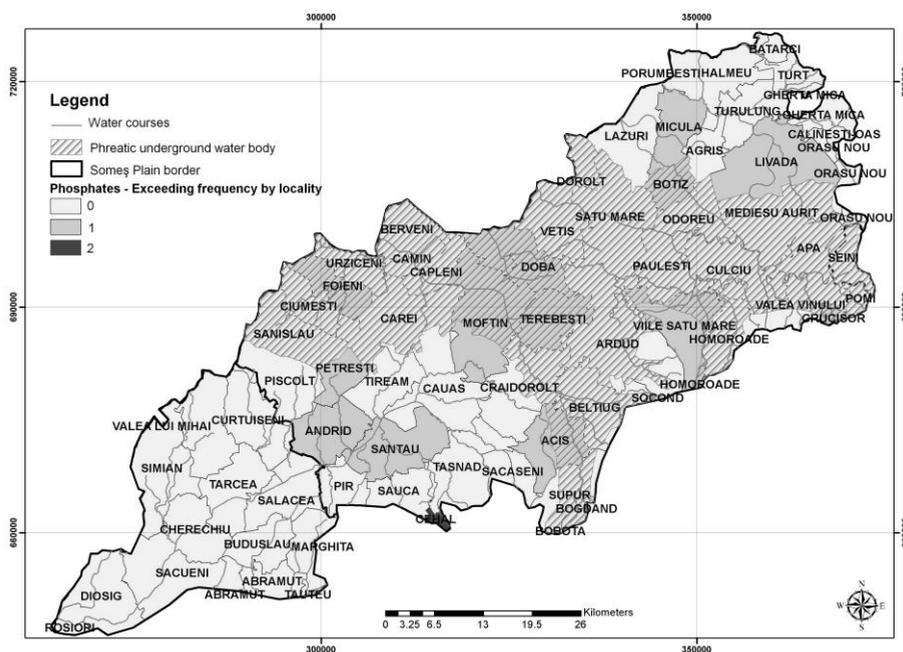


Figure 3. Phosphates exceeding frequency for phreatic waters in the Someș Plain

For the **year 2011** the situation has improved by reducing situations with exceeding threshold values of determined parameters. Thus, the water body from Someș alluvial cone presented local exceedings of the average ammonium concentration in two drillings: Oar F3 (1.4665 mg / l) and Viile Satu Mare F1 / II (3.31 mg / l); soluble orthophosphate for Viile Satu Mare F1 / II drilling (0.51 mg / l) and arsenic for Doba F1 MA / II drilling (18.745 mg / l). In the underground

water body of Carei Plain, of all monitored points, one drilling registered local exceeded for orthophosphate indicator: Foieni F1 (1.48 mg / l). At the level of the Someș alluvial cone water body, of all monitored points, only two deep drills registered exceeding values of the local threshold, namely: Doba F 1AD for arsenic (12.96 mg / l compared to the threshold value of 10 mg / l) and Terebești F1AD for two parameters: arsenic (13.12 g / l) and orthophosphate (0.668 mg / l).

In the **year 2012**, for the Someș alluvial cone water body, have been identified parameters exceeding as follows: *ammonia* (with threshold concentration of 1.4 mg / l) presents higher values at Viile Satu Mare F1 / II drilling (1657 mg / l) and at 11 pollution tracking wells, namely: Ferma Botiz FP1 (1.545 mg / l) and FP3 (2.59 mg / l), Ferma Apa FP1 (1.425 mg / l), Ferma Bicau FP1 (2 19 mg / l).

In the **year 2013** there have been local exceeding of threshold values for the indicators - ammonium, at the monitoring drillings from the following zoo technical units: SC Danamari SRL – the Pig growing farm from Seini, well no. 1 (1.85 mg / l), well no. 2 (2.3 mg / l) and well no. 5 (3.87 mg / l); SC AVE Impex SRL at the farms: Botiz (1,835 mg / l), Apa (1.86 mg / l), Bicau (2,385 mg / l) and Vetiş FP1 (2.81 mg / l), FP2 (2.76 mg / l) FP3 (2985 mg / l) and PF4 (2.94 mg / l); phosphates presented exceedings of threshold values of 0.5 mg / l at Doba Landfill drilling: FP2 (1.17 mg / l) and FP3 (1.072 mg / l) and at Fântana de la Crucișor (2098 mg / l); nitrates and nitrites presented local exceeding at Seini, Doba and Lipău.

Regarding the realized determinations in the Ier hydrographic basin that overlaps the southern part of the Someș Plain, we notice a fairly high exceeding incidence of the maximum permissible concentrations for manganese (threshold value 0.05 mg / l), but also low values dissolved oxygen concentrations (the threshold limit is 6 mg / l).

Thus, from 2005 to 2009, the environmental reports of Satu Mare and Bihor County Agencies have considered a total of 48 drillings on which were determined the concentrations of underground water quality parameters. Most cases (32) were associated with exceeding of threshold value for manganese. The year with most frequent situations was the year 2007.

CONCLUSIONS

The contamination of underground phreatic water bodies from Someș Plain is determined by pollution processes through infiltrations from surface sources that generate nitrogen products - ammonia, nitrites, nitrates or phosphates. Also may appear local exceeding for manganese, heavy metal, pH outside the range of neutral limits, excess iron, etc. In general, indicator values exceed the admitted limits with relatively small values from the average value, which ensures a

relatively good general condition in terms of ground water quality in the alluvial bodies of Someș Plain.

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