Physicochemical Quality Evolution of Groundwater from the Area of an Chemical Platform

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The most important natural resource which cannot be optimally used and sustained unless its quality is properly assessed, is groundwater. In the present study, the physicochemical variations of groundwater from the area of an chemical platform were determinate. The physicochemical parameters determined for the groundwater were evaluated by comparing the results obtained with the the limits allowed under current legislation. For this study were examining 16 drillings for a period of five years. Water samples were collected quarterly from each sampling point in the study. The physico-chemical quality indicators analyzed for each source were: pH, chlorides, sulfates, bicarbonates, carbonates, sodium, calcium, magnesium, ammonium, filterable residue, suspended matter, mercury and CCO-Mn.Interpretation of physicochemical data revealed that groundwaters studied was neutral to slightly alkaline. The cations such as sodium (Na+) for all groundwaters studied it was in general found above the limit imposed under the laws in vigor in almost all studied drillings except drillings generally located upstream of the industrial platform. The anions such as chlorides (Cl-) exceeded, in general, the limit allowed under current legislation. The filterable residue concentration was observed in all the studied drillings and the parameter such as sulfate (SO_4^{2-}), were within the limit allowed under current legislation for the most all studied drillings, for the whole period investigated. In general, the sulfate quality indicator exceeds the required limit, for drilling located downstream and in vicinity of the chemical platform.

Keywords: groundwater quality, physicochemical quality, drillings

Groundwater plays a crucial role [1] as a decentralized source of drinking water for millions of rural and urban families, besides fulfilling the irrigation needs [2]. The inherent qualities of groundwater [3, 4] such as consistent temperature, widespread and continuous availability, excellent natural quality, limited vulnerability, low development cost, and drought reliability have made it an immensely important and dependable source of water supply for both developed and developing countries [5]. The demand for groundwater has increased manifold over the years due to population growth, rapid urbanization and industrialization, agricultural expansion [6, 7], and economic development. The groundwater quality is [8], however, being deteriorated mostly due to overexploitation, increased application of fertilizers, unsanitary conditions prevailing in rural and urban areas, improper sewage management, inadequate water planning, lack of awareness and, non-implementation of desired measures. The concentration of several inorganic and organic substances beyond the acceptable range causes an adverse impact on human health. Systematic evaluation of groundwater quality is therefore necessary for meeting the increasing drinking water [9, 10] demand and essential for optimal utilization of available groundwater on a sustained basis. The groundwater quality, primarily governed by the extent and composition of dissolved solids, is of great significance in determining its suitability for drinking purpose. Under natural conditions, the spatial and temporal variations in the composition of groundwater depend on rainwater, soil strata, and aquifer materials [11]. The variations in the groundwater quality are due to rock–water interaction and oxidation–reduction reactions during percolation of water through aquifers [12-15]. The groundwater quality from the area of chemical platform is dependent on bedrock geology, climate, and impacts of pollution from agricultural and industrial sources. Its evaluation is therefore essential to determine its suitability for drinking purpose.

Taking cond those mentioned above, the present study aims to determinate the evolution of groundwater quality from the area of an chemical platform, over a five year period.

Experimental part

Materials and Methods

All chemicals used to prepare reagent solutions, were analytical grade, according to the standards of dermination methods in use. Distilled water was used for quality 2 according to ISO 3696. Determination of quality indicators was done according to standards water in force specific to each indicator analyzed.

Experimental studies on the physico-chemical characterization of the studied samples were performed by electrochemical methods using a Multiparameter Orion Star A 215 (for pH); by volumetric methods using calibrated biurettes (for chlorides, bicarbonates, carbonates, calcium, magnesium and CCO-Mn); by the spectrophotometric method using Spectrophotometer Analytic Jena UV-VIS-SPECORD 210 Plus (for sulfates and ammonium), by flamphotometric method using Flame photometer Analytic Jena FLAFO 4/766695 (for Sodium) and by gravimetric methods using a analytical balance Precision XB 220 (for filterable residue and suspensions).

All methods used were standardized methods and are in accordance with current legislation.

Procedure

Groundwater samples were collected in polyethylene containers new 1L. Each container was washed with water collection site drilling to reduce the possibility of

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Place of the sampling	Name of the sample	Water level in drilling [m]	GPS Coordinates	
Inside	1	4,14	N:45°02452'	E: 024°17742'
	2	4,34	N:45°02664'	E: 024°117988'
	3	2,57	N:45°02861'	E: 024°18033'
	4	4,77	N:45°02485'	E: 024°17881'
	5	4,15	N:45°02853'	E: 024°18411'
	6	0,3	N:45°02631'	E: 024°17428'
Near	7	4,15	N:45°02434'	E: 024°18068'
	8	3,62	N:45°02642'	E: 024°18177'
	9	5,52	N:45°02454'	E: 024°17965'
	10	4,15	N:45°02305'	E: 024°17773'
	11	2,98	N:45°02788'	E: 024°18352'
Upstream of the industrial platform	12	*	N:45°03633'	E: 024°18729'
	13	2,13	N:45°02388'	E: 024°18732'
	14	3,72	N:45°02490'	E: 024°18562'
Downstream of the industrial platform	15	*	N:45°01087'	E: 024°17160'
	16	*	N:45°01969'	E: 024°18140'

* Constant level

Table 1
INFORMATION ABOUT THE ANALYZED SAMPLES (ARRANGEMENT OF DRILLING, DRILLING WATER LEVEL)

contamination of the sample with impurities resulting from the manufacturing process of the container. Water sampling location is shown in Table 1, it is rendered and the depth of drilling water sampling. To avoid oxidation subsequent processes that can occur at water-air interface, the containers were completely filled with water and close the lid was done during immersion. Samples were stored at 4ºC until analysis to minimize degradation.

Groundwater samples were collected from depth (drilling soles) with a harvester made for this purpose, after water has previously been emptied 3 times with a motopomp.

Values obtained for physicochemical parameters investigated in momentary samples collected each quarter from the five years of the study were pooled and analyzed from the procedure of assessment of water status in accordance with the limit values specified by the norm on the benchmarks for determining quality drinking water [16, 17] and groundwater [18].

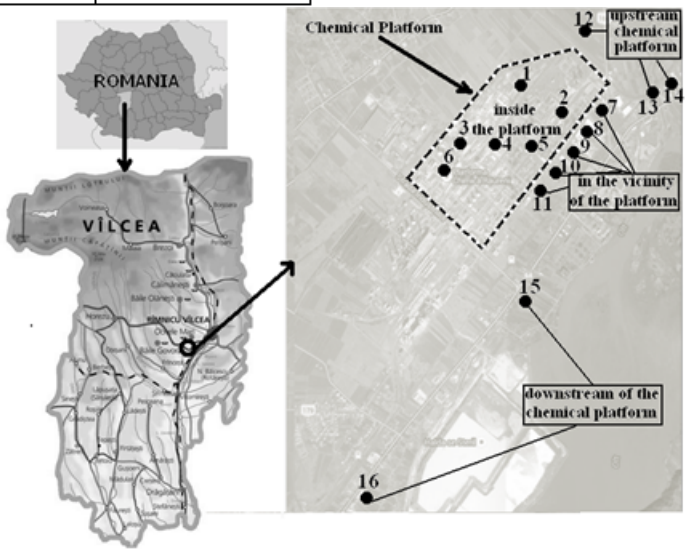

Fig. 1. Study area from the groundwater samples (inside, in the vicinity, upstream and downstream of the chemical platform)

Results and discussions

Study area

This paper aims to evaluated the quality of groundwater from the area of an chemical platform. The groundwater samples were taken from drillings located within inside, in the vicinity, upstream and downstream of the chemical platform (fig. 1).

Groundwater samples studied were taken from drillings located both inside and near of the industrial platform and from drillings upstream and downstream industrial platform. The groundwater samples were collected from each sampling point. For each water sample the concentrations that were determined was for the following indicators: *p*H, chlorides, sulfates, bicarbonates, carbonates, sodium, calcium, magnesium, ammonium, filterable residue, suspended matter, mercury and CCO-Mn, using standardized techniques for each indicator.

The results of physic - chemical properties are shown in Figure 2- 4 and compared with the maximum permissible values according to Law 458/2002 - on drinking water quality, the Law 311/2004 amending and supplementing Law 458/2002 on drinking water quality and HG 53/2009 and Direction Olt water (groundwater body ROOT08) (table 2) [18].

Ammonium analysis

The limit allowed under H.G. 53/2009 and direction Olt water (groundwater body ROOT08) for ammonium quality indicator is 2.6 mg/L. The ammonium quality indicator for

Nr. crt.	Quality indicator	Limit allowed under H.G. 53/2009 and direction Olt water (groundwater body ROOT08)	Limit allowed under Law 458/2002 on drinking water quality and the Law 311/2004 amending and supplementing Law 458/2002 on drinking water quality
U.M.		mg/L	mg/L
1	***Ammonium***	***2,6***	***0,5***
2	***Sulfates***	***250***	***250***
3	***Chloride***	***250***	***250***
4	***Mercury***	***-***	***0,001***
5	***CCO-Mn***	***-***	***5***
6	***Sodium***	***-***	***200***

Table 2
THE LIMIT ALLOWED UNDER CURRENT LEGISLATION

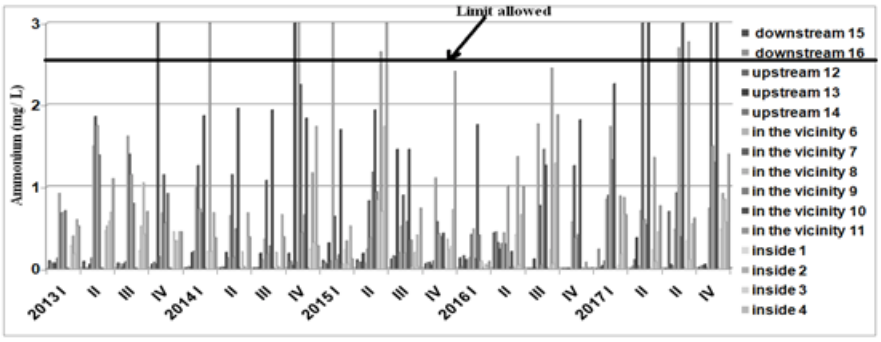

Fig. 2.Evolution of the ammonium quality indicator for a period of 5 years for the drillings located inside, in the vicinity, upstream and downstream of the chemical platform

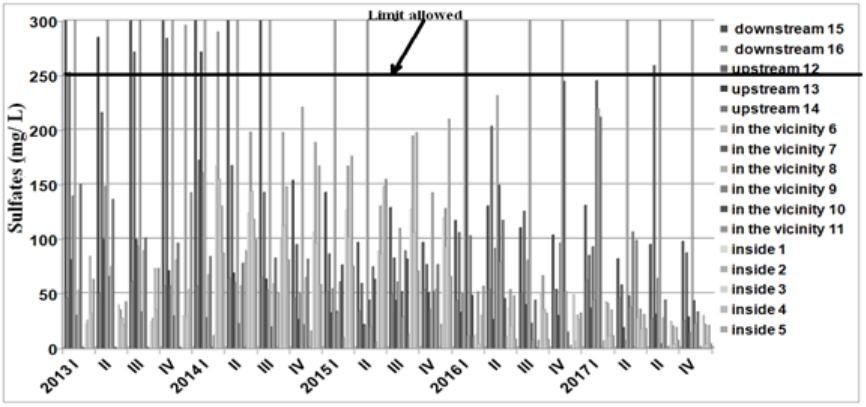

Fig. 3. Evolution of the sulfates quality indicator for a period of 5 years for the drillings located inside, in the vicinity, upstream and downstream of the chemical platform

most studied drillings does not exceed the limit imposed by the legislation in force for the whole period investigated. In general, as shown in figure 2, the ammonium quality indicator exceeds the required limit for drilling downstream of the chemical platform.

Analysis of sulfates

The limit allowed under H.G. 53/2009 and direction Olt water (groundwater body ROOT08) for quality indicator sulfate is 250 mg/L. The quality indicator sulfate, for most studied drillings does not exceed the limit imposed by the legislation in force for the whole period investigated. In general, as shown in figure 3, the sulfate quality indicator exceeds the required limit, for drilling located downstream and in vicinity of the chemical platform.

Chloride analysis

The limit allowed under H.G. 53/2009 and direction Olt water (groundwater body ROOT08) for quality indicator chlorides is 250 mg/L. The quality indicator Chloride, for most studied drillings exceed the limit imposed by the legislation in force for the whole period investigated. In general, as shown in figure 4, the chloride quality indicator does not exceeds the required limit, for drilling located upstream of the chemical platform.

Analysis of Mercury

Mercury was determined from three drilling located upstream and downstream of the industrial platform and also for drilling no. 1 situated inside of the industrial platform. Following the results, the mercury was below the limit of 0.001 mg/L for all drilling located upstream and downstream of the industrial platform and for drilling no. 1 was observed that mercury contamination depends by sampling period (weather) of the water in drilling and by operation of mercury installations from the area near the drilling during sampling.

Analysis of CCO-Mn

The limit allowed under Law 458/2002 on drinking water quality and the Law 311/2004 amending and supplementing Law 458/2002 on drinking water quality - Thresholds for intervention, for quality indicator CCO-Mn is 5 mgO_2/L.

Following the results for the entire period and for all investigated areas was observed that for almost all drillings studied quality indicator CCO-Mn exceeds the limit allowed by the legislation in vigor.

Filterable residue analysis

Filterable residue was determined during the investigation, for all drillings studied and found that it is higher for drillings located inside and near of the industrial platform, than drillings located upstream of the industrial

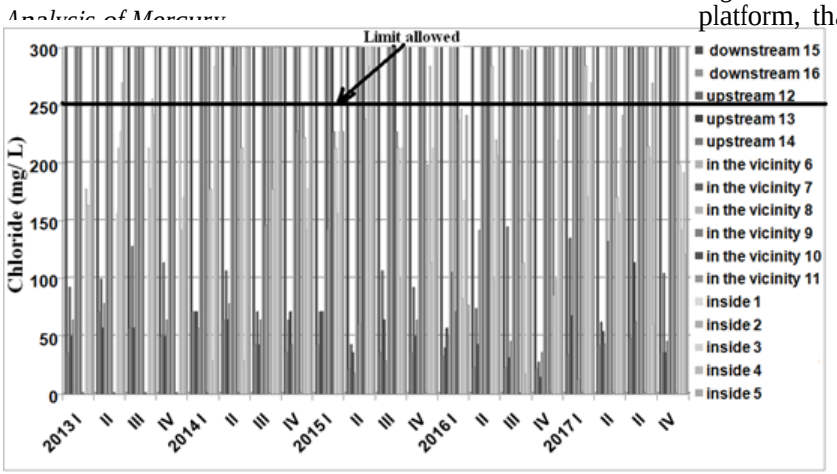

Fig. 4. Evolution of the chlorides quality indicator for a period of 5 years for the drillings located inside, in the vicinity, upstream and downstream of the chemical platform

platform, this in generally depending on the inorganic loading of these drillings.

Sodium analysis

The limit allowed under Law 458/2002 on drinking water quality and the Law 311/2004 amending and supplementing Law 458/2002 on drinking water quality - Thresholds for intervention, for quality indicator Na is 200 mg/L. Following the results for the entire period and for all investigated areas was seen as a quality indicator sodium concentration was found above the limit imposed under the laws in vigor in almost all studied drillings except drillings generally located upstream of the industrial platform.

Conclusions

In this paper, were presented studies regarding the physicochemical quality evaluation of groundwater from the area of an chemical platform. For this study were examining 16 drillings for a period of five years.

Based analyses indicated that, depending on the place of harvest, the quality of groundwater varies. For groundwater collected from drillings located inside and in the vicinity of the industrial platform in physicochemical analyzes it was observed that a number of physico-chemical and specific contaminants were higher near pollutant sources.

In assessing groundwater pollution was observed as deep water samples from drillings in the vicinity of the platform industry contain more pollutants in areas downstream to the upstream industrial platform. Regarding the time evolution of the analyzed samples is found that it depends by: sampling period (season when they were sampled), thus the weather at the time of sampling; depth of water in drillings with as drilling depth was greater the more polluted it is weaker; the area where drillings are located (inside, near, upstream and downstream of the industrial platform); and by the activity of industrial platform (possible damage to the installations located in this area of production in that period).

Interpretation of physicochemical data revealed that groundwaters studied was neutral to slightly alkaline. The cations such as sodium (Na^+) for all groundwaters studied it was in general found above the limit imposed under the laws in vigor in almost all studied drillings except drillings generally located upstream of the industrial platform. The anions such as chlorides (Cl^-) exceeded, in general, the limit allowed under current legislation. The filterable residue concentration was observed in all the studied drillings and the parameter such as sulfate (SO_4^{2-}), were within the limit allowed under current legislation for the most all studied drillings, for the whole period investigated. In general, the sulfate quality indicator exceeds the required limit, for drilling located downstream and in vicinity of the chemical platform.

Industrial pollution, as can be seen from the results of this study persist over time and is felt at depths of over 4 m and at distances over 5 km of industrial platform (platform drillings downstream industries). Considering the data obtained we can say that it is difficult for such a polluted industrial area to a decommissioned. Disposal of such areas may take decades.

The study therefore indicates the necessity in regular monitoring of groundwater levels and adopting suitable recharge and management measures to overcome overexploitation and pollution to facilitate sustainable groundwater quality from the area.

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17.*** Law 311/2004 amending and supplementing Law 458/2002 on drinking water quality
18.*** H.G. 53/2009 and direction River water (the body of groundwater ROOT08)

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