INCIDENCE OF NITRATE, NITRITE, CHLORIDE AND PHOSPHATE IN GROUNDWATER IN MODIVAS, PORTUGAL

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ABSTRACT

The aim of this project consisted in the evaluation of chemical quality of groundwater in domestic wells situated in the village of Modivas, which belongs to the district of Porto, in north of Portugal. The population doesn't have a public water supply system and the groundwater is a significant source for domestic, livestock breeding and agricultural use.

The quality of water samples were collected from domestic wells with an approximate deph of 15 m and the quality has been investigated with respect to pH, conductivity, temperature, nitrate, nitrite, phosphate and chloride. Geographical coordinates were also measured at each location, using a GPS device.

The obtained results show that a strong nitrate contamination exists in the studied area. A very small percentage of wells (2%) were above the guideline for nitrite. As for the other parameters (chloride and phosphate) the results never exceeded the legal limit.

KEYWORDS

Groundwater, sewage, agricultural activity, water analysis, nitrate.

INTRODUCTION

The intensity of agriculture activity has increased significantly during the past 30 years, resulting in increased detection of agricultural contaminants (nutrients, pesticides, salts, trace elements, and pathogens) in groundwater. Another factor that contributes for this contamination is the lack of sewage system, being all the effluent sent to septic tanks. These decant the effluent along time. The remaining muds are removed from time to time and the liquid is conducted to a draining-well (cesspool) that allows infiltration to the ground. So, the use of this water can cause health problems in humans and animals (Fennesy *et al.*, 1997 e Wakida *et al.*, 2005).

As Modivas (Figure 1) is located near the sea (average distance of 4000 m), chloride was evaluated to determine salt contamination in the aquifers. The nitrate, nitrite and phosphate were quantified to confirm the contamination due to human activity.

The aim of the present study is to investigate the state and quality of groundwater in Modivas accordingly to Decreto-Lei 243/01 and Decreto-Lei 238/98, by measuring a total of 6 chemical and physical parameters. The number of groundwater samples analysed was 90, collected in the village of Modivas. The water is used mainly for irrigation and drinking.

EXPERIMENTAL

Groundwater samples were mainly obtained from domestic wells with an approximately depth of 15 m located in the village of Modivas. The schematic representation of sampled area is illustrated in Figure 2.

Samples were collected in polyethylene bottles from 90 wells. The samples were analysed within 48 h of collection. Standard methods were used for the determination of chemical and physical characteristics of the water (APHA, 1995). The parameters analysed were pH, conductivity, temperature, nitrate, nitrite, phosphate and chloride. pH, conductivity and temperature were measured at the moment of sample collection, using portable equipment.

Determination of nitrate, nitrite and phosphate was made using a UV-VIS spectrophotometer (Shimadzu UV-2101 PC). Prior to each analysis, all instruments were calibrated according to the manufacturer's recommendations.

Measurement of UV absorption at wavelength of 220 nm enables rapid determination of NO_3^-. However, dissolved organic matter may also absorb at 220 nm and nitrate does not absorb at 275 nm; for these reasons, a second measurement was made at 275 nm to correct the nitrate value (APHA, 1995).

Nitrite was determined through the formation of a reddish purple azo dye produced at pH 2.0 to 2.5 by coupling diazotized sulphanilamide with N-(1-naphthyl)-ethylenediamine dihydrochloride (NED dihydrochloride). This photometric measurement was made at 540 nm (APHA, 1995).

Phosphate was measured using a colorimetric method at 475 nm. In the presence of ammonium molybdate and vanadium a yellow vanadomolybdophosphoric acid is formed. The intensity of the yellow colour is proportional to phosphate concentration (APHA, 1995).

Chloride was determined using an argentometric method. In a neutral or slightly alkaline solution, potassium chromate can indicate the end point of the silver nitrate titration of chloride. Silver chloride is precipitated quantitatively before red silver chromate is formed (APHA, 1995).

So as to validate analysing methods, inter-lab analysis were made.

All chemicals were Merck pro analysis grade and all solutions were prepared using purified water (conductivity < 0,1 μScm^{-1}) obtained from a Barnstread E-pure 4 system.

RESULTS AND DISCUSSION

The results are presented in Tables 1 and 2. These provide a comprehensive picture of the characteristics of groundwater with regard to the various physical and chemical indicators determined. The tables present the minimum and maximum values of the samples analysed, the Decreto-Lei guideline and the percentage of samples above the guideline.

From tables 1 and 2 it can be seen that the nitrate values of groundwater are high, reaching 280 mg/L, with a percentage of 74 % above the Decreto-Lei 243/2001 guideline. These high values are probably due to agriculture activities, raising livestock and contamination by the cesspools. The Figure 2 shows the geographic distribution of the wells and the degree of nitrate contamination.

A very small percentage of wells (2%) were above the guideline for nitrite. As for chloride and phosphate the results never exceeded the legal limit. No existence of chloride in water proves that there isn't an intrusion of sea water in groundwater; it is often assumed that chloride in groundwater is dominantly derived from marine salts (Morales *et al.*, 2000).

When the values of nitrate, nitrite or phosphate are above the guideline the water is not suitable for drinking, but could be used for irrigating crops. In this study, 74 % of the samples

analysed were above the guideline. Figure 3 indicates, in each street, the number of wells that have suitable or not suitable water for drinking.

CONCLUSIONS

Our investigation demonstrates that the ground waters are contaminated with high concentrations of nitrate. These waters are not suitable for drinking because the chemical quality is not guaranteed. Water is essential to sustain life, and a satisfactory (adequate, safe and accessible) supply must be available to all. Every effort should be made to achieve proper drinking-water quality.

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Street	Nitrate mg/L (NO_3^-)	Nitrite mg/L (NO_2^-)	Phosphate mg/L (P_2O_5)	Chloride mg/L (Cl^-)	pH	Conductivity µS/cm	Number of Samples
Aldeia Nova	73-127	<0,004	<0,18-0,70	46-61	5,2-5,9	382-514	5
Arroteia	38-114	<0,004-0,34	<0,18	22-41	5,9-6,9	230-428	4
Covelo	92-136	<0,004-2,7	<0,18	58-101	5,9-6,4	441-695	6
Estação	<5-93	<0,004-5,8	<0,18-4,80	43-87	5,8-6,2	270-490	6
Estrada	33-155	<0,004-0,23	<0,18	54-116	4,6-5,4	480-699	7
Fonte	4-80	<0,004-0,05	<0,18	30-67	5,6-6,0	189-587	6
Igreja	61-121	<0,004-0,007	<0,18	42-49	5,8-6,3	474-557	3
Lage	8-280	<0,004-0,009	<0,18-0,30	23-115	5,2-6,2	285-719	15
Longa	47-108	<0,004-0,007	<0,18	28-39	5,6-5,9	275-430	2
Modivas de Baixo	92-151	<0,004-0,006	<0,18	46-63	5,6-6,1	448-592	6
Moinho	70-106	<0,004-0,01	<0,18	41-55	5.6-6.6	339-437	3
Monte	103-190	<0,004-0,02	<0,18	43-70	5,2-6,2	568-640	5
Nove Irmãos	41-68	<0,004	<0,18	24-45	5,9-6,2	247-391	4
Padrão	79-153	<0,004	<0,18	40-64	5,4-5,9	440-563	5
Passos	23-110	<0,004	<0,18	43-72	5,5-6,2	494-549	4
Revilhões	40-60	<0,004-0,06	<0,18	34-47	5,9-6,1	280-320	2
Travessa do Viso	24-161	<0,004-0,04	<0,18	53-153	5,3-6,1	440-520	7

Table 1
Minimum and maximum values of the samples analysed.

	Decreto-Lei 243/2001	Samples above guideline (%)
Nitrate mg/L (NO_3^-)	50	74
Nitrite mg/L (NO_2^-)	0,5	2
Phosphate mg/L (P_2O_5)	5[a)]	0
Chloride mg/L (Cl^-)	250	0
pH	6,5-9,0	77
Conductivity µS/cm	2500	0

Table 2
Decreto-Lei 243/2001 and Decreto-Lei 236/1998 guideline and groundwater quality.
a) Decreto-Lei 236/98

Figure 1
Localisation of the village of Modivas (Portugal)

Figure 2
Geographic distribution of the wells and the degree of nitrate contamination.

Figure 3
Absolute frequency of the samples waters analysed.