THE IMPACT OF ANTHROPOGENIC NUTRIENTS ON GROUNDWATER NITRATE CONCENTRATION IN THE BÂRLAD AREA

Breabăn Iuliana Gabriela*, Paiu Madalina*

*Alexandru Ioan Cuza University, Faculty of Geography and Geology, Iasi, Romania,e-mail: iulianab2001@yahoo.com

Abstract

The organic residual matter of animal origin has in its composition, beside the nutrients necessary for the growth and evolution of crop plants, potential toxic substances that can build up in soil and groundwaters with concentrations that exceed the limit alert negatively influencing the environment's quality.

This study aims to establish correlations between the average nutrients'pressure's level resulted from manure and nitrate's concentration present in the water of Bârlad city and surrounding villages' wells. The working mothodology consisted in collecting 60 groundwater samples in two consecutive years (2011 and 2012), samples which have been later analized in the laboratory (pH, conductivity, COD, dissolved oxigen, N-NO_3). Simultaneously the data obtained from the general agricultural census from 2011 was used to measure the average nutrients'pressure for each village using a methodology developed by ICPA. Considering the obtained data it was estimated the impact on the environment and were defined the areas vulnerable to nitrates of agricultural sources.

Key words: nitrate, groundwater, nutrients pressure, GIS

INTRODUCTION

Nitrates are found naturally in soil and water in small quantities. Agricultural practices in the communist period, based on intensive agriculture, assumed increasing use of chemical fertilizers. Unused amounts of nitrate remaining in the soil were then transported to groundwater through rain, melting snow or irrigation, contaminating them, especially where there is a sandy soil texture. Studies have found several ways to accumulate excess amounts of nitrates in the soil, such as: manure, which contains both based effluent ammonia and organic forms of nitrogen that can be converted into ammonia in the soil and then nitrificated by the bacteria from soil application of nitrogen fertilizer in amounts much higher than those that can be assimilated by plants (Burow K., et al., 2010, Puckett L. et al., 2011).

Access routes into the body of the nitrates are by ingestion of food and contaminated drinking water, which can be as toxic for both human and animal populations. Children are the most vulnerable, due to the presence of some bacteria in the digestive tract that reduces nitrate to nitrite, which in

contact with hemoglobin form methemoglobin, which implicitly involves blocking oxygen and suffocation (Mocanu Ana Maria, 2005).

Nitrates are highly soluble, dissolving easily in water, making it extremely difficult and expensive to decontaminate the polluted areas (DeSimone L.A.et al. 2009, DeSimone, L A., 2009).

The European Union has created a number of legal instruments for the protection and sustainable management of water resources such as the Framework Directive 2000/60/EC and Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources (Nitrates Directive) in which the general objective is to reduce water pollution. Both quantitative and qualitative follow closely the management of water and healthy ecosystems, aiming to achieve "good water status" by 2015.Directive 91/676 / EEC was transposed in Romania by GD 964/2000 approving the Action Plan for the protection of waters against pollution caused by nitrates from agricultural sources, which stipulates that our country needs to review, revise or supplement at least every four years, the list of designated nitrate vulnerable areas to take account of changes and factors since the previous appointment (Panoiu I et al, 2008, Fleşeriu A. Oroian I., 2010).

As a result, the Interministerial Commission for the implementation of the Action Plan for the protection of waters against pollution caused by nitrates from agricultural sources has approved the action for nitrate vulnerable zones by Decision no. 21130/DC/14.10.2010. In our country the first designation of vulnerable and potentially vulnerable areas was made in 2003 ICPA with the Romanian Waters National Administration. Teritory of 255 localities have been designated as nitrate vulnerable zones. In 2008 were redesignated areas vulnerable to nitrate pollution, considered as vulnerable zones villages located in 2003, should be classified as areas potentially vulnerable and vulnerable to nitrate pollution.

Studied area is part of a county with low economic potential, being considered one of the poorest counties in the country, were the main activity of the population is still agriculture, crop cultivation and livestock breeding, the sewage systems for waste waters being insufficient developed, characterized by an excess input of nitrogen in the environment.

The zone is located within the southern part of the Moldavian Plateau, mainly on the Barlad River Floodplain, the Barlad city being crossed by 46°14` Northern latitude parallel line and the 27°42` Eastern longitude meridian (figure 1). The study area is extend mostly on the Barlad River Valley. The altitude varies between 56m (Barlad floodplaine) – 120m Tuguiata hill) – 150m (Graveyard hill)- 205m (Crang hill) – 230m (Perieni) - 240m (Dealul mare – Big hill) – 346m (Grajdeni hill). The mean annual precipitation recorded at Perieni – Barlad station, for over 30 years, is 504.3

mm (Ionita I. et al. 2006) with a downward trend (480.8 mm in 2008), while temperature shows an upward trend from 9.8 to 11.0 in 2008 (Ramboi V., 2008). According to CLC 2000 the lands are mainly ocupied by agricultural activity. From a total of 265001.99 ha, 91.67% represent non irrigated arable land, 2.53% broad leaved forests, 2.02% pastures, while the other have less then 1%.

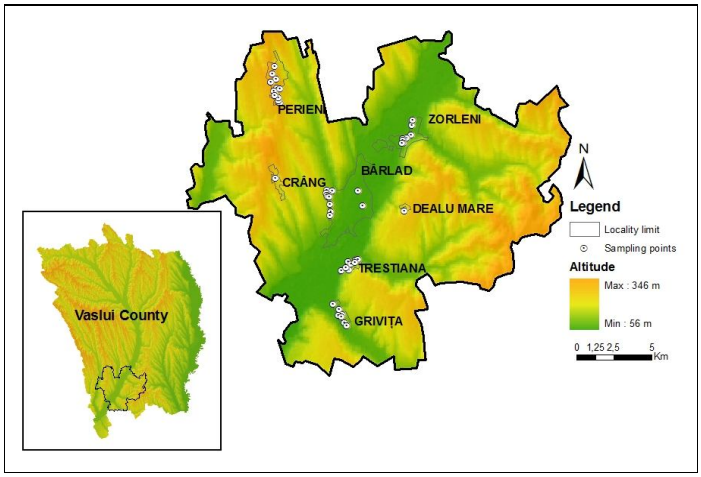

Fig.1. The location of study area in Vaslui County and distribution of sampling points

MATERIAL AND METHOD

The surface deposits from the area, are mainly composed by successive layers of clay and sand, delimiting different aquifers (Dragusin D., 2005, Macaleț R., Dragusin D., 2008).The aquifer is a groundwater reservoir providing a sustainable efficiency and it is used for public and agricultural water supply.

In July 2011 a number of 63 wells were mapped from seven villages (Perieni, Crang, Grivita, Trestiana, Dealu Mare, Zorleni, Simila) and one city (Barlad). The collected water samples have been preserved by refrigeration at 4^{o}C and then analysed in the laboratory, for nitrates with sodium salicylate method at 410, using a Shimadzu UV 1601 spectrophotometer. In July 2012 due to drought 5 of the 63 wells were dried up and that made it impossible to take water samples.Therefore in 2012 were taken only a number of 58 samples for nitrate analysis. The spatial distribuition of results were made using the ArcGis 9.3 software.

Among other regulations the Action Programme for Nitrate Vulnerable Zones from agricultural sources include the responsability of local authorities in rural declared nitrate vulnerable zones, together with representatives of county agricultural directorates and district offices of agrochemical soil studies to assess the pressure of organic fertilizers to the

villages and completed electronically, according to a predefined layouts the table 1, updating information being performed at every two years.

Table 1

Model for calculating the pressure in the locality induced by livestock manure

Animal category	Average weight	Number of animals		Transfer coefficient for N	N production
Calves	0-50		X	**20**	0
Calves (0.3–1 years)	50-250		X	**35**	0
Cattle (1- 2 years)	250-600		X	**55**	0
Dairy cattle	>400		X	**81**	0
Pigs	98		X	**13**	0
Pigs	68		X	**11**	0
Pigs	90		X	**15**	0
Gestating sows	125		X	**10**	0
Sows with piglets	170		X	**38**	0
Boars	160		X	**13**	0
Sheeps/goats	45		X	**7**	0
Breeding birds	1,8		X	**0,36**	0
Fattening birds	0,9		X	**0,36**	0
Horses	450		X	**45**	0
Total households					**0**
Net production of nutrients in the village					

RESULTS AND DISSCUSIONS

Using agricultural census data from each studied vilages, by calculating according table 1 rules, the induced pressure values induced manure locality are obtained (table 2) .

Table 2

Induced pressure from livestock manure values

Locality	**Kg/N/ha**
Bârlad	31,33516
Zorleni	28,50671
Perieni	23,38669
Ciocani	16,18415
Griviţa	14,18564

Analysing data obtained in Tables 2 and 3 it can be seen that for developed urban areas built variation of nitrate content is higher (Barlad city) than in less developed rural areas, dominated by grasslands (Ciocani, Grivita). Also, can be noticed the variation of nitrate content, thus even in 2012 the minimum and maximum is lower then 2011, the average is greater (284mg/L *vs.*222 mg/L), the coefficient of variation growing on the north west to south east (Perieni to Grivita in 2012), while in 2011 shows slightly higher values but constant.

Table 3

Descriptive statistics of the nitrate content (mg/L) of domestic wells in the interest zone

	Total		Perieni		Trestiana		Zorleni		Grivita		Barlad	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Max	672	518	313	518	672	464	346	483	672	474	277	278
Min	10	1	64	144	90	142	47	1	10	11	39	71
Average	222	284	176	340	394	348	212	322	334	314	115	159
St dev	157	139	81	95	191	101	105	163	203	174	71	80
Variation coefficient %	70	49	46	28	48	29	49	51	61	55	62	50

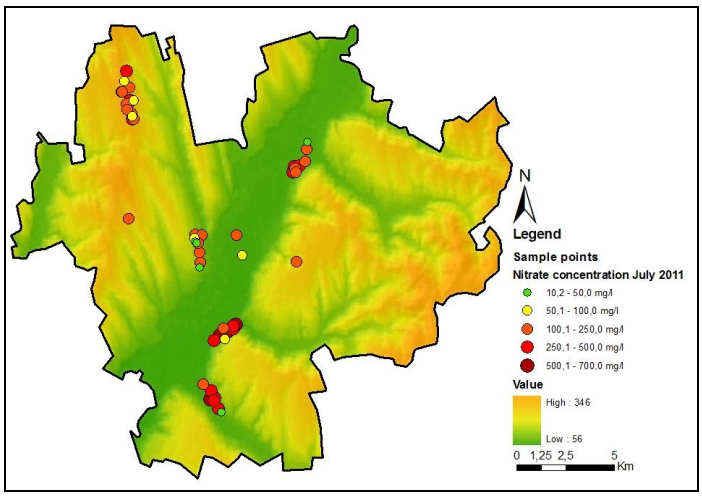

Fig.2 Geographic distribution of nitrate concentrations in samples collected from domestic wells in the study area in July 2011

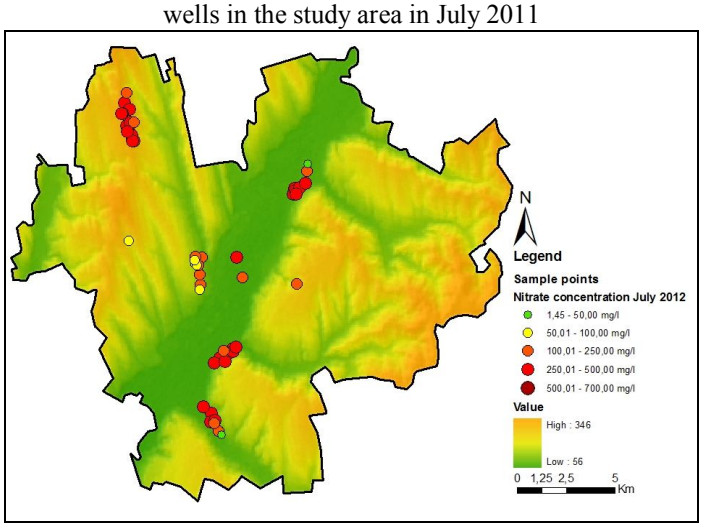

Fig. 3 Geographic distribution of nitrate concentrations in samples collected from domestic wells in the study area in July 2012

CONCLUSIONS

The domestic wells assure drinking water for the most of the inhabitants from the area. Most wells shows values exceed the CMA's (50 mg /L), in 2012 more uniform spatial distribution being noticed.

Exists a direct correlation between groundwater level and nitrate quantity (672 mg/L in 2011 *vs.* 518 mg/L in 2012), having a shorter lag time then the effective rainfall, the level being a potential predictor of seasonal changes. The land uses category influence also the content of nitrate, arable and urban category being more significantly with increased of groundwater level then pasture.

Acknowledgments

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