MICROBIOLOGICAL ASPECTS OF UNDERGROUND WATER QUALITY FOR HUMAN CONSUMPTION IN RURAL AREA

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Keywords: drinking water quality, groundwater, rural area, microbiological parameters
Abstract: Underground water sources from rural area of Northeast of Romania are frequently polluted with fecal contaminants. Surface and groundwater sources used as drinking water were affected in 2005-2007 by natural disasters (floods, drought).
In the period 2007-2009 were analyzed 321 samples of water from underground sources for human consumption. Descriptive statistics for 1038 microbiological indicators are presented in this paper.

INTRODUCTION

Water is an essential element for life and for development of human collectivities.

Water sources for human consumption are surface water (with different compositions and variable over time and require treatment for drinking) and groundwater (phreatic and deep). Over 95% of the world's fresh water, except for glaciers and ice caps, is located underground. Groundwater is the source of drinking water for three quarters of EU citizens (EU). Groundwater parameters have relatively constant composition, with a high mineralization depending on the geological structure of the layer crossed and hydrodynamic factors. [1-3].

Pollution of groundwater occurs through infiltration of solid and liquid substances, boosted by meteoric waters, which wash the waste from the soil or because of sewage entering the soil by collection system. The degree of pollution depends on the porous medium to canvas the area of penetration of groundwater and the characteristics and quantity of pollutants. The main forms of pollution of groundwater pollution are domestic, industrial, agricultural and from transportation. In rural areas, sources of pollution from intensive agricultural activities in the past, from the application of fertilizers and plant protection product as, or failure to comply with sanitary protection zone or conditions of implementation of water catching. [2, 4-5].

Over large parts of the world, humans drink water that contains disease vectors or pathogens or contain unacceptable levels of dissolved contaminants or solids in suspension. Such waters are not potable and drinking such water or using it in cooking leads to widespread acute and chronic illness and is a major cause of death in many countries. Water is considered drinkable, if it can be drunk safely, without harming human health in any way. Legally, water quality is defined by local laws, which however differ from one country to another. [5-9]

In Romania, rural areas are 93.6%, including 48% of the total population. In rural areas, 67% of people live without access to drinking water supply and more than 90% are not connected to sewerage systems. Water supply to villages is often provided (6.7 million inhabitants, 66.3%) of their sources (wells), whose flow and quality varies greatly depending on environmental conditions. So often does not meet water quality requirements stipulated by law. [10-12]

In 2005-2007, natural disasters (floods, drought) affected surface water and groundwater used as drinking water supply in all districts of Northeast of Romania.

MATERIALS AND METHODS

In the period July 2007 - July 2009, we collected water samples from rural villages located in 5 counties in NE region of Romania: Botosani (BT), Iasi (IS), Neamt (NT), Suceava (SV) and Vaslui (VS). Were chosen the most representative sources of water in this locality, depending on the number of users and increased accessibility (public wells near the town hall, school, church, main access routes). Water sources studied were public wells, drilled wells, captured springs (public drinking fountain, small distribution network) and centralized local networks (from groundwater sources, without a physical or chemical disinfection).

Originally, fecal contamination was determined by the presence of coliform bacteria, a convenient marker for a class of harmful fecal pathogens. The presence of fecal coliforms (like E. coli) serves as an indication of recent contamination by sewage. Enterococci are an indicator for an older contamination. Microbial pathogenic parameters are typically of greatest concern because of their immediate health risk.

Microbiological indicators (coliforms, *E. coli*, Enterococci, and *Salmonella*) were followed for the samples.

Samples of water, laboratory testing and interpretation of results were performed according to the quality of drinking water, following the methodologies of the current standards.

The results were collated and statistically processed using specialized software: *Microsoft Excel, Epiinfo*.

RESULTS AND DISCUSSIONS

321 samples were collected, of which three quarters water from wells. (Fig.1)

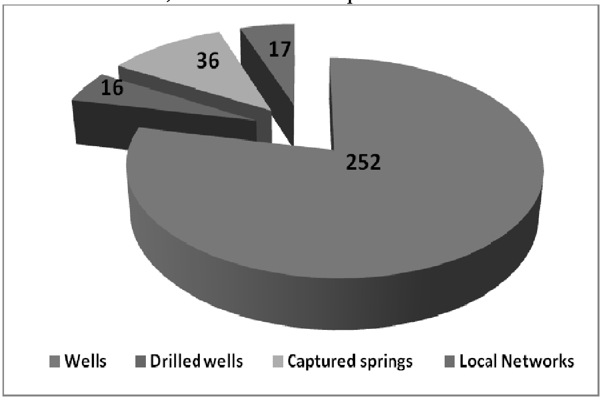

Figure 1 - Sources of samples

1038 microbiological indicators were analyzed from 321 samples of water. Microbiological indicators of fecal contamination had overrun more than 80% of the samples. (Fig. 2, 3, table 1)

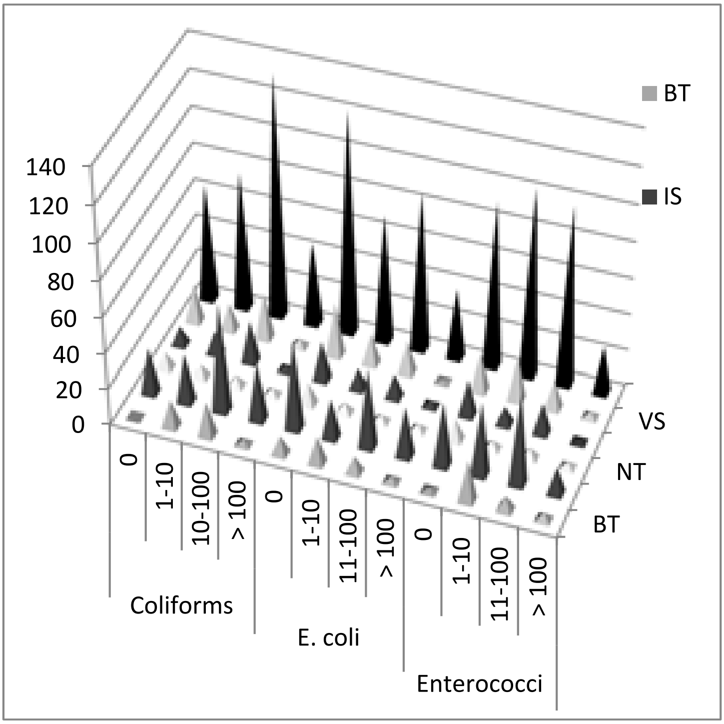

Figure 2 – Bacterial load of water samples.

Table 1- Descriptive statistics for microbiological indicators

Indicators		**BT**	**IS**	**NT**	**SV**	**VS**	**NE**
	CFU/100ml	*count samples*					
Coliforms (ISO9308/1/2000) Condition of admissibility: 0 CFU/100ml	0	0	25	9	10	21	65
	1-10	15	27	7	12	15	76
	10-100	19	60	6	23	26	134
	> 100	3	32	4	3	4	46
	median	*14*	*20*	*4*	*15*	*10*	*14*
	mean	*65*	*103,2*	*473*	*37,7*	*24*	*110*
	maxim	*709*	*761*	*7030*	*455*	*227*	*7030*
	Standard Error	*25,4*	*14,7*	*305*	*11,8*	*5,31*	*27*
E. coli (ISO9308/1/2000) Condition of admissibility: 0 CFU/100ml	0	10	50	12	21	30	123
	1-10	15	22	6	11	17	71
	11-100	9	44	4	13	18	88
	> 100	3	28	4	3	1	39
	median	*5*	*10,5*	*2,5*	*2*	*3*	*5,5*
	mean	*44*	*61,1*	*338*	*17,9*	*14*	*68*
	maxim	*532*	*676*	*5273*	*227*	*146*	*5273*
	Standard Error	*19,5*	*10*	*220,8*	*5,7*	*3,3*	*18,6*
Enterococci (ISO7899/2/2000) Condition of admissibility: 0 CFU/100ml	0	2	36	12	20	22	92
	1-10	23	41	5	10	25	104
	11-100	8	52	6	17	16	99
	> 100	4	15	3	1	3	26
	median	*6*	*9*	*3*	*2,5*	*3,5*	*5*
	mean	*77,5*	*42*	*281*	*12,2*	*32,8*	*59*
	maxim	*1100*	*773*	*6455*	*103*	*691*	*6455*
	Standard Error	*34,53*	*9,23*	*247,5*	*2,89*	*14,18*	*20,3*
Microbiological	*Overall*	***37***	***144***	***26***	***48***	***66***	**321**
	Adequate samples	***0***	***22***	***8***	***9***	***18***	**57**
	Inadequate samples	***37***	***122***	***18***	***39***	***38***	**254**

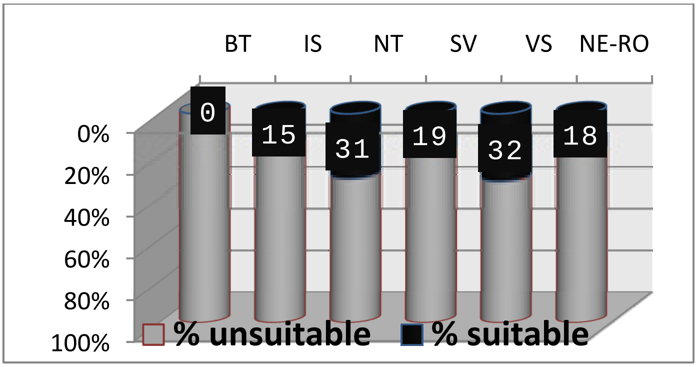

Figure 3 - microbiological adequacy of water samples

The highest values were encountered in flooded affected area. Some samples had a very high bacterial loading (over 5000 UFC/ 100ml). However, *Salmonella spp.* was not present in any of the 33 samples analyzed from flooded areas.

Most public wells served 8 to10 families, but sometimes the same local water source is used by more than 50 families. (Fig.4) Higher number of consumers was for local networks, spring wells or when the well or drilling well serves an educational institution.

Could not establish a correlation between the number of users and the degree of microbiological contamination of the well (*Pearson correlation index =- 0.07*).

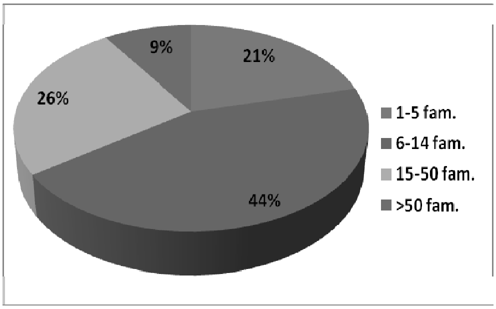

Figure 4 - use of wells

The depth of water sources was important for its quality, the most protected being over 15 m ($\chi 2 = 27.91$, df = 2, $p < 0.001$). (Table 2)

Table 2 – water quality and depth of wells

Depth	Suitable samples	Unsuitable samples
≤ 4m	7	88
4-15 m	6	106
> 15m	19	42

Water extraction and distribution affect the degree of microbiological contamination, which in the case of wells is higher than drilled wells and distribution networks. ($\chi2 = 71.27$, df = 3, $p <0.001$) (Table 3)

Table 3 – water quality and sources of samples

	total	unsuitable	suitable	% suitable
Wells	252	228	24	9,5
Drilled wells	16	4	12	75
Captured springs	36	25	11	30,5
Local Networks	17	7	10	58,8

Water quality from wells was affected due to non-compliance with hygiene rules on the location and construction of wells especially for newly built homes, and irrational and uncontrolled use of pesticides and agricultural fertilizers. More than half of the wells had construction deficiencies (distance to possible sources of pollution, not own bucket, cap and roof, not waterproof deck around) and inadequate maintenance (regular analysis and disinfection). [13]

Laboratory analysis of water samples performed in previous years have proved that water was not suitable for human consumption in high proportions (80-90% of cases) due to fecal contamination (coliforms, Escherichia coli, enterococci) or presence of chemical pollutants (nitrates, nitrites, etc.). [10-12]. A similar situation was found in our study.

In Moldova, many individual farms used manure as fertilizer mainly because it is the cheapest and available. Households are often not provided with protected platforms for garbage collection and animal husbandry. Latrines or septic tanks are constructed near houses and wells, thus continuing pollution by nitrates and contamination of surface and groundwater.

Generally, the locals considered as good drinking water, and no subjective reports of digestive disorders or deterioration in health condition following the consumption of water from their or public wells. This positive perception, despite inadequate laboratory results is explained by the development of immunity against bacterial species commonly in water.

CONCLUSIONS

In rural areas of NE Romania area groundwater used as drinking water source is microbiological polluted.

Water quality for human consumption is an important objective included in the EU directives, which it aims to protect public health.

It is important to protect the water sources through a preventive approach and application of methods of environmental protection and development of secure treatment and water distribution.

It is also necessary to promote health, to effectively inform the population about the conditions of construction, protection, maintenance and regular monitoring of local drinking water facilities.

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