Wastewater Leaching into the Wells: a study in Finland

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ABSTRACT

In this study 96 wells (66 shallow and 30 deep) from sparsely populated and agricultural area from Western and Eastern Finland were analyzed during the year 2006 in order to asses the general quality of the wells. 14 wells did not fulfil the potability criteria and 76 wells had at least one quality indicator over/under the recommended value. Combining DOC, nitrate and HPLSEC chromatographical data 40 shallow and 15 dug wells have been found influenced by leaching. From these, 15 shallow and 8 dug wells presented wastewater type chromatograms. All wastewater influenced wells are situated near to a dairy farm or at distances less than 50 m or downstream to a septic system.

INTRODUCTION

Improperly purified wastewater-effluent leaching into the wells/groundwater is in almost all of the cases the cause of waterborne epidemics in Finland [1]. Consequently the early identification of both wastewater and/or surface water leaching is of key importance in realizing effective prevention of well contamination. Organic matter and particularly NOM (natural organic matter) has been shown in numerous previous studies to be characteristic for different types of water, respectively for surface-, ground- and wastewater [2, 3].

In this study 96 wells (66 shallow and 30 deep) from sparsely populated and agricultural area from Western- and Eastern Finland were analyzed during the year 2006. The scope of this study was to assess the general quality of the wells and to identify those under the influence of wastewater/surface water leaching.

MATERIALS AND METHODS

The samples were analysed for several conventional chemical and microbiological water-quality indicators: TC, FC, E.coli, electrical conductivity, pH, turbidity, colour, COD, nitrate, nitrite, chloride, fluoride, sulphate and bromide, according to SFS-EN ISO standards. DOM (Dissolved Organic Matter) of the wells, secondary wastewater effluents and surface waters was studied by means of DOC (Dissolved Organic Carbon) and HPLSEC (High Performance Liquid Size Exclusion Chromatography) analyses. In addition information about proximity of a potential source of well pollution was collected.

RESULTS AND DISCUSSION

In total 14 wells did not fulfil the potability criteria given by health-based guideline values. The recommended values for several water quality indicators were also exceeded for a large number of wells, 76 (79.2 %) of wells having at least one quality indicator over/under the recommended value (figure 1).

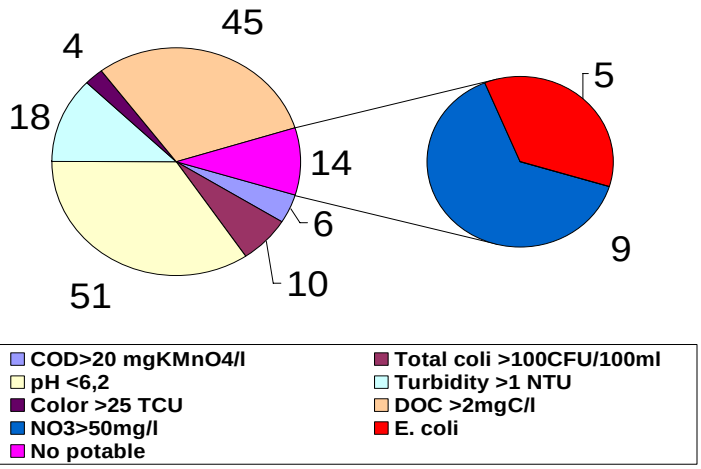

Figure 1. Number of wells with quality indicators over/under guideline and recommended values.

In both deep and shallow wells were cases with DOC >10mg/l, but as expected, the overall DOC was lower in the deep wells. Nitrate concentrations exceeded the mean values measured in Finland, deep wells presented unexpectedly high percent of nitrate contamination (Figure 2).

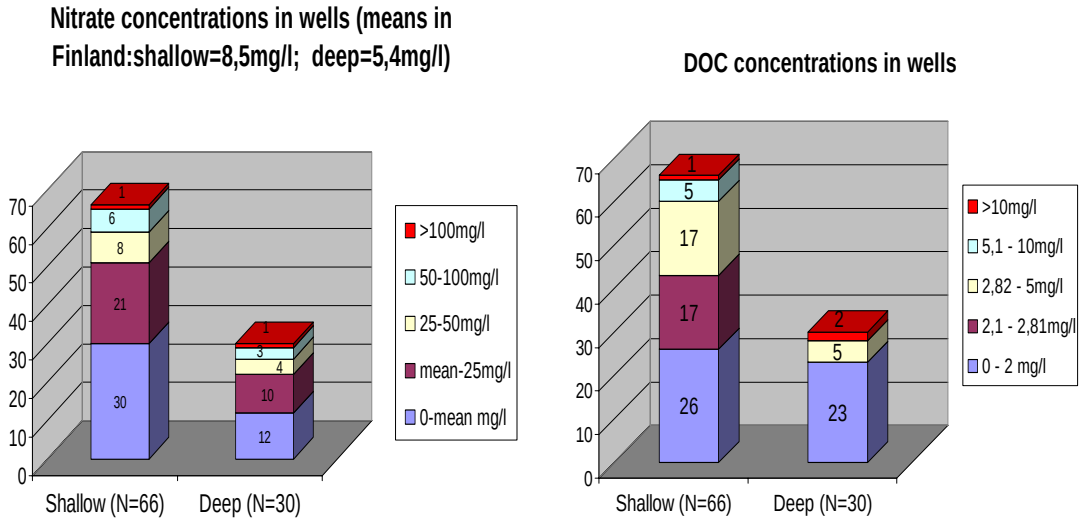

Figure 2. Nitrate and DOC concentration distribution in the wells.

HPLSEC chromatography with TSKgel G3000SW column showed significant differences between surface water and wastewater effluent chromatograms. In the surface water the humic-type HMW (high molecular weight) and IMW (intermediate molecular weight) fractions (I, II, III respectively IV, V) dominate. In the secondary wastewater effluent the non-humic type LMW (low molecular weight) fraction has been found dominating.

The chromatograms of the wells varied from case to case, with clearly distinguishable wastewater- respectively surface water MSD (molecular size distribution) (Figure 3).

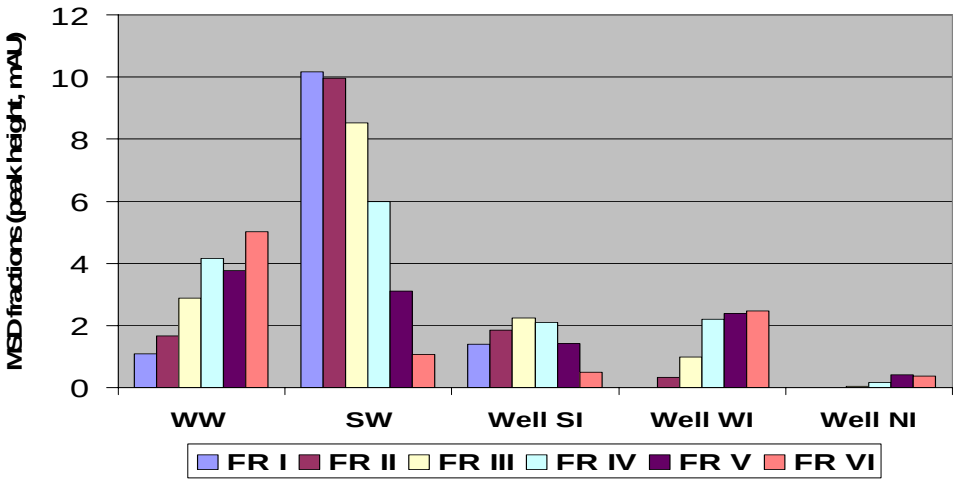

Figure 3. DOM fractions in typical cases.
WW-secondary wastewater effluent; *SW*-surface water; *Well SI* -surface water influenced well; *Well WW* -wastewater influenced well; *Well NI* -no influenced well

On the basis of the HPLSEC data of the wells and their increased DOC (>2mg/l) concentrations 40 shallow and 15 deep wells have been found influenced by leaching. From these, 15 dug and 8 borehole wells presented wastewater type chromatograms, these wells having increased nitrate concentrations (> 25mg/l) also (Figure 4).

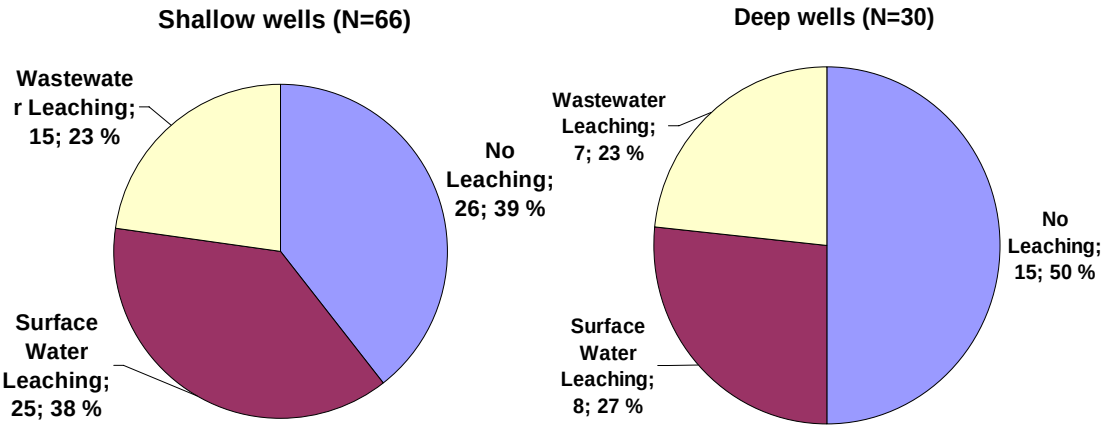

Figure 4. Number of wells under the influence of leaching.

All wastewater influenced wells are situated near to a dairy farm or at distances less than 50 m or downstream to a septic system.

CONCLUSIONS

The wells are most affected by wastewater leaching in the regions with intensive agricultural activities (dairy farms). Shallow and deep wells are both vulnerable to leaching. HPLSEC data can be used to roughly estimate the presence and nature of leaching.

ACKNOWLEDGEMENTS

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