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INFLUENCE OF A FARM INFRASTRUCTURE ON CALCIUM, MAGNESIUM, ZINC, AND IRON IONS CONCENTRATIONS IN WELL WATER

WPŁYW INFRASTRUKTURY ZAGRODY WIEJSKIEJ NA STĘŻENIE JONÓW WAPNIA, MAGNEZU, CYNKU I ŻELAZA W WODACH STUDZIENNYCH

Abstract: Study was carried out in 16 villages localized in Podlasie province. One dug well in agricultural farm was selected in each village. Calcium, magnesium, zinc, and iron ions concentrations were determined in well water samples. Moderate influence of some elements of a farm on calcium and magnesium contents in well water was observed. Study revealed the effect of well distance from inventory buildings on zinc concentrations in analyzed water.

Keywords: dug wells, zinc, farm

There are many sources of underground water contamination, and most often, their negative influence superimpose [1].

Well localization and its sanitary status within the farm as well as proper management of animal wastes determine the water quality in wells [2].

Supplying the underground water with calcium and magnesium is due to elution from geological environment as well as these elements migration from organic fertilizers stored in farms [3]. According to Wolak [4], wrong stored wastes in dumps are considerable source of zinc in underground water. High zinc concentrations are also associated with that metal ore zones and anthropogenic pollution; its significant contents are present in municipal and industrial sewage [5].

Wells of several to dozen meters depth can be most frequently met in farms. Well water is exposed to contamination due to improperly stored animal wastes and runoff from the farm area. Uncontrolled sewage disposal from households is another source of that pollution [6].

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The paper aimed at evaluating the influence of farm elements on calcium, magnesium, zinc and iron ions concentrations in water of selected farm wells within upper Narew river catchment.

Material and methods

Study was carried out in 16 villages localized in Podlasie province. One dug well in agricultural farm was selected in each village. All studied wells are supplied by water from the first water-carrying layer. Water samples from every farm were collected in spring, summer, autumn, and winter 2005. Calcium, magnesium, zinc, and iron concentrations were determined in water samples by means of AAS technique after filtering through microporous filters (d = 0.45 μm). Only soluble forms of the elements were determined. The correctness of applied method referring to Ca, Mg, Zn, and Fe ions contents was verified on a base of reference material (SRM 1643e, Trace Elements in Water) analysis. Also distances of the well from inventory buildings, household, and cultivated fields were measured.

Values of arithmetic mean and Pearson correlation coefficients were calculated using the experimental data. Statistical data was applied clustering analysis for analysis of the study results; it is based on a notion of object or variable distance within multi-dimensional space. That technique makes possible to present grouped objects or their features in a form of bundle diagram. Calculation of Euclidean distance is a direct way to calculate distances between objects. This measure determines a real geometric distance between objects in space and is calculated on a base of raw data. The method presents the similarity between objects or their features, which is a function of a distance. Objects are grouped in arrangements (clusters) with curly bracket combining particular variables. Those variables are more similar to each other when the distance between them is smaller.

Analyses results were the background to the evaluation of water quality taking into account the Decrees from 2000, 2002, and 2004 [7–9].

Results and discussion

According to the Decree (2002), the distance of wells providing with drinking water for people and farm purposes should be at least 15 meters from inventory buildings. The real distances were different in particular studied villages (Table 1). Wells were the worst localized in Fasty, Złotoria, Tykocin, Michałowo, Bokiny, Uhowo and Doktorce. Well in Nowodworce was characterized by the smallest distance from household (1 m), that in Rzędziany was the farthest (30 m). Distances of studied wells from cultivated fields were within the range from 5 m (Tykocin) up to 600 m (Doktorce). Study revealed the lowest calcium content (56.23 mg $\cdot$ dm^{-3}, II class) according to limit values given in the Decree (2004) in water from well localized in Narew, the highest (108.42 mg $\cdot$ dm^{-3}, III class) from well in Rzędziany (Table 1). Calculations revealed a slight dependence of calcium concentration in studied well water on their distance from inventory buildings (Pearson coefficient r = –0.26 at p = 0.0001). The lowest

Table 1

Localization of studied wells and general statistical parameters of well water

Well localization	Statistical parameter	Ca	Mg	Fe	Zn	Well distance from: inventory buildings	household	cultivated field
		[mg · dm^{-3}]				[m]		
Narew	Mean	56.23	20.91	0.031	0.016	19	2	400
	SD	20.21	4.3	0.015	0.009			
Rzędziany	Mean	108.42	28.03	0.024	0.042	14	30	25
	SD	52.1	14.2	0.011	0.021			
Nowodworce	Mean	79.16	20.49	0.023	0.067	13	1	250
	SD	38.31	12.21	0.012	0.031			
Doktorce	Mean	93.55	26.13	0.015	0.287	12	7	600
	SD	41.32	12.56	0.007	0.136			
Zarzeczany	Mean	87.83	26.41	0.014	0.038	16	9	200
	SD	42.12	13.21	0.007	0.016			
Supraśl	Mean	96.11	29.38	0.017	0.023	17	15	150
	SD	46.21	15.12	0.008	0.012			
Siekierki	Mean	78.96	27.61	0.019	0.077	14	11	100
	SD	36.21	13.21	0.011	0.031			
Bokiny	Mean	90.84	29.38	0.015	0.011	11	8	500
	SD	43.12	16.78	0.007	0.006			
Fasty	Mean	106.44	29.45	0.018	0.168	7	6	10
	SD	54.12	15.23	0.009	0.083			

Table 1 contd.

Well localization	Statistical parameter	Ca	Mg	Fe	Zn	Well distance from: inventory buildings	household	cultivated field
		[mg · dm^{-3}]				[m]		
Uhowo	Mean	86.32	26.57	0.018	0.063	11	10	200
	SD	43.23	14.21	0.010	0.031			
Tykocin	Mean	85.67	28.91	0.019	0.093	8	8	5
	SD	42.12	14.27	0.011	0.042			
Mościska	Mean	104.05	23.48	0.022	0.057	15	10	95
	SD	51.21	11.21	0.010	0.021			
Michałowo	Mean	63.91	19.78	0.021	0.116	9	2	9
	SD	31.21	10.24	0.012	0.061			
Ploski	Mean	79.33	25.19	0.019	0.049	16	5	20
	SD	39.62	12.45	0.012	0.024			
Bondary	Mean	83.61	19.95	0.024	0.068	15	15	150
	SD	41.23	10.23	0.011	0.033			
Złotoria	Mean	94.31	27.92	0.019	0.077	7	20	65
	SD	46.32	13.54	0.010	0.032			

magnesium content (19.78 mg · dm^{-3}) was recorded in water from well in Michałowo, the highest (29.45 mg · dm^{-3}) in Fasty. Those values were within the I class of water quality according to the Decree (2004). Decree from 2000 stated that magnesium concentration in studied water was lowest than its permissible level, which was announced in Attachment No. 2. Moderate dependence of magnesium concentration in well water on their distance from inventory buildings was recorded (Pearson coefficient $r = -0.32$ at $p = 0.001$). According to Pokojska and Dopierała [10], manure that can be found in cow-houses and storage dumps within the farm contains 0.36 % of calcium and 0.12 % of magnesium. Previously presented interdependencies confirm these reports. The lowest iron level (0.014 mg · dm^{-3}) was found in water from well in Zarzeczany, the highest (0.031 mg · dm^{-3}) in Narew. These values are within the I class for underground water quality and are lower than 0.2 mg · dm^{-3} – permissible limit for drinking water. Studies and analyses revealed the lowest zinc content (0.011 mg · dm^{-3}) in water from well in Bokiny, and the highest (0.287 mg · dm^{-3}) in Doktorce. Those values are within the I class of underground water purity as well as below permissible limit for drinking water (up to 3 mg · dm^{-3}). Poor dependence of zinc concentration in analyzed water on well distance from inventory buildings occurred at Pearson coefficient $r = -0.46$ and at $p = 0.001$ (Fig. 1). The data clustering analysis (Fig. 2) revealed small Euclidean distance of following variables: well distance from cow-house and zinc concentration in well water. That probably resulted from the influence of pollution containing zinc ions on well water. The analysis is the confirmation of above discussed Pearson's correlations. In Poland, manure and liquid manure cattle main-

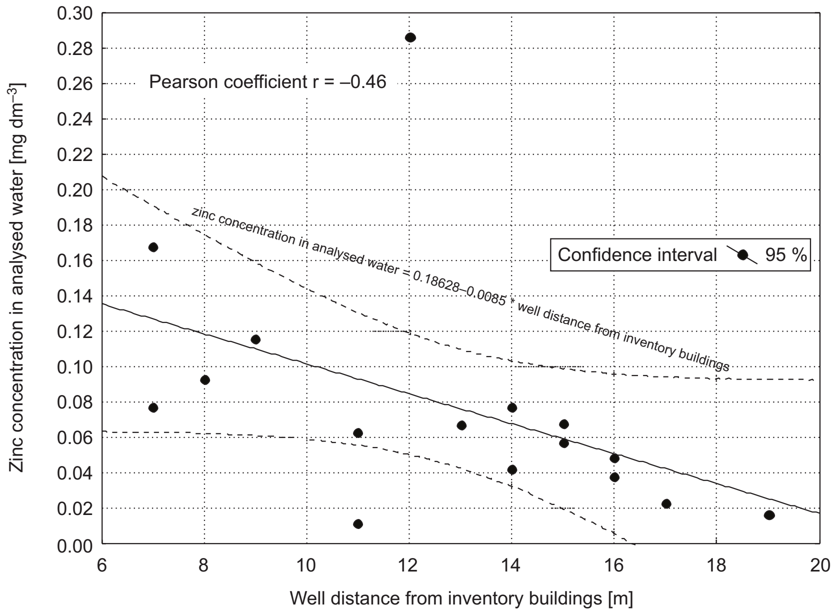

Fig. 1. Dependence of well distance from inventory buildings on zinc concentration in analyzed water

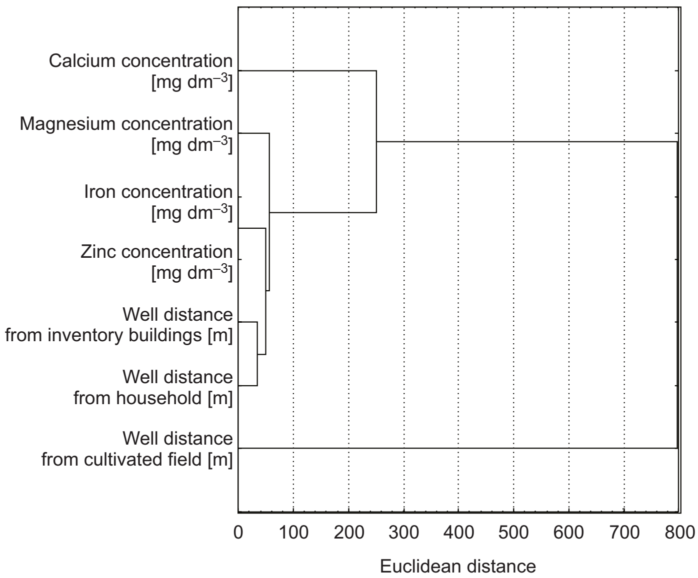

Fig. 2. Euclidean distances between studied parameters

tenance system dominates and the ways of these fertilizers storage favor the water contamination [11]. Durkowski [12] confirmed the influence of manure storage within the farm on well water quality.

Conclusions

1. Moderate influence of some farm elements on calcium and magnesium concentrations in well water was observed.
2. Studies revealed the influence of well distance from the inventory buildings on zinc ions concentrations in analyzed water.
3. In order to make water quality better in studied wells, the improvement of their sanitary status as well as rational water and sewage management within farms is necessary.

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Abstrakt: Badania prowadzono w 16 wsiach położonych w województwie podlaskim. W każdej wsi do badań wybrano po jednej studni kopanej z gospodarstw prowadzących działalność rolniczą. W próbkach wody oznaczono jony wapnia, magnezu, cynku i żelaza. Na podstawie badań stwierdzono umiarkowany wpływ niektórych elementów zagrody wiejskiej na stężenia wapnia i magnezu w wodach studziennych. Badania wykazały wpływ odległości studni od budynku inwentarskiego na stężenie jonów cynku w analizowanych wodach

Słowa kluczowe: studnie kopane, cynk, zagroda wiejska