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# PHOSPHATES IN GROUNDWATER UNDER GRASSLANDS IN POLAND



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# **Background and Objectives**

Phosphorus contained in the soil is therein not very mobile therefore generally poorly leached, and as it is usually believed, it is not a hazard to groundwater quality. However in recent years, phosphorus leaching into the groundwater begins to be seen as an important problem (Forrest et al. 2006), because relatively high concentrations of phosphorus are also registered in such waters (Holman et al. 2010).

Results of studies also indicate that phosphorus from groundwater moves into

The concentration of phosphate phosphorus in water samples was varied, depending on:

- soil category Figure 3;
- form of use grassland Figure 4;
- soil pH Figure 5-6;
- type of monitoring point Figure 7.



watercourses (Domagalski, Johnson 2011), and may affect their ecological status. In this context, some postulates are formulated, that it should be developed the knowledge of the sources and reasons of groundwater pollution by phosphorus and risks posed by this nutrient to groundwater, and through them – to surface water (Holman et al. 2008; Welch, Kingsbury, Coupe 2010).

Potential high probability of groundwater pollution with phosphate exists on agricultural land, especially if they are long term and excessively fertilized with phosphorus (Domagalski, Johnson 2012; Holman et al. 2008).

The aim of this study is to evaluate the phosphate pollution of shallow groundwater occurring under grassland in Poland, in terms of some factors affecting quality this water.

# **Materials and Methods**

The studies conducted in the period 2008–2011. Water samples for analysis are taken twice a year, in spring and autumn from 340-380 (depending on the year and season) monitoring sites located in the areas occupied by grassland in Poland. In these samples phosphate phosphorus concentrations was determined in the laboratory by spectrophotometric method according to Polish Standard PN-EN ISO 6878: 2006.

# **Figure 3**. P-PO<sub>4</sub> concentration in groundwater depending on soil type in 2008-2011





**Figure 4**. P-PO<sub>4</sub> concentration in groundwater depending on form use of grasslands in 2008-2011

**Figure 5**. P-PO<sub>4</sub> concentration in groundwater depending on pH in mineral soils in 2008-2011





#### **Figure 6**. P-PO<sub>4</sub> concentration in groundwater depending

**Figure 7**. P-PO<sub>4</sub> concentration in groundwater depending

#### **Results and Discussion**

The average annual concentration of phosphate phosphorus in groundwater in areas occupied by grassland in Poland in 2008-2010 amounted to 0.19-0.29 mg P-PO<sub>4</sub>·dm<sup>-3</sup> during the spring and 0.28-0.62 mg P-PO<sub>4</sub>·dm<sup>-3</sup> in the autumn – Table 1.

**Table 1**. Descriptive statistics of phosphate-phosphorus concentrations in groundwater in areas

 occupied by grassland in Poland in 2008-2011

| Specification  | Spring |      |      |      |               | Autumn |      |      |      |               |
|--|--------|------|------|------|---------------|--------|------|------|------|---------------|
|  | 2008   | 2009 | 2010 | 2011 | 2008-<br>2011 | 2008   | 2009 | 2010 | 2011 | 2008-<br>2011 |
| Number of samples  | 380    | 376  | 363  | 364  | 1483          | 346    | 360  | 361  | 340  | 1407          |
| The arithmetic mean,<br>mg P-PO <sub>4</sub> -dm <sup>-3</sup> | 0.23   | 0.29 | 0.22 | 0.19 | 0.24          | 0.32   | 0.41 | 0.28 | 0.62 | 0.41          |
| Median,<br>mg P-PO <sub>4</sub> -dm <sup>-3</sup>              | 0.07   | 0.08 | 0.06 | 0.05 | 0.06          | 0.12   | 0.11 | 0.07 | 0.10 | 0.10          |
| Standard deviation,<br>mg P-PO <sub>4</sub> -dm <sup>-3</sup>  | 0.48   | 0.61 | 0.47 | 0.39 | 0.50          | 0.61   | 0.79 | 0.58 | 1.77 | 1.05          |

The quality of groundwater in most monitoring points correspond to the criteria defined for classes I-III groundwater quality due to the concentration of phosphate (from 0 to 0.33 mg  $P-PO_4 \cdot dm^{-3}$ ), i.e. with reference to this indicator were characterized by good chemical status - Figure 1-2.

on pH in organic soils in 2008-2011

on type of water sampling point in 2008-2011

### Conclusions

- In the period 2008-2011 the average annual concentration phosphate phosphorus in groundwater under grassland in Poland, amounted 0.19-0.29 mg·dm<sup>-3</sup> in the spring and 0.28-0.62 mg·dm<sup>-3</sup> in the autumn.
- 2. In each year of the study in autumn period always occurred higher average annual concentrations of  $P-PO_4$  in water samples, compared with the spring.
- 3. In the analyzed period of years, approximately 80-86% and 76-82% of the monitoring points respectively in the spring and autumn season, occurred water meet the requirements from I to III class groundwater quality due to the concentration of phosphate phosphorus.
- 4.  $P-PO_4$  concentration in groundwater was varied depending on the soil category, type of use grassland, type of monitoring point and soil pH.
- 5. Relatively highest average annual concentrations of P-PO<sub>4</sub> occurred in

groundwater associated with soils very light and heavy, from the pastures,



**Figure 1**. Percentage of water samples collected in spring 2008, 2009, 2010 and 2011 in various classes of  $P-PO_4$  content

**Figure 2**. Percentage of water samples collected in autumn 2008, 2009, 2010 and 2011 in various classes of P-PO<sub>4</sub> content

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# in large part also with soil slightly acidic, and waters from drains.

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