INDICATORS FOR UNDERGROUND WATER QUALITY

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INTRODUCTION

In Poland, until 1997, there was no obligation to monitor the composition of waste stored in municipal landfills. Large amounts of hazardous wastes got together with municipal refuses at these landfills. The wastes mainly contain batteries, fluorescent lamps, varnish manufacture's wastes, old drugs and pesticides, and also used oil and lubricants. Nowadays, it is hard to say what kind of compounds (and of which toxicity) will permeate from municipal landfills to underground waters. There is a high probability of negative effects of waste dumps on the quality of underground water, especially those dumped prior to 1990, and especially in the waste dumps that were not closed off watertight.

The main purpose of this study is to compare the chemical quality of the underground waters around one of the oldest and largest municipal landfills of the Pomeranian province (Poland) with the results of ecotoxicological screening (Fig. 1). Ecotoxicological assessment of the examined underground waters was performed on the basis of the classification system of Persoone et a. (Persoone et al., 2003).

Fig.1. *Studied area.*

EXPERIMENTAL

COLLECTION OF UNDERGROUND WATER SAMPLES FOR ANALYSES

Research on the ecotoxicology of underground waters was conducted for a large municipal waste dump in the Pomeranian province (more than 10 thousand Mg of waste are stored there), opened before 1990, and which is not watertight. Piezometers were located at the input of water courses (10), and at the output of water courses (14) around the municipal landfill. Samples of water from piezometers were taken according to the ISO-standard (PN-ISO 5667, 2004; PN-EN ISO 5667, 2004) by a specialised hydrogeological company.

CHEMICAL ANALYSES

The range of the examinations of physical and chemical parameters, accordingly with the Decree of the Minister of the Environment regarding the range, time, method and conditions for monitoring of waste dumps, included pH measurement, specific electrolytic conductance, heavy metal content (Cu, Zn, Pb, Cd, Cr+6, Hg), the polycyclic aromatic hydrocarbons (PAH) sum and total organic compounds (TOC). These examinations were made every three months by accredited analytical laboratories on the basis of standard analytical methods.

TOXICITY TESTS

The toxicity was measured applying the acute toxicity test with bacteria *Vibrio fischeri* (*Microtox®*), crutacea *Daphnia magna* (*Daphtoxkit F^{TM}*), crustacea *Thamnocephalus platyurus* (*Thamnotoxkit F^{TM}*), monocotyledonous plants: *Sorghum saccharatum* and dicotyledonous plants: *Lepidium sativum*, *Sinapis alba*- test *Phytotoxkit F^{TM}* (Table 1).

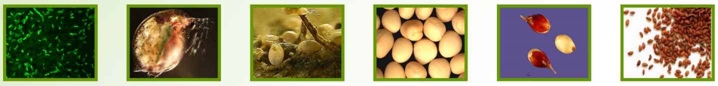


Table 1. *List of biotests used for toxicity measurement of samples.*

ORGANISMS	TYPE OF TESTS	ENDPOINT	TEST DURATION	STANDARD PROCEDURE
Bacteria ***Vibrio fischeri***	*Microtox ®* (Strategic Diagnostics Inc., USA)	bioluminescence inhibition	0.5 h	PN-EN ISO 11348-2(3):2002
Crustacea ***Daphnia magna***	*Daphtoxkit F^{TM} magna* (MicroBioTests Inc., Mariakerke-Gent, Belgium)	mortality	48 h	According to producer's operational procedure
Crustacea *Thamnocephalus platyurus*	*Thamnotoxkit F^{TM}* (MicroBioTests Inc., Mariakerke-Gent, Belgium)	mortality	24 h	
Plants *Sorghum sacharatum, Lepidium sativum, Sinapis alba*	*Phytotoxkit F^{TM}* (MicroBioTests Inc., Mariakerke-Gent, Belgium)	decrease of seed germination; decrease of rooth growth	3 d	

RESULTS AND DISCUSSION

- In our studies, water samples were collected from piezometers from November 2007 till April 2009, with a frequency of four times per year. Piezometers were located at the input water courses (10), and at output water courses (14) around the municipal landfill (Fig. 1). Generally input water was chemically cleaner than output water, but chemical quality of water in each piezometer was fluctuating; the most often exceeded parameter was conductivity and TOC.

- The toxicity was measured applying the acute toxicity test with bacteria *Vibrio fischeri* (*Microtox®*), crutacea *Daphnia magna* (*Daphtoxkit F^{TM}*), crustacea *Thamnocephalus platyurus* (*Thamnotoxkit F^{TM}*), monocotyle-donous plants: *Sorghum saccharatum* and dicotyledonous plants: *Lepidium sativum*, *Sinapis alba*- test *Phytotoxkit F^{TM}*. Water samples were classified according to ecotoxicity classes proposed by Persoone et al. for natural waters. Ecotoxicological quality of samples from each piezometer varied with date of sampling (Fig. 2).

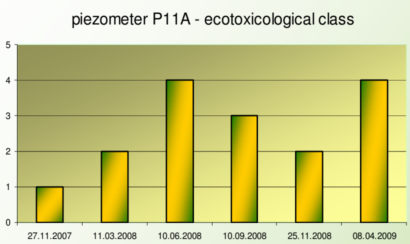


Fig.2. *Variation of ecotoxicological class of water with date of sampling.*

RESULTS AND DISCUSSION- continued

- Only samples collected from piezometer 17A were of bad quality and were classified as class IV. Quality of input water (60 samples) and output water (80 samples) was presented as a percentage contribution of sample in each ecotoxicity class in Fig. 3. From the input waters 46,7 % of the samples belong to class II, while 42,5% samples of output water belong to class IV. These data show that municipal landfill has an influence on the ecological quality of underground water.

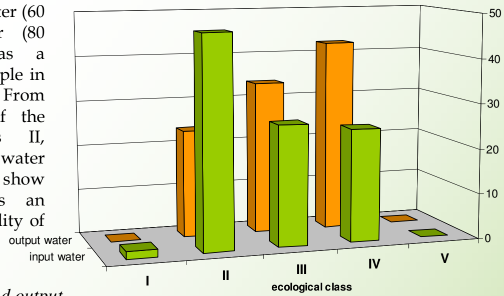
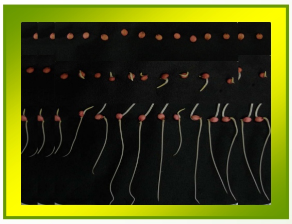


Fig.3. *Quality of input water and output waters presented as a percentage contribution of sample in each ecotoxicity class.*



- Plant tests (phytotests) have given similar results. Because of the simplicity of the manual procedure *Sorghum saccharatum* is recommended as the best test species for this type of assay (Fig. 4.)

Fig.4. *Example of the phytotest with Sorghum sacharatum as an indicator.*

- Sensitivity of the tests decreases in the following order:

Thamnotoxkit > Daphtoxkit > Phytotoxkit = Microtox,

the most sensitive organism was *Thamnocephalus platyurus* (Fig.5)

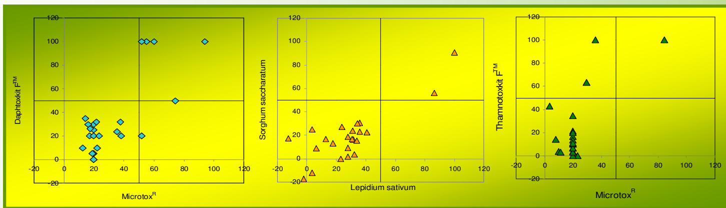


Fig.5. *Comparision of sensitivity of various tests.*

CONCLUSIONS

Comparision of chemical and ecotoxicological quality of water (Fig.6) allows to earmark samples with high toxicity and low chemical concentrations showing that sometimes the monitored chemical parameters do not reveal the potential risk posed by landfills for the environment.

Ecotoxicological methods can therefore be used as a useful and practical screening tools for priori[illegible]mental m[illegible]

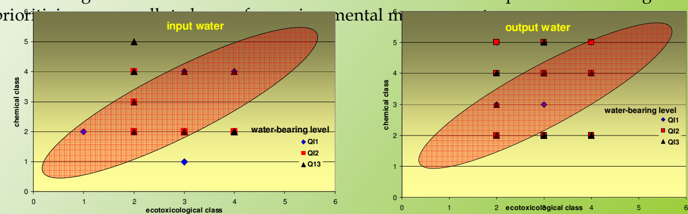


Fig.6. *Comparision of chemical and ecotoxicological quality of undreground water.*

ACKNOWLEDGEMENTS

This study was financially supported by the Polish Committee for Scientific Research.