The potential of the Phytotoxkit microbiotes for toxicity evaluation of sediments in eutr freshwater ecosystems

Izabela Czerniawska-Kusza
Department of Land Protection
University of Opole
Oleska 22, 45-052 Opole, Poland

The study was conducted on sediments collected from the dam reservoir of Turawa (south western Poland). Turawa reservoir was built on the Mała Panew river in 1934 year. For years, it has been subjected to pollution by domestic sewage from surrounding tourist resorts and industrial effluents containing heavy metals. Consequently, in the last decade severe blue-green algal blooms developed during summer seasons, among others.

The objective of the present work was to assess:

- the contamination of sediments in the eutrophic dam of Turawa
- the potential phytotoxic effects of contaminated (heavy metal-rich) sediments

The study provides an assessment of phytotoxicity using the Phytotoxkit microbiotest and different methods of a sample treatment.

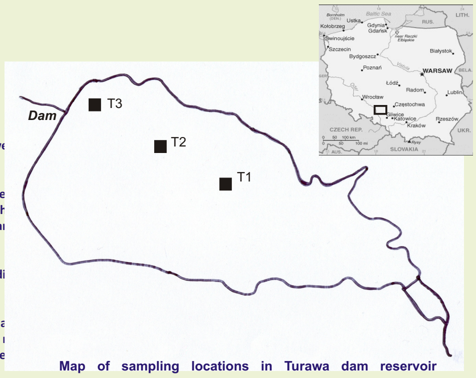
Materials and methods

Sediment samples were collected from three stations (T1-T3), which we selected to reflect various degree of contamination.

Physico-chemical analysis included basic properties of sediments (grain-size composition, pH, EC, organic carbon and potassium content) as well as h metal (Cd, Cr, Cu, Ni, Mn, Pb, Zn) content both in dried sediments ar water. The analyses were performed according to Polish Standards.

Evaluation of sediment phytotoxicity was based on germination and seedi growth of three vascular plants: sorghum *Sorghum saccharatum*, mustard *Sinapis alba*, and garden cress *Lepidium sativum*. Both end points of the analysis were combined in a germination index (GI), according to the equa GI=(GsLs)/(GcLc), where Gs and Ls are seed germination (%) and r elongation (mm) for the sample; Gc and Lc the corresponding control value

Phytotoxkit microbiotest was performed on:
(1) whole fresh sediments, only after decantation of overlying water
(2) solid phases of sediments, after centrifugation and drying
(3) liquid phases of sediments (sediment pore water)



Map of sampling locations in Turawa dam reservoir

Germination index (GI) values (% of control) and effects of plant rea

Whole fresh sediments

Plant	T1	T2	T3
Sorghum saccharatum	127.0	179.9	175.6
Sinapis alba	103.8	95.7	153.8
Lepidium sativum	45.7	69.7	55.6

Solid phases of sediments

Plant	T1	T2	T3
Sorghum saccharatum	83.6	85.0	120.0
Sinapis alba	176.2	205.2	186.6
Lepidium sativum	123.8	153.9	225.6

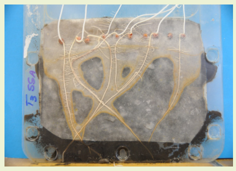
Liquid phases of sediments

Plant	T1	T2	T3
Sorghum saccharatum	123.5	95.4	95.0
Sinapis alba	113.2	107.6	114.5
Lepidium sativum	110.8	93.7	101.0

no effect — inhibition — stimulation

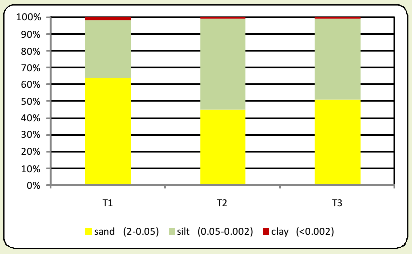
Adverse effects obtained after plant exposure to the whole fresh sediments


Lepidium sativum - growth inhibition

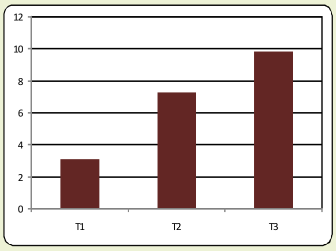

Sorghum saccharatum - growth stimulation

Basic physical and chemical properties of sediments in the collected samples

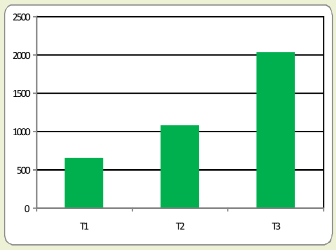
Granulometric composition of sediments
Percentage of particular grain fractions



Organic carbon content in sediments (%)



Potassium content in sediments (mg kg^{-1} dry mass)



Sampling sites	pH H_2O	pH KCl	EC (mScm^{-1})
T1	6.27	6.07	0.768
T2	6.21	6.04	0.991
T3	6.36	6.20	1.149

Heavy metals in sediments from Turawa reservoir (mg kg^{-1} dry mass)

Sampling sites	Cd	Cr	Cu	Mn	Ni	Pb	Zn
T1	60.56	18.32	38.77	326.60	18.37	131.47	1338.0
T2	168.00	25.95	80.00	540.50	26.00	215.75	2920.6
T3	279.86	36.75	105.06	940.30	36.61	312.19	4772.0
Heavy metals in pore water [mg dm^{-3}]							
T1-T3	<0.001	<0.008	<0.002	<0.004	0.02-0.03	<0.003-0.03	0.044-0.097

Results of the physico-chemical analysis

Sediment samples differed in their chemical composition. The content of organic carbon, potassium, and heavy metals increased towards the dam (from site T1 to T3).

Though dried sediments were metal-rich, the concentration of heavy metals in sediment pore water was extremely low in th samples. The same rule applies to the potassium content, which ranged in pore water from 5.53 to 6.41 mg dm^{-3} (common ar waters).

Results of the phytotoxicity analysis

Due to chemical composition of pore water, no effect was observed in the majority of tested seeds. Both the germination rate were not different from the controls.

Tests with sediments resulted in GIs significantly different from the controls. Both beneficial and harmful effects were obtained, the sediment treatment (fresh vs dried). However surprisingly, monocotyledonous (*S. saccharatum*) and dicotyledonous (*S. alba* and *L. sativum*) plants responded adversely to the applied sediments.

General remarks and conclusions

Differences in sediment characteristics can be very important modifiers of bioavailability/ toxicity of contaminants. The results sugg beneficial effects may overrun harmful ones, such as toxicity of heavy metals, when sediments are nutrient-rich (potassium being for root growth) and in the neutral pH conditions. In the acidified conditions (sediments with pore water of pH 5.85), heavy met in water suppressed plant growth, with the exception of *S. saccharatum.*

The three plant species responded differently to contaminated sediments, in both analyzed variants, which may result from their mechanisms for adaptation to stress factors. Thus, the probability that one of the species used in the Phytotoxkit microbiotest wi onmental pollution, changeable in its toxic nature, is very high.