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The utilization of bottom sediments to improve soil fertility

KRAKOW 2015

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Introduction

Problems

degradation soil properties

silting of water reservoirs

The sediment does not pose a hazard for the environment, the environmentally justified method of such sediment management is their use as structure and soil forming material on soilless grounds and wastelands.

Location

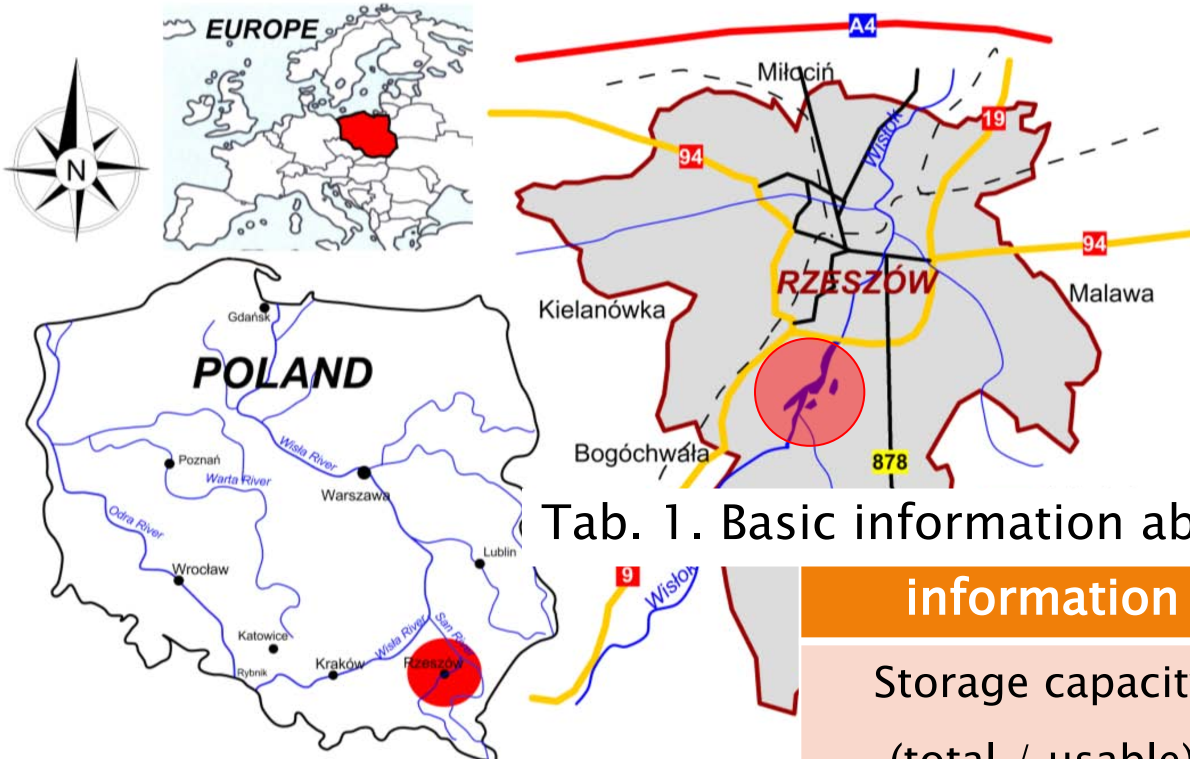


Fig. 1. Localization of the Rzeszów

Tab. 1. Basic information about the Rzeszów reservoir

information	value
Storage capacity (total / usable)	1.80 / 0.66 mln m^3
Year of completion	1973
Reservoir length	6.74 km
Water table area	68.2 ha
Mean depth	2.64 m
River	the Wislok , the Strug

Silting

Tab. 2. Capacity of Rzeszów reservoir over the years

Storage level	1974	1986	1994
Normal Storage Level 199,50 m n.p.m.	1,79 mln m^3	1,2 mln m^3	1,36 mln m^3
Min Sorage Level 198,50 m n.p.m.	1,14 mln m^3	no data	0,60 mln m^3

Silting

Aim of study

The aim of the study was to assess the effect of bottom sediments on the selected properties of the light soil and the chemical composition of the plants test.

Material and methods

Tab. 3. Characteristics of selected sediments and soil properties

Materials	Granulometric composition	pH	C	N	P_2O_5	K_2O
		KCl	$g \bullet kg^{-1}$		$mg \bullet kg^{-1}$	
Sediment	clay	7.1 ±0.2	23.5 ±5.3	2.3 ±0.5	144 ± 25	212 ±12
Soil	loamy sand	5.0	16	1.2	70.4	112

Tab. 4. Concentration of heavy metals in bottom sediment and soil

Materials	Zn	Cu	Ni	Cr	Pb	Cd
	$mg \bullet kg^{-1}$					
Sediment	107 ±18	21 ±4	33 ±6	35 ±5	19 ±2	4.5 ±0.3
Soil	50	31	13	15	10	0.44

Tab. 5. Concentration of elements in bottom sediment

Bottom sediment	K	Ca	Mg	Na	P	Fe
	$g \bullet kg^{-1}$ s.m.					
Mean	3.8 ±0.7	19.5 ±3	5.4 ±0.6	0.74 ±0.03	0.86 ±0.1	18.5 ±2

Material and methods

Tab. 6. Pot experiment scheme

Soil	sediement
% share	
100	0
95	5
90	10
70	30
50	50

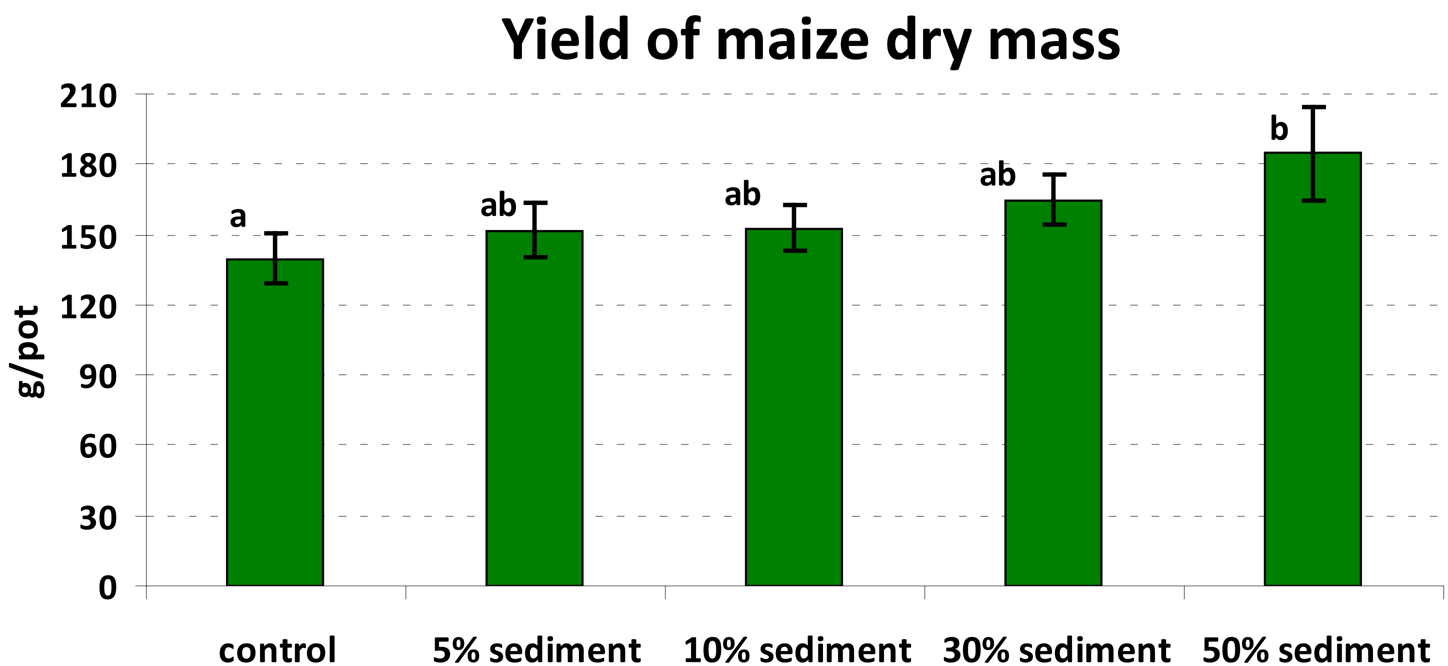
Vegetation period – 86 days

Tab. 7. Analysis after harvesting the plants

Soil Properties	Plants
pH_{KCl}, C organic	Yield
Cation exchange capacity	Macroelements,
Zn, Cu, Ni, Pb, Cd	Zn, Cu, Ni, Pb, Cd

The obtained results were verified statistically using the one-way ANOVA at significance level α=0.05, by means of Statistica 10 programme.

Results



Treatment	Shoots	Roots
	g • pot^{-1}	
Control	118.5 a	21.0 a
5% sediment	128.0 ab	23.7 a
10% sediment	125.5 ab	27.0 a
30% sediment	133.5 b	31.2 ab
50% sediment	144.8 c	39.8 b

*homogenous groups ac[illegible] to Tukey test, α < 0,05, n.i. – statistically insignificant

Results

Tab. 8 and 9. Content of macroelements and trace elements in maize (shoots)

Treatment	K	P	Ca	Mg	N
	g • kg^{-1}				
Control	17.4 b	1.9 b	2.5 a	1.5 a	10.7 ab
5% sediement	16.8 ab	1.6 ab	2.8 a	1.9 ab	11.5 b
10% sediement	16.9 ab	1.4 a	3.6 b	2.1 b	11.9 b
30% sediement	14.6 a	1.3 a	3.8 b	2.6 c	4.4 a
50% sediement	15.0 a	1.1 a	3.8 b	3.0 d	4.7 a

Treatment	Zn	Cu	Ni	Pb	Cd
	mg • kg^{-1}				
Control	48.6c	1.67a	0.96	0.52b	0.31c
5% sediement	36.8b	1.87a	0.89	0.56b	0.13b
10% sediement	32.3ab	1.91a	0.95	0.53b	0.09ab
30% sediement	29.9ab	2.91b	0.75	0.29a	0.08ab
50% sediement	25.8a	3.01b	1.02	0.33a	0.07a

***homogenous groups [illegible]ding to Tukey test, α < 0,05, n.i. – statistically insignificant**

Results

Tab. 10 and 11. Soil properties after pot experiment

Treatment	pH KCl	H mmol (+)/kg	C org. g/kg	N g/kg
Control	4,72 a	22.5 b	8.88	0.72
5% sediement	6.42 b	11.2 ab	9.29	0.83
10% sediement	7.02 c	10.3 ab	10.86	0.92
30% sediement	7,18 cd	6.5 a	14.12	1.08
50% sediement	7,31 d	6.7 a	10.89	0.93

Treatment	Zn	Cu	Ni	Pb	Cd
	mg • kg⁻¹ (1 mol HCl • dm⁻¹)				
Control	13.9 a	1.42 a	0.89 a	14.3 b	1.33 b
5% sediement	14.7 ab	1.32 a	1.29 ab	13.1 ab	0.62 a
10% sediement	16.6 b	1.75 a	1.18 ab	12.9 ab	0.55 a
30% sediement	19.8 c	3.78 b	2.30 bc	12.3 a	0.50 a
50% sediement	24.5 d	6.58 c	3.62 c	12.2 a	0.48 a

*homogenous groups according to Tukey test, α < 0,05, n.i. – statistically insignificant

Conclusions

1. Bottom sediment added to light soil had a positive effect on maize biomass yield.

2. Plant biomass did not meet the criteria for fodder with respect to quality because of too small contents of macroelements. While using bottom sediment for plant cultivation one should apply supplementary mineral fertilization because of the sediment low concentrations of phosphorus and potassium.

3. The experiment demonstrated that the applied bottom deposit supplement positively affected improvement of the analyzed soil (pH, content of C – org. and N) and decreased available content of elements toxic for plants, i.e. lead and cadmium.

4. An applied bottom deposit revealed in its composition a considerable share of clay fractions, alkaline reaction and low total heavy metal content, therefore it may be applied as an admixture to light soils to improve their productivity.

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