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HEAVY METAL AND CONTAMINANT LOADING IN THE ODER RIVER FLOODPLAINS AND CONSEQUENCES FOR LIVESTOCK MANAGEMENT

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Abstract

The predominately pristine lower Oder floodplains have experienced sedimentation and enrichment of heavy metals and contaminants since the start of industrialization in the region. With the creation of the German-Polish National Park, which included the flooded grassland area, intensive milk production has been prohibited. The objective of this research was to estimate the impact of the floodplain heavy metal and contaminant levels on the lower Oder region. Soil and plant content were analyzed for three transects according to accepted DIN methods. High content in soil did not consistently result in high plant contents; however, higher content levels were often observed in hollows. A particular vegetation characteristic of heavy metal soil content was not observed. Exceeded levels in terms of the German fodder ordinance were most frequently detected for Cadmium and Manganese. Extensive pasturing of suckler cows and young or beef cattle is possible with the exception of problem areas.

Keywords: floodplains, floodet grassland, sedimentation, matter accumulation, heavy metals, and fodder quality

Introduction

The lower Oder River valley located on the border between Germany and Poland is known as one of the few nearly pristine floodplain landscapes remaining in central Europe. During high water levels of the Oder River, the original two to three kilometer wide river valleys are available as an overflow area. With lower Oder water levels in the summer, the riverbank acts as a dam protecting the grassland vegetation from moderate water level variations. During the six month winter period, the total floodplain area spanning a distance of 60 kilometers is flooded and may also be used as a retention area during extremely high water events in the summer. Flooding of the Oder polder has resulted in significant sedimentation and higher levels of heavy metals and contaminants in the clay floodplain soil since the start of industrialization. After the political reunification of Germany, the area, more than 10,000 ha, was temporarily placed under protection, and since 1995 designated as a German-Polish National Park. Nature protection of the area is now also enforced by land use regulations in which fifty percent of the National Park must be designated as a total reservation.

Material and Methods

Initial investigations from 1990 demonstrated a differentiated contamination of the topsoil. In order to determine the pattern of pollution, in 1997, three transects for investigation were laid in an east-west direction through the area (north, central, south). Forty-five soil investigation measurements were taken at three testing depths. Soil profile borings to 1,20 m revealed the relief and the sequence of soil layers. Altitude measurements were conducted using GPS. The determination of the soil physical and chemical parameters was carried out according to the corresponding DIN norms.

The locations of the soil sampling were additionally categorized according to plant

communities (System BRAUN-BLANQUET).

Next, the plant substance was analyzed of the corresponding mixed samples and of single species for all the components important for determining the quality of fodder, including heavy metals.

Results and Discussion

Compared to other locations, the Oder floodplain soil had clearly higher heavy metal concentrations, predominately for Zinc, Cadmium, Arsenic, Lead and Copper. Most noticeable is the enrichment of manganese that will be mobilized in substantial amount in the Oder River system. The highest concentrations were detected in particular for the upper soil layer, 2-10 cm; this was also observed for polyaromatic hydrocarbons and phenol. Greater accumulations were observed in hollows, and lower concentrations at higher elevated locations (HÖHN, HIEROLD and SCHALITZ, 1998). It was shown that increased soil contents of heavy metals, micro and macroelements must not inevitably coincide with a high content in plants.A high transformation potential was most apparent for the elements Cd, Mn, Zn, Fe, but also Na and Ca. The elements Pb, P and K are prevalent in soil; however, do not result in exceeded levels in the plants (Tab.1).

The plant communities on the investigation areas were:

- *Alopecuretum pratensis* (Regel 25)	Summer groundwater level 50-90 cm
- *Phalaridetum arundinacea* (Koch 26, Libbert 31)	Summer groundwater level 15-50 cm

They were found in different forms dependent on altitude and groundwater level. Small-area depression vegetation (*Ranunculo-Aloperuretum geniculati* (Tx. 27) was also found. A particular vegetation characteristic of the heavy metal or contaminant condition, such as in the degraded mining areas, was not determined.

Cadmium as an easily mobile element may not exceed 1 mg kg^{-1} in the dry fodder. High content in the plants was most significantly observed in the vegetation in the depressions (nr. 13 B *Polygonum amphibium*, nr. 16 *Glyceria fluitans*/*Polygonum amphibium*).

To some degree, very high **Manganese** contents, which clearly exceeded the German fodder ordinance, were observed. The exceeded contents were predominately found in the more moist locations (nr. 4, 13, 16). The contents were particularly high after the summer flooding. After the extreme @one hundred-year@ flooding incidence from 15.07 B 02.09.1997, higher contents of Se, Zn, and Fe were also measured in individual plants. In the first regeneration phase of the grassland sward, the share of the contaminant-accumulating plant, *Polygonum amphibium*, was extremely high. The indication of the contamination potential for the area, and in particular, the low-lying areas near the Oder, justified the designation of the total reserve areas as well as the exclusion of pasturing in areas determined to be detrimental to the animal health.

On account of the rapid matter transformation in the plant-animal system it was useful, after the changes in the agricultural policies (1990) to conclude the milk production in the floodplain polder of the Oder. Low-lying areas and hollows should be excluded in future plans for suckler cows and beef cattle grazing. Fodder grown after the summer flooding should generally not be used for animals due the dirty condition and contaminant enrichment.

References

Höhn, A., Hierold W., and Schalitz G. (1998). Regionale Kennzeichnung und Bewertung der Schadstoffbelastung von Überschwemmungsgebieten zur Landnutzungsplanung am Beispiel des Nationalparks AUnteres Odertal@. Report ZALF Müncheberg and State Environmental Office Brandenburg, 112 P.

Table 1 - Content of heavy metals and micro-elements in the plant matter, Transect II (central folder).

Transect II Nr.	ppm As	ppm Se	ppb Mo	ppm B	ppb Cr	ppm Zn	ppm Pb	ppb Co	ppb Cd	ppb Ni	ppm Mn	ppm Fe	ppm Cu	ppm Al	ppm Sr	ppb Li
a) 1. Growth 06.06.1997																
West 1	< 2	< 2	415	4,63	84	17,69	1,18	< 10	< 10	527	25,6	58,7	5,17	11,29	14,13	221
2	< 2	< 2	40	4,16	21	70,69	4,69	163	113	1316	192,0	55,7	5,67	< 2	16,27	331
3	< 2	< 2	36	5,24	4	72,71	1,52	58	58	1224	189,6	60,1	5,52	< 2	26,37	460
4	< 2	< 2	227	7,74	69	38,77	3,45	449	59	1247	518,7	256,9	3,95	14,87	29,16	1597
3 km 5	< 2	< 2	182	6,63	< 5	26,16	1,24	308	< 10	606	415,3	147,9	4,30	5,63	24,11	1121
6	< 2	< 2	499	6,44	89	54,39	2,88	53	225	1533	55,0	93,6	8,01	42,87	17,08	493
7	< 2	< 2	250	10,92	147	88,55	1,66	1019	241	1668	1205	308,0	8,18	71,96	34,29	15173
9	< 2	< 2	264	6,59	39	31,19	2,20	35	27	753	45,6	50,3	6,59	< 2	19,21	214
13	< 2	< 2	451	24,53	2439	183,08	3,75	2840	722	5183	1132,1	2602	9,54	822,91	36,33	2708
14	< 2	< 2	150	5,57	659	128,93	1,71	216	295	2720	131,0	341,0	9,18	236,21	25,16	701
16	< 2	< 2	499	6,01	1160	62,14	2,96	1911	1067	1480	1825,6	1365	6,14	436,61	39,17	1988
East 17 (near Oder)	< 2	< 2	171	4,63	58	52,07	0,54	136	36	570	370,9	79,7	5,38	< 2	23,06	909
uper limit green fodder (DM)	2 (4)*	0,5 (1,5)	2500			250	40	10000	1000		250	1250	30			
b) Growth after flooding (Individual species) 13.11.1997																
Polygonum amphibium	1,61	1,89	240	28,59	1180	127,7	3,15	1200	400	4490	1617	1515	10,20	563,4	54,82	2250
Potentilla reptans	3,93	4,35	610	26,73	1200	286,0	4,63	4680	730	12960	5946	1950	8,46	530,7	73,40	2400
Rorippa amphibia	1,87	2,13	330	23,73	670	338,0	3,35	1550	1110	6490	1692	1140	8,84	548,8	87,40	3560
Alopecurus geniculatus	2,66	2,58	440	6,25	2660	201,4	7,50	2770	550	9490	3558	2372	12,84	1101,9	27,02	3270
Agropyron repens	1,28	2,54	670	7,35	470	72,6	2,03	70	160	2350	366	384	13,00	189,5	22,04	470

*folder content may be 2,5x greater for non-commercial uses.