

PHYTOREMEDIATION AND WETLAND HABITAT DEVELOPMENT ON A CONTAMINATED SEWAGE SLUDGE DEPOSIT – PRACTICAL EXPERIENCES

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BioPlanta – Competence in Environmental Engineering

- A leader in the application of plant biotechnology for environmental remediation
- Successful phytoremediation projects since 14 years

- Habitat development
- Environmental assessment
- Landscape planning
- Biological remediation of water and soil



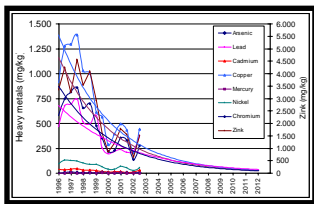
PHYTOREMEDIATION AND WETLAND HABITAT DEVELOPMENT



- Site Description



- Phytoremediation Strategy



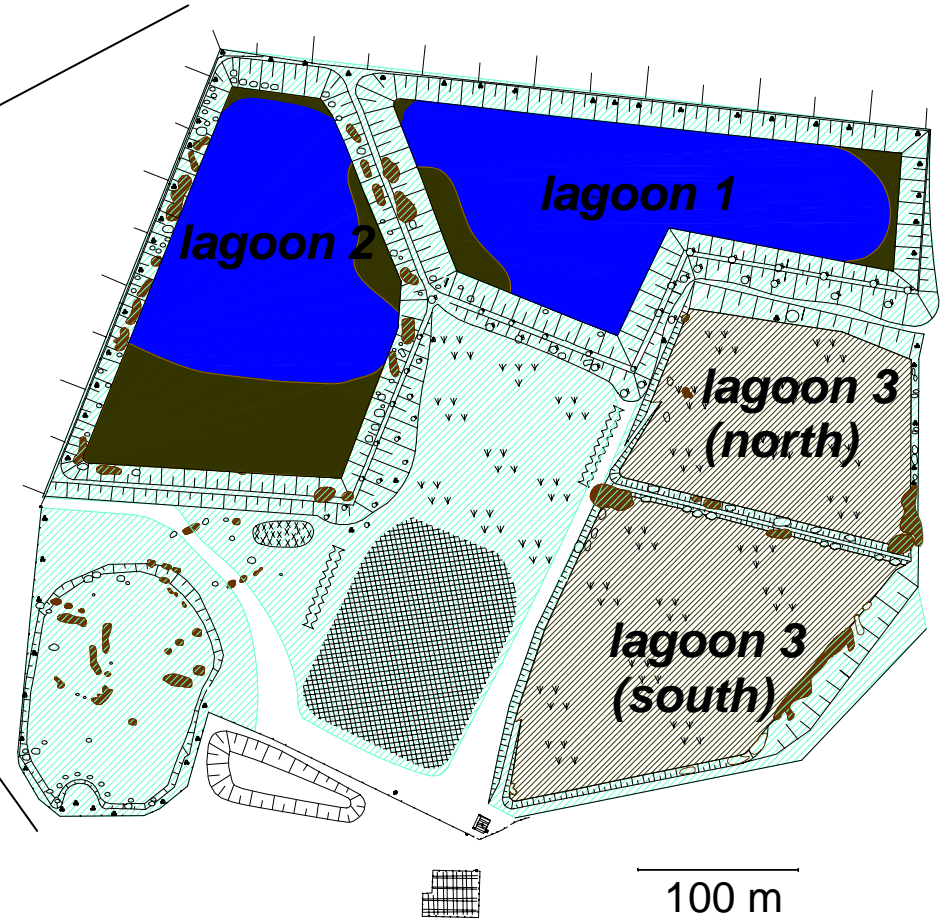
- Remediation Results



- Landscape and Development



The Site: A Former Sludge Deposit





History of the Sludge Deposit

- Since 1955 sludge from the central wastewater treatment plant of Leipzig was pumped to lagoons on the site
- In the 1960s, because of capacity problems, an unlined gravel pit was used to store additional sludge (lagoon 3, the most contaminated part of the site)
- Two additional lagoons (now called 1 and 2) were built in the 1980s
- The sludge dewatering plant was closed in 1990
- At the time of closure, about 300,000 m³ sludge were stored on the site
 - Water content 40 - 60 %
 - Contamination with heavy metals, phenols and hydrocarbons



Contamination at the Beginning of Remediation

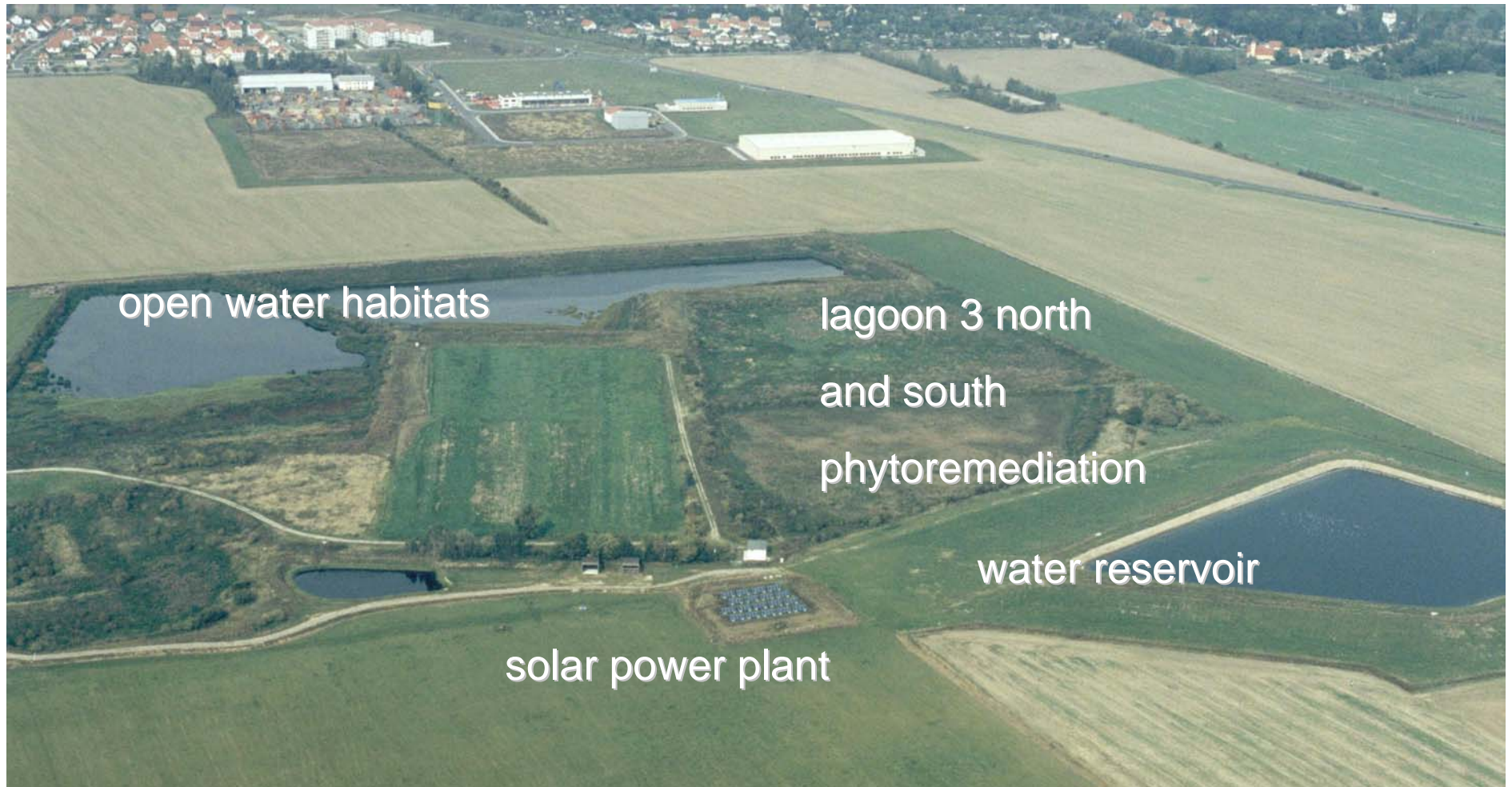
- Contamination of the sludge with lead, cadmium, zinc, copper and chromium, nickel and mercury exceeds the threshold values
- In some samples elevated levels of phenolics and nitrite were found
- All samples show very high phosphate-concentrations

Contaminant	Target values	lagoon 3 south
	ppm	ppm
Lead	150	580
Cadmium	5	31
Chromium	250	590
Nickel	100	47
Mercury	2	3
Copper	100	1000
Zinc	500	3,200
Phenolic index	1	2

Values presented are from 1993



Aerial View



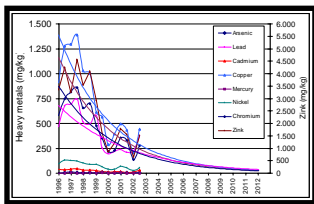
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Objectives of the Remediation

- Prevention of contaminant transfer into the groundwater
- Reduction of the contaminant concentrations below threshold values
- Preservation of the habitat structure (resting area for wetland birds)
 - Open water areas, shallow banks
 - Integration of the remediation plants into the habitat
 - Use of local plants



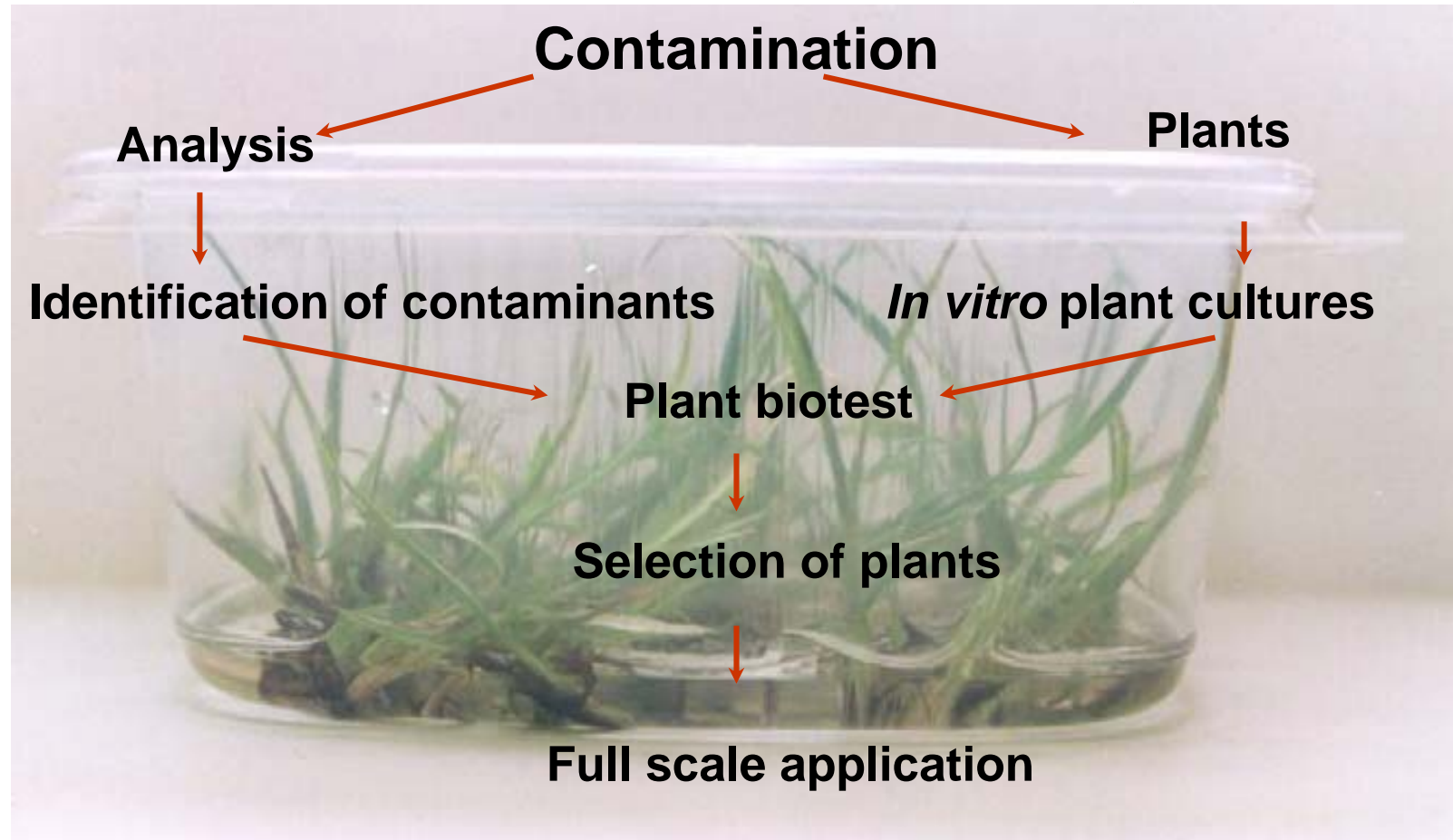


Timeline of Remediation Operations

1989-1990	Recognition of the problem, first ideas to use plants for remediation
1992	BioPlanta was contracted to develop and accompany the phytoremediation
1993-1995	Development of methods, deconstruction of technical installations
1993-1994	Plant development in the BioPlanta laboratory
1995	Start of the phytoremediation by propagation of plants and application on site
2012	Planned end of active remediation



Development of a site-specific technology

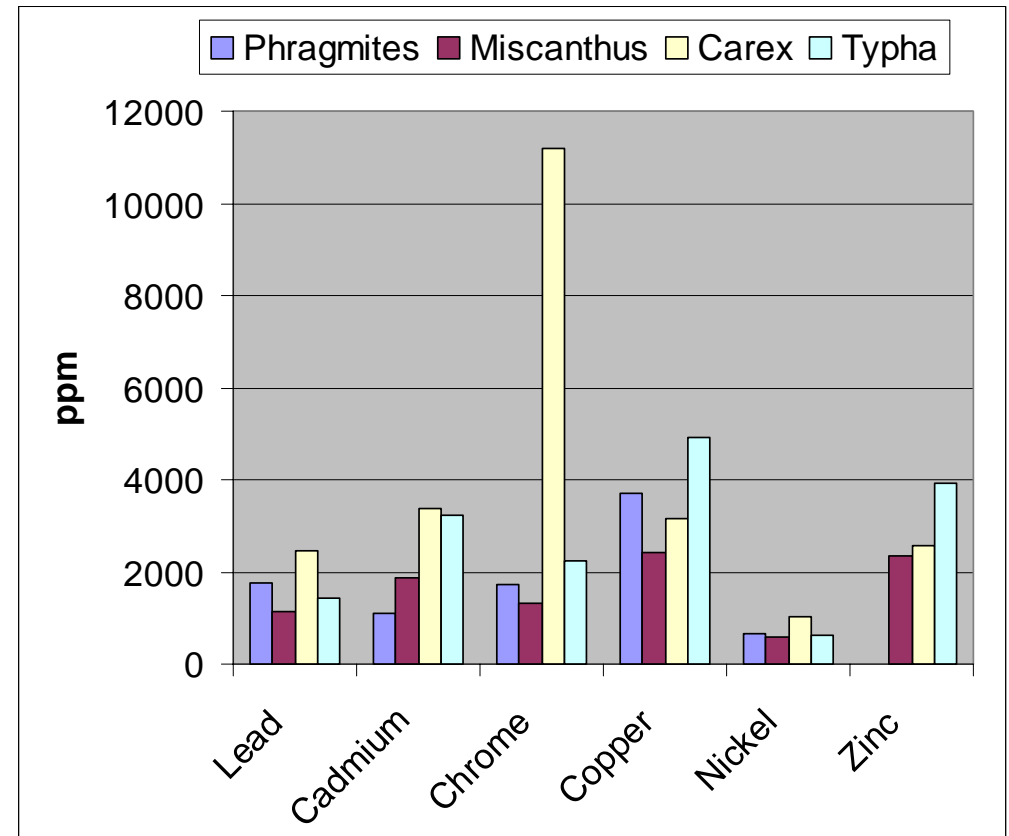




In vitro Experiments

Maximum of metal accumulation in plant biomass *in vitro* for *Miscanthus sinensis*, *Phragmites communis*, *Carex disticha*, *Typha latifolia* after 8 weeks

Metal	Phragmites	Miscanthus	Carex	Typha
	Concentration ppm			
Lead	1770	1130	2470	1420
Cadmium	1101	1878	3387	3244
Chrome	1720	1326	11190	2246
Copper	3705	2422	3167	4916
Nickel	643	602	1034	631
Zinc		2355	2553	3924





Full-Scale Remediation: Methods

- A technology for the biological capping of large sludge deposits was developed by BioPlanta.
- Optimized plants are precultivated on coconut fibre mats. A proprietary technology is used to apply the mats onto sludge areas, that are not accessible to people or machines.
- Comparing different remediation options, phytostabilisation combined with an *in situ* phytodecontamination turned out to be the economically and ecologically favorable solution.
- The planted reed is harvested every winter to remove extracted metals.



Phytoremediation in Lagoon 3 south: Reed





Phytoremediation in Lagoon 3 north: Willows



Salix spp. were planted in the northern part of lagoon 3 in 2002

Outlook on growth and harvest



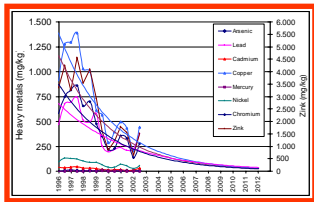
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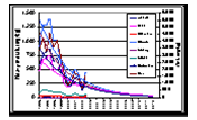
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Phytoremediation in Lagoon 3 south: Reed

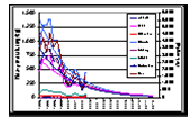


Reed planting



Harvesting

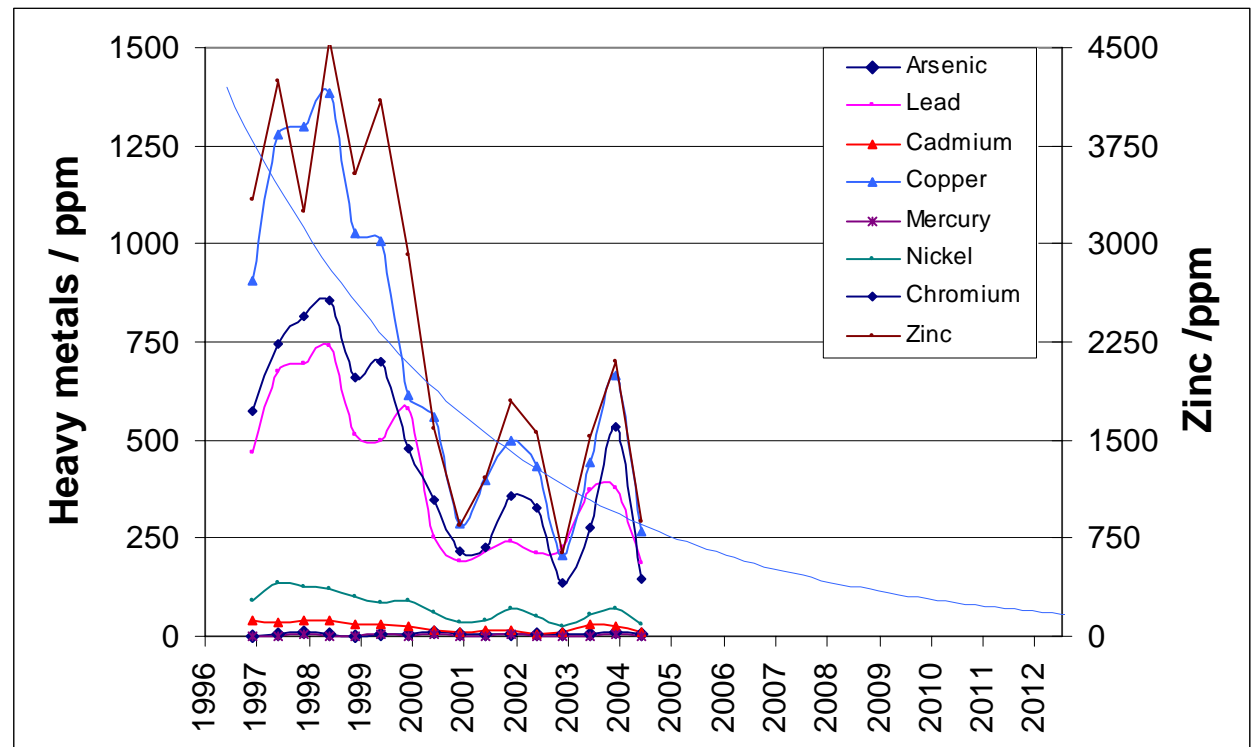
year	yield in tons	dry matter
1996	12	4
1997	12	10
1998	16	11
1999	18	15
2000	32	18
2001	29	20
2002	36	24
2003	79	51
2004	62	(~ 40)

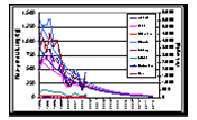


Phytoremediation in Lagoon 3 south: Reed

Until Dec. 2003 these amounts of heavy metals have been removed

Lead	140 g
Cadmium	79 g
Chromium	158 g
Copper	1,401 g
Nickel	215 g
Zinc	34,674 g

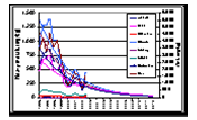




Current Contaminant Situation

- Contaminant concentrations are continuously decreasing
- Threshold values will be reached by 2012
- Legal restrictions
 - no fishery, bathing, usage as drinking or irrigation water
 - no agricultural use in the core zone
 - only partial, supervised public accessibility





Summary of Remediation Results

- The selected remediation strategy (capping to prevent erosion, contaminant removal and water management by plants), is successful on a large scale.
- The target values are almost reached.
- The biomass yield is increasing with decreasing contamination
- Extensive watering is necessary to maintain the reed vegetation
- The establishment of willow species was difficult, a high percentage of plants died, growth was slow
- Different woody species have to be tested

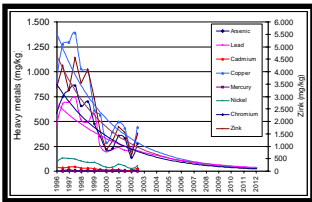
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Impression of the “Phytoremediation-Landscape”





Continuing Remediation until 2012

- Remediation has priority over aesthetic aspects
- Management of the existing remediation cultures
- Plantation of additional cultures, e.g. poplars
- Improved analytical monitoring, adjustment of the analytical parameters
- Research into new methods of phytoremediation





Landscape Development until 2012

- Continuation of the water regime
- Biological covering of additional areas
 - erosion protection, minimization of seepage
 - improvement of soil function (enrichment in humics, improved water holding capacity, buffering of soil reaction, improved sorption capacity)
 - inhibition of soil acidification by liming
- Involvement of nature conservation associations in the monitoring and development of the habitat





Environment-Compatible Utilization after 2012

- Nature preserve
 - Place for environmental studies and projects in environmental education
 - Construction of a classroom and lab building
 - Public tours and projects in cooperation with non-profit organizations
- > A powerful PR-instrument in communicating the environmental commitment of the owner





Thank you for your attention.