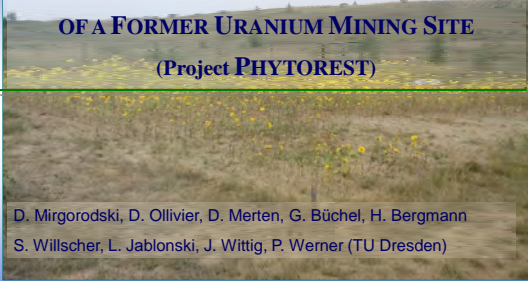





## PHYTOREMEDIATION EXPERIMENTS ON A SLIGHTLY CONTAMINATED TEST FIELD OF A FORMER URANIUM MINING SITE (Project PHYTOREST)



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### 1. Problem

- **Problem:** Radionuclides and heavy metals (anthropogenic) in the soil in low, but environmental and ecotoxicological relevant concentrations
- Larger areas are contaminated, so that alternatives of site remediation are not cost-efficient and ecologically reasonable



Example: Former U mining area around Ronneburg

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### Remediation of large, low to medium heavy metal contaminated sites




→ Common solution strategies:

1. Set-aside of the land (problem in small countries)
2. Large-scale covering (expensive)
3. Application of immobilizing chemicals (expensive)

↪ No removal contaminants, possible problems with mobility

Alternative method:

→ **Phytoremediation** as emerging and sustainable technology for low contaminated sites

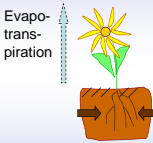
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### 2. Alternative Solution

**PHYTOREMEDIATION**

**Main Principles**



1. Phytoextraction (root, shoot) of the heavy metals
2. Phytoimmobilisation (sequestration) of HM
3. Minimization of seepage water formation by evapotranspiration and new soil formation
4. Improvement of soil quality (ecological factor)

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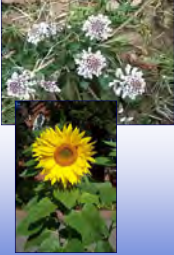
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**PHYTOREMEDIATION**

More than 400 plant species known for their use for phytoremediation  
e.g. *Thlaspi species*, *Helianthus annuus*, *Zea mays*, *Salix caprea*, *Populus tremula*, *Phragmites species*

**Requirements for the application**

- Bioavailability of the HM (mobility)
- Occurrence of the contaminants in the root zone
- Satisfying growth of the plants
- Tolerance of the plants against contaminants



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### Objectives for the phytoremediation




- Prevention/ minimization of HM/R input into environment and food chains
- Ecological improvement of the area
- Preservation of natural soil functions/ prevention of secondary environmental impacts
- CO<sub>2</sub>-neutral energy production from plant material if possible

Utilization of the plants

Thermal energy

Biogas

Biofuels (e.g. rapeseed oil)

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### 3. Site of investigation

- U low grade leaching dump (1971 – 1990) near Ronneburg/ East Germany
- Removal of the dump after close of mining, contamination of the glacial sediments underneath
- Partial removal of contaminated sediments, covering with allochthonic soil
- Today: Area was given back to the neighbour community, but set-aside ordinance

Investigation of phytoremediation on this area

Plant experiments    Soil and groundwater    Utilization of the plants

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### 4. Approach in the project

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- Test of new variants of phytoremediation in laboratory- and field experiments (germination and pot experiments, test field „Gessenwiese“)
- Balance of the time- and space dynamics of mass flow streams in the system plant-soil-ground water in a field experiment (lysimeter, soil hydrological measurement points)

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- Investigation of a material and energetical utilization of the plant residuals (bioethanol, biogas, thermal utilization)
- Balance of the fate of HM/R in the different waste streams after the utilization of the HMR- laden plant material

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### 5. Experimental Setup

**Utilized Plants**

- *Helianthus annuus* (sunflower)
- *Triticale* Groundwater well
- *Brassica juncea* (Indian mustard)

**Different soil amendments**

- Test field soil
- Testfield soil with mycorrhiza and bacteria culture (*Streptomyces*) (TF + MS)
- Test field soil with 10 kg/m<sup>2</sup> calcareous topsoil (MIX)

Test site    Lysimeter station    Data logger house

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**Preparation of the harvest for utilization experiments**

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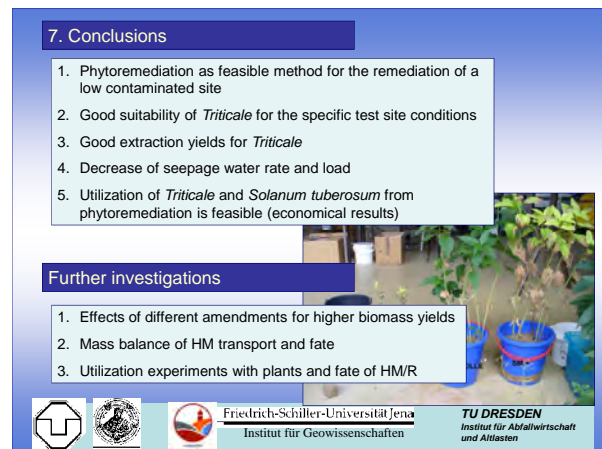
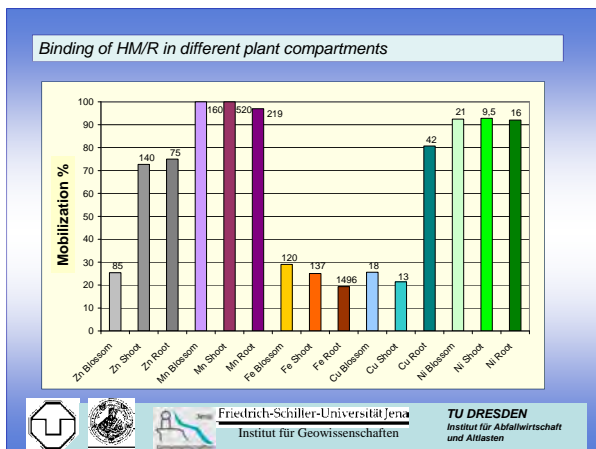
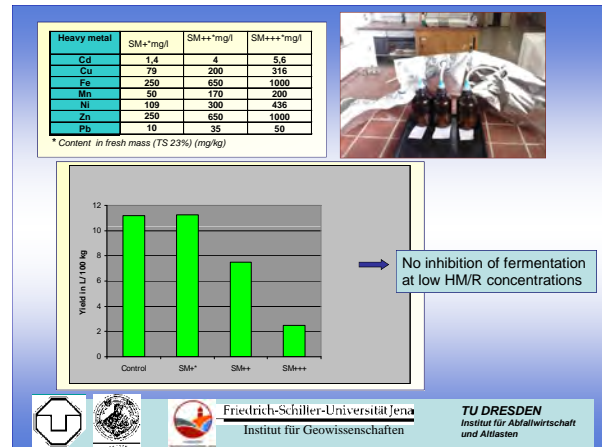
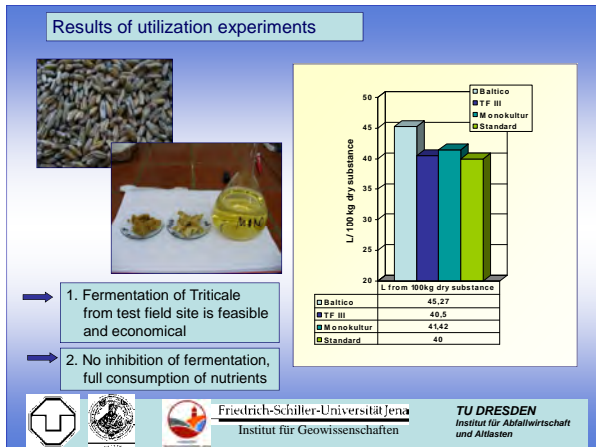
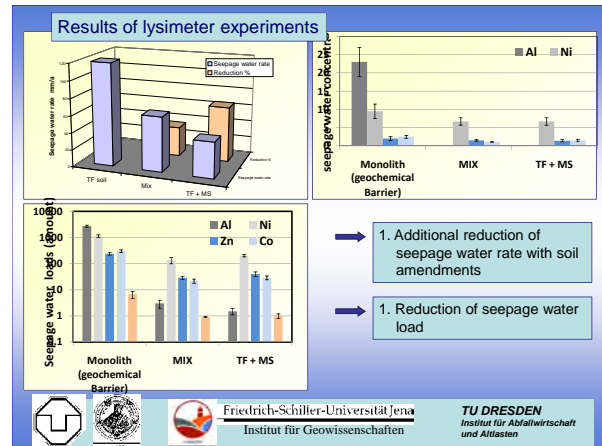
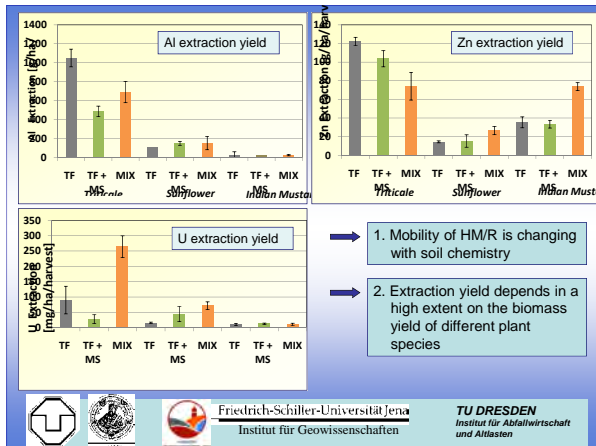
### 6. Results

**Biomass yield**

Depending on plant species and their specific suitability for the soil substrate

Species	Soil Amendment	Biomass Yield [kg/ha/harvest]
Triticale	TF	~4000
	TF + MS	~4000
	MIX	~3500
Sunflower	Mono	~2500
	TF	~500
	TF + MS	~500
Indian Mustard	MIX	~700
	Mono	~700
	TF	~500

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