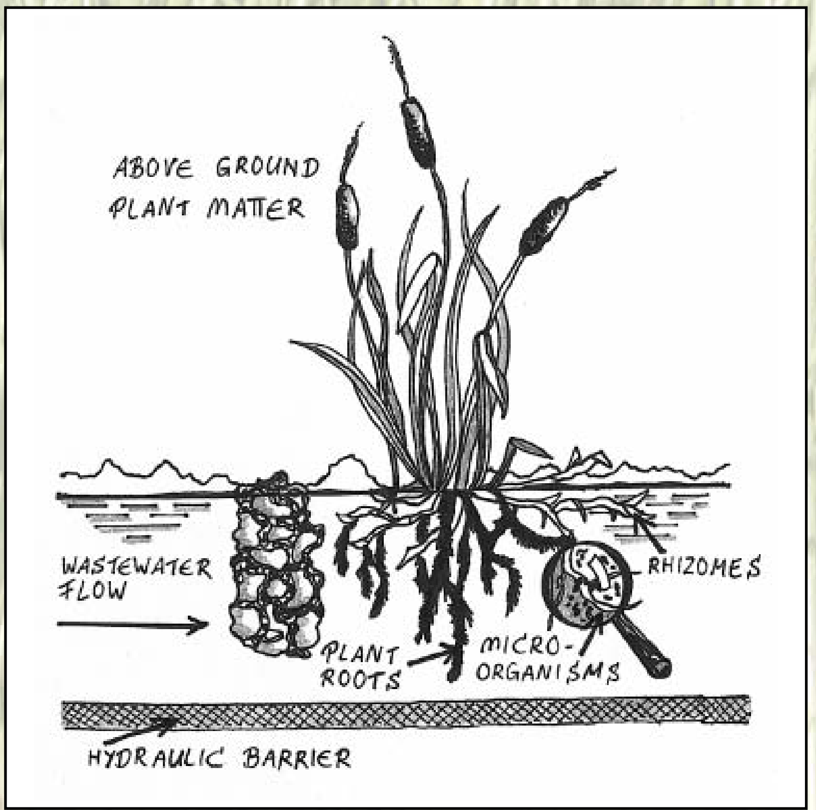
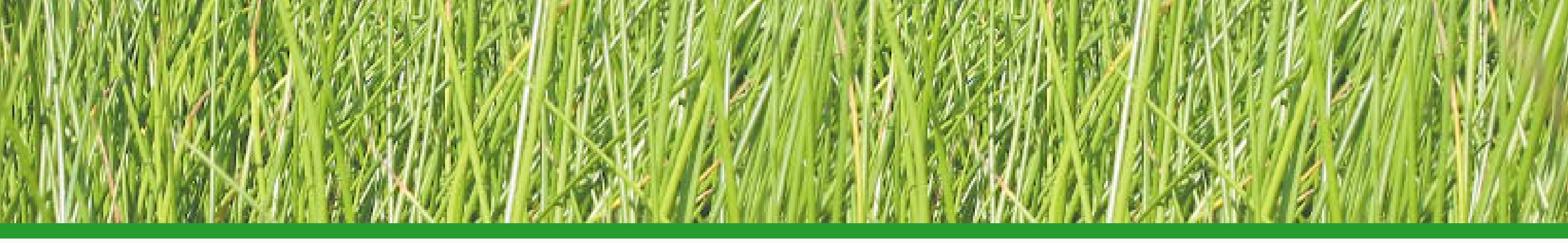
UFZ Centre for Environmental Research
Leipzig-Halle
in the Helmholtz Association

Constructed Wetlands – Treating Wastewater with Cenoses of Plants and Microorganisms

A Research Association at UFZ Centre
for Environmental Research Leipzig-Halle

In the Helmholtz Association


ABOVE GROUND PLANT MATTER
WASTEWATER FLOW
RHIZOMES
PLANT ROOTS
MICRO-ORGANISMS
HYDRAULIC BARRIER



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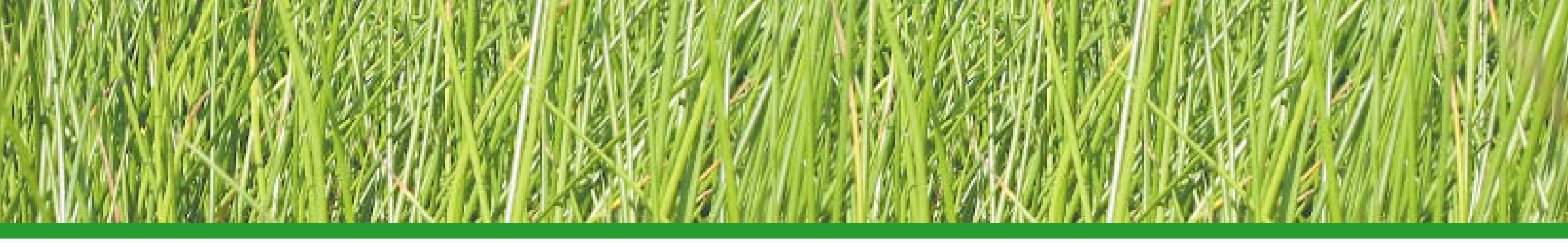

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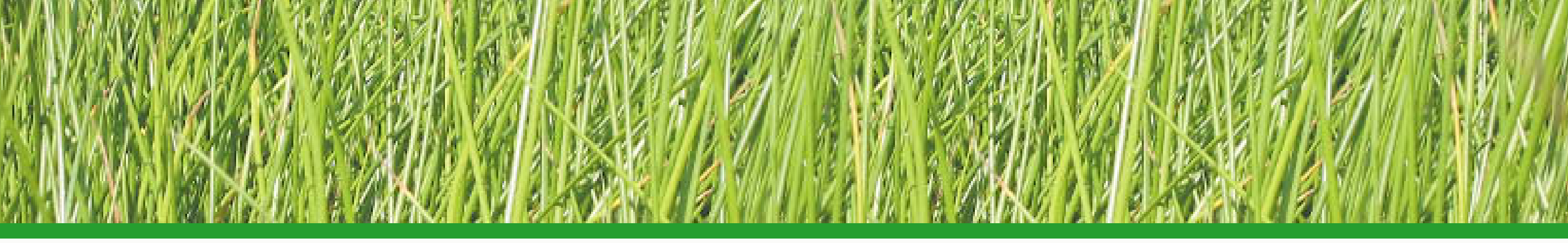

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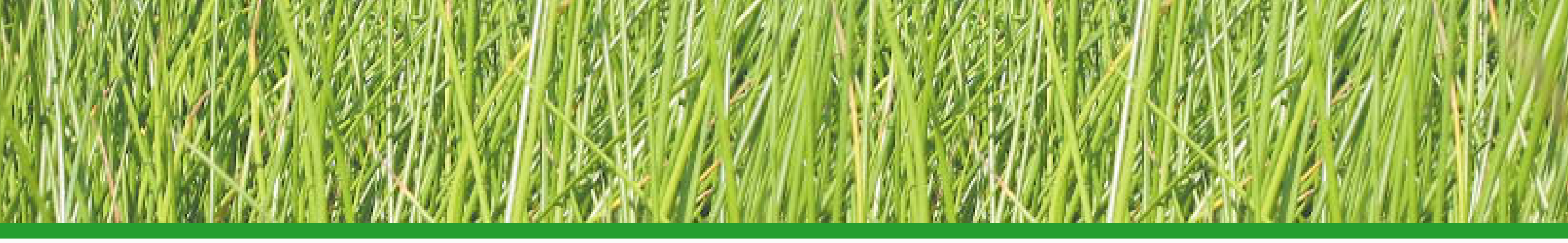


1 Tasks and aims

It has long been known that plants possess the natural ability to assimilate carbon dioxide from the atmosphere and to emit oxygen and thus purify the atmosphere. In the last three decades, plants have also been used to treat sewage and to detoxify soil and sludge. These quasi-natural processes, known as "phyto-remediation", take advantage of the complex interactions between plant roots and micro-organisms in the so-called rhizosphere. This "phytotechnology" is becoming increasingly attractive for both economic and ecological reasons. The processes offer a broad, interesting field for science and research, since the knowledge of the rhizospheric complex interactions between the plants, microorganisms, soil, water and pollutants is still limited.

The underlying philosophy of phytoremediation research at UFZ is to exploit and to optimise the processes in the rhizosphere. Low-cost, simple systems will be developed to control the environmental problems of different countries in several continents irrespective of their industrial capabilities and conditions – without losing sight of the key principle of cleaning up polluted environmental media in a natural, ecologically balanced way.

This entails both scientific basic investigations into the turnover processes and field trials in order to overcome practical constraints. Basic research chiefly concentrates on the complex biological and physicochemical interactions inside the rhizosphere.

With an interdisciplinary research concept, the main topics being dealt within national and international co-operations are:

- Biological and physicochemical processes of metal removal from contaminated waters in constructed wetland systems
- Advanced treatment of municipal wastewater regarding hygienisation (the removal of pathogenic germs) and the removal of hazardous organic compounds (pharmaceutical, persistent personal care products, other toxic household and industrial chemicals)
- Nitrogen, sulphur and carbon cycles in the technical ecosystem of a constructed wetland
- Effects of plants on the redox processes and microbial activity in the rhizosphere of wetland systems
- Cost-benefit analysis of different wastewater treatment technologies (particularly constructed wetlands)

2 Research Fields

2.1 Advanced treatment of municipal sewage: *hygienisation*

It is generally accepted that constructed wetlands (planted soil filters) may enable the effective, economical and ecological treatment of industrial and municipal wastewater. In addition to the elimination of contaminants and toxic ingredients, another objective of wastewater treatment is the removal of pathogens. It is known that pathogen removal is more efficient in constructed wetlands compared to traditional wastewater treatment methods. Fundamental scientific knowledge of the processes of pathogen removal in constructed wetlands is highly limited at present. The principles of pathogen removal in these plants have not yet been investigated, and this hampers optimum technical performance.

Consequently, the technical and scientific aspects of the project are geared towards the practical study of the rhizospheric interactions responsible for effective removal of pathogens in constructed wetlands. Obtaining better insights into the principles of pathogen removal in these systems is essential for further optimisation of these processes. A second important feature of this "green technology" is the possibility of utilizing pre-treated water chiefly containing just the inorganic fertilizers nitrogen and phosphate for agricultural purposes such as irrigation.

The objectives described above are pursued in laboratory models as well as in pilot plants at various locations in Mexico and Germany.

Percolation column experiments at laboratory scale

2 Research Fields

2.2 Advanced treatment of municipal sewage: *removing hazardous organic compounds*

Fundamental aspects of the fate of pharmaceuticals and personal care products during the treatment of municipal wastewater in quasi-natural treatment systems such as constructed wetlands and ponds have not been thoroughly examined and are not yet fully understood. It was often assumed that these compounds would be more efficiently removed by these quasi-natural treatment systems than by most conventional technical systems. The reasons for this supposed advantage could be the higher biological complexity (interactions between the soil matrix, microorganisms and plants) and the higher retention time of the wastewater in these biologically more complex systems. However, this hypothesis is not really proven yet. Hence, we are investigating the metabolism and removal of some compounds within this group of compounds, with the aim of evaluating removal efficiencies in order to establish new approaches for improving the efficiency in these quasi-natural treatment systems (constructed wetlands and ponds).

Within the "Phytoremediation" co-operation project, the Department of Analytical Chemistry is studying the fate of pharmaceutical trace residues in municipal wastewater within planted soil filter and pond systems. The aim is to develop and improve analytical techniques in order to enable the determination and quantification of the pharmaceutical trace residues increasingly contaminating the aquatic environment. Work includes several fields of sample preparation such as SPE, SPME, liquid–liquid extraction and liquid chromatography, as well as hyphenated organic analytical techniques such as GC-MS(MS), LC-MS and CE-MS.

The fate of pharmaceutical residues in municipal wastewater within planted soil filter and pond systems was also integrated in the joint research project "Investigations into the influence of process engineering in sewage treatment plants on the elimination of some estrogens and xenoestrogens in wastewater". This co-operation project was funded by the BMBF (German Ministry of Education, Science, Research and Technology) and co-ordinated by Prof. Hegemann from the Technical University of Berlin.

LC-MS-MS as used to analyse polar organic compounds

2.3 Biological and physico-chemical processes of metal removal from contaminated waters and fixation in constructed wetland systems

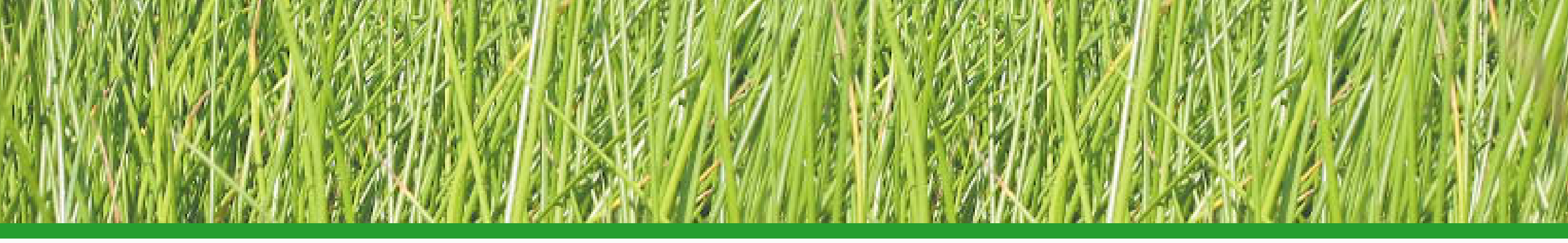
It is well known that waters polluted by heavy metals can be efficiently treated by using artificial ponds or wetland systems. Metal removal in these systems involves the following mechanisms:

- filtration and sedimentation of suspended particles
- adsorption
- incorporation into plant material
- precipitation by microbially mediated biogeochemical processes

Our aim is to investigate the benefits of anaerobic processes (dissimilatory sulphate reduction, chromium reduction, etc.) for the fixation and precipitation of heavy metals and some metalloids (e.g. As). The goal is to improve the existing wetland biotechnologies used for the fixation/recovery of heavy metals from mining waters, landfill leachates, and industrial effluents. Until now, the application of full-scale wetland systems has been afflicted by the following constraints limiting the activity of sulphate-reducing and other anaerobic bacteria:

- high concentrations of dissolved oxygen and the resulting high redox potentials
- acidity of effluents, i.e. low pH
- limitation of organic substrates

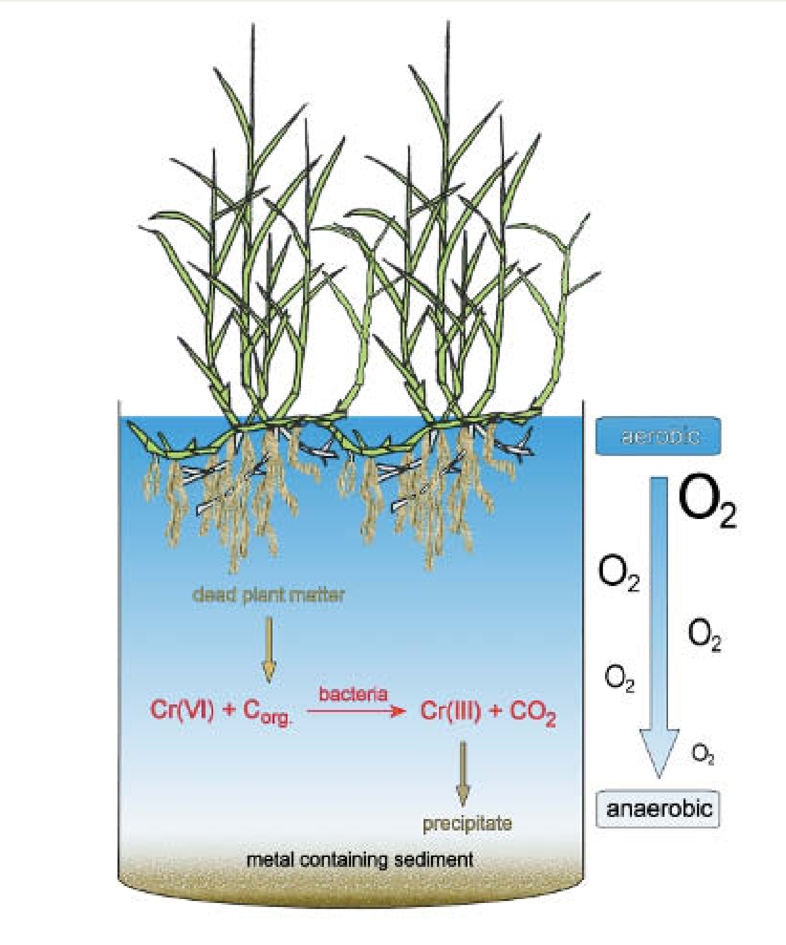
IC-ICP-MS coupling to separate and identify polar arsenic species



2 Research Fields

2.3 Biological and physico-chemical processes of metal removal from contaminated waters and fixation in constructed wetland systems

Small testing unit for exposition experiments of plants to chromium-contaminated wastewaters



Principle of the Cr(VI) removal process

2 Research Fields

2.4 Nitrogen, sulphur and carbon transformation processes in constructed wetlands

This project addresses microbial and abiotic nitrogen and sulphur turnover processes related to the microbial carbon metabolism in the complex system of constructed wetlands.

This project focuses on the metabolic processes of the microbial communities within the biofilms on the plant roots and soil particles. The investigations are based on the structural analysis of the cenoses and the response of the bacteria. The cenoses are characterized by molecular biological techniques such as FISH, specific PCR (e.g. NiR) and DGGE, as well as by using antibodies. Isotope methods such as the 15N dilution method enable the various conversion processes (nitrification, denitrification, anoxic ammonia oxidation etc.) and their interconnections to be elucidated.

Results of the laboratory investigations provide the basis for the quantitative modelling of the turnover processes, which will then be compared with the data of full-scale treatment plants. These investigations aim at obtaining better insight into the complex processes in constructed wetlands for wastewater treatment and thus at understanding the conditions necessary for optimum process control and the development of new, more efficient treatment methods.

Mobile test unit of horizontal flow filter

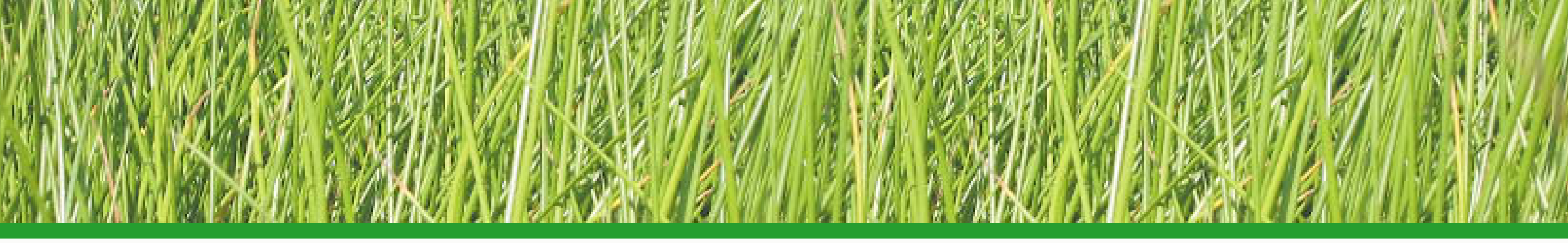
Column system to investigate nitrogen transformation processes

2 Research Fields

2.5 The role of plants in the redox processes of the rhizosphere

The ability of helophytes to release oxygen into their rhizosphere is important for the waste-water treatment processes in wetlands. The amount of oxygen released by helophytes depends on various parameters and the physiological state of the plant. By using different species of helophytes in laboratory-scale experiments, this oxygen input is currently being quantified and described in relation to light intensity redox conditions, temperature of the rhizosphere and phyllosphere, age of the plants etc. The oxygen released by the roots changes the redox conditions of the rhizosphere and affects biological and abiotic processes. Attention is largely focused on investigating the relationship between oxygenation and the abiotic and biotic rhizosphere processes related to the removal of various organic and inorganic contaminants in laboratory-scale experiments. Here, the activity of certain anaerobic and aerobic bacteria will be monitored in standardised microcosms simulating the diurnal variation of aerobic and anaerobic conditions present in phytoremediation systems.

Laboratory system for measuring plants' oxygen output into their rhizosphere



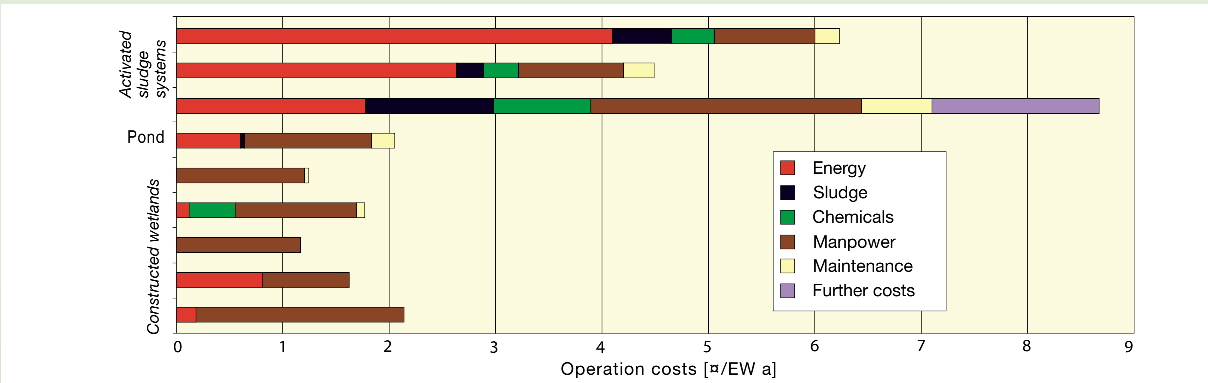
2 Research Fields

2.6 Economical studies on different wastewater treatment technologies (particularly constructed wetlands)

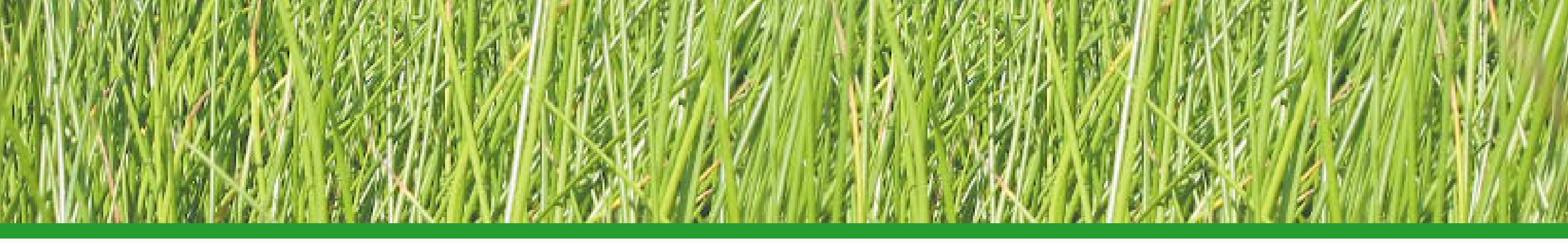
In the last few decades, wastewater engineers have concentrated on centralised drainage and treatment systems, which were often applied without any modification in less densely populated areas. The search for appropriate technologies for rural areas is becoming more and more important in Europe due to the wastewater directive which forces communities below 2000 inhabitants to treat their wastewater. In other countries, interest is increasing in overcoming the wastewater problems which are causing health and environmental risks. Because of the economical limitations of many communities, not only technical aspects but also other criteria, such as affordability, influence the decision for a treatment system and the respective technology. There are not many studies dealing with economical aspects of rural wastewater and the database is very limited. In many cases, affordability is seen to be synonymous with low initial costs.

The research project aims at comparing different technologies for the treatment of wastewater produced by communities of between 50 and 5000 inhabitants. Technologies such as activated sludge systems, sequencing batch reactors, membrane technology and constructed wetlands are compared in terms of costs, including initial costs, costs for energy consumption, sludge removal and treatment, maintenance, and reinvestment.

Initial and running costs are internal costs, which have to be paid by the company or community operating the plant. However, various external costs exist and are not considered in the usual cost comparison. Hence, the study will broaden the concept to a cost/benefit analysis and include aspects such as institutional needs, reliability, and the possibility of upgrading the technologies. It also investigates costs and benefits on the national level, such as health and environmental costs of different wastewater treatment systems. Future price structures are investigated and taken into account. Data are collected from Germany as well as from Mexico and other Latin American countries.



Structure of operations costs of selected treatment plants in Mexico (N. Seyring, 2005)



2 Research Fields

2.7 Remediation of contaminated groundwater

Meso-scale experimental wetland for groundwater remediation

In the peripheral areas around point sources and widespread contaminated regions of industrial “mega–sites”, recalcitrant hazardous substances such as BTEX, chlorinated benzenes and ethenes respectively other pollutants often stay unchanged for decades under anaerobic conditions in the aquifer. Considering the standards of the EC Water Framework Directive, the fate of pollutants should be investigated especially at environmental interfaces, such as floodplains, riverbanks and groundwater tables near the surface. In the case of volatile pollutants, volatilisation and fate of contaminants in vadose zone have to be taken into account. On the other hand, remediation of contaminated groundwater using artificial floodplains (constructed wetlands) might be a promising and cost-saving alternative to pump-and-treat technologies or reactive barriers. Therefore the implementation of an engineered habitat in the form of a large-scale constructed wetland exploiting the principles of biological degradation is applicable in order to reduce pollution levels and to retain contaminant discharge to natural surface water. Due to site-specific contamination inventories and hydrogeological and microbial environments, meso-scale mobile wetlands are applied for on-site pilot studies.

3 Selected reference projects

3.1 Heavy metal removal by bioreactors and constructed wetlands

Research project supported under NATO Collaborative Linkage Grant No. EST.CLG.978918 (2003-2004)

Contact: P. Kuschk, UFZ, Dep. of Bioremediation

Partners:

- UFZ – Centre for Environmental Research Leipzig-Halle (Leipzig, Germany), Department of Bioremediation and Centre for Environmental Biotechnology (UBZ) at the UFZ
- Wageningen University (Wageningen, The Netherlands),
- Institute of Biochemistry and Physiology of Microorganisms of RAS (Pushchino, Russia),
- Institute for Biology of Inland Waters of RAS (Borok, Russia)

The research of the project is focused on the biological processes able to remove metals, particularly chromium, from wastewater.

Main results:

1. A wide range of physical, chemical and biotic processes contribute to the detoxification of metals in constructed wetlands and the planted soil filter wihch provides a heterogeneous gradient system containing both oxic and anoxic zones. In that system, the plants provide the substrates and thereby the conditions needed by the bacteria for metal fixation.

2. Different laboratory scale wetland systems (horizontal surface and subsurface flow system, and a pond with a floating plant mat; all systems planted with *Juncus effusus*) were tested for their chromium removal rates. The best results were obtained with the subsurface flow system. Considering the gravel's low adsorption capacity for chromium and the low removal rates of *Juncus effusus* in a hydroponic system, this result can only be attributed to anaerobic bacteria establishing in the system.

3. A chromate-reducing bacterial mixed culture consisting of different species of anaerobic and facultative anaerobic bacteria was enriched. A succession of bacterial reductive processes takes place in the consortia and sulphide is only accumulated in the system after the chromium has been precipitated.

4. A chromate-reducing bacterium was isolated and characterized. The presence of nitrate increased both the specific Cr(VI) reduction rate and the cell number.

From left to right:
Peter Kuschk, Mikhail Vainshtein, Anna Vatsourina, Dmitriy Kosolapov, Roland A. Müller

5. The supply of organic substrates promotes the development of anoxic conditions and the activity of the metal-reducing and sulphate-reducing bacteria in both bacterial consortia and constructed wetlands.

3.2 Elimination of pathogenic germs in municipal sewage using constructed wetlands

Joint Project supported by the BMBF grant No. 02WA0107 (2000-2004)

Web page: www.ufz.de/hygiene
Contact: Roland A. Müller; UFZ-UBZ

Partners:

- UFZ-UBZ (Centre for Environmental Biotechnology at the UFZ)
- UFZ- Dep. Bioremediation
- Martin-Luther-University Halle-Wittenberg, Medical Faculty, Institute for Hygiene
- Umweltschutz-Nord Ltd
- ÖKOTEC Ltd

Main aims:

- Technological optimisation of the removal of pathogens in constructed wetlands
- Obtaining better insights into the principles of pathogen removal in these systems for the purposes of process optimisation

Results:

Within the scope of the joint project, constructed wetland systems in pilot and technical scale were optimised regarding the reduction of faecal indicator organisms and pathogenic or facultative pathogenic microorganisms. The influencing variables and mechanisms of germ reduction were analysed molecular-biologically at the laboratory scale.

Horizontal and vertical filters at the pilot scale in Mexico (Xochitla Park) and Germany (Langenreichenbach) were examined as separated systems or coupled two-stage systems for their maximum achievable germ removal.

Various loading and endurance tests for the different single-stage systems were carried out. The operation was accompanied by physico-chemical (COD, BOD, NH_4^+-N, NO_3^--N, N_{total}), microbiological (colony-forming units at 22 °C / 36 °C, coliform bacteria and *E. coli*, thermo tolerant coliform bacteria, enterococci, clostridiae, salmonellae, shigellae, *Vibrio cholerae*), and parasitological analyses (*Cryptosporidium parvum, Giardia lambia,* helminth eggs) of the effluent water and the filter material.

At the Mexican plant as well as at the German ‚Langenreichenbach' plant, the concentrations of *E. coli* and thermo-tolerant coliform bacteria were lowered by 2 to 4 orders of magnitude in single-stage operation. In two-stage operation mode, the concentrations were diminished by 5 to 6 orders of magnitude. Combined with the other parameters, particularly parasite and salmonella concentration, the effluent quality of an optimised setup meets the WHO quality standards for reuse, e.g. for irrigation.

Investigations in a model filter showed that plants do not have a significant influence on the germ removal. However, a positive correlation of elimination and occurrence of protozoa and bdellovibrios could be observed. Investigations in the different filter plots at the “Langenreichenbach” pilot plant reveal that the covering of the bed material by biofilms in deeper zones of the filter is marginal. This leads to the conclusion that adsorption plays only a minor role in germ removal in this plant.

Similar constructed pilot plants to compare the pathogene removal by means of different soil filters:

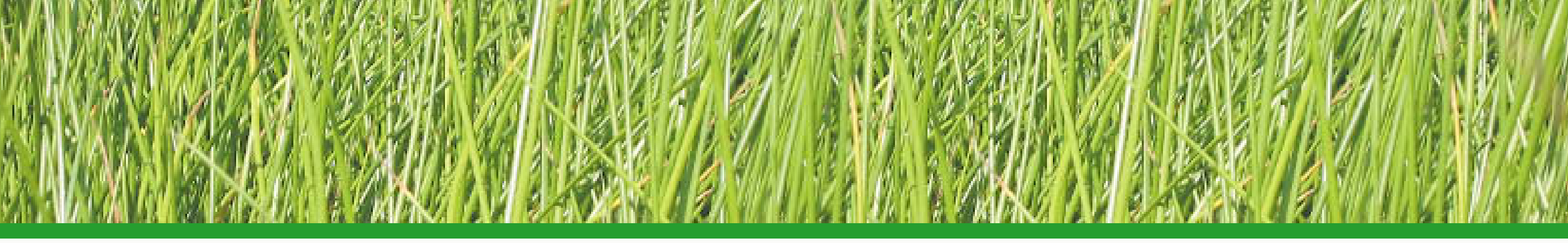
Pilot plant “Langenreichenbach”, Germany

Conclusions:

The superior removal performance of *E. coli* germs by multi-stage systems at hydraulic loadin grates equal to those of single-stage systems can be partly attributed to the higher hydraulic effectiveness.

By characterising the microbial communities of the rhizosphere, a significant contribution was made to clarifying the process mechanism that contributes to the germ removal. This knowledge will provide valuable control points for further optimisation and performance of the plant. It can be assumed that predation by protozoa and bdellovibrios plays a significant role in terms of bacteria removal. Regarding this process, however, the importance of bacteriophages is still completely unknown. Strategies for optimising the germ removal in planted soil filters should therefore aim at better understanding of predation effects and a specific control of these processes. Due to successful technology development a demonstration plant actually is constructed on the Philippines (Bohol).

Pilot plant “Xochitla”, Mexico



3 Selected reference projects

3.3 Passive treatment of tannery effluents

Scientific and Technological Co-operation Project between Germany and Mexico

Supported by the BMBF (Germany) and CONA-CYT (Mexico)

Contact: A. Gerth (BioPlanta Ltd.)

German partners:

- **BioPlanta Ltd.**
  Tasks:
  project co-ordination, engineering, design of the treatment plant
  web page: www.bioplanta-leipzig.de

- **UFZ-Centre for Environmental Research Leipzig Halle; Centre for Environmental Biotechnology (UBZ) and Department of Bioremediation**
  Tasks:
  scientific research, consulting
  web page: www.phyto.ufz.de

Mexican Partners :

- **Teneria Europea (in Leon)**
  Tasks:
  construction of the treatment plant, system optimisation
  web page: www.teuropea.com

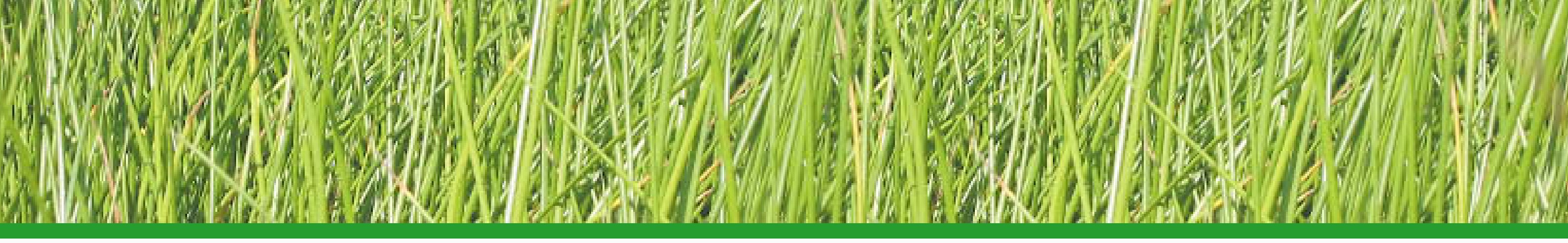
- **CIATEC-Centro de Investigación y Asesoría Tecnológia en Cuero y Calzado (in Leon)**
  Tasks: consulting
  web page: www.ciatec.mx

Summary:

Mexico and Germany are interested in developing cost-effective methods for removing heavy metals from contaminated wastewater resulting from mining, leather-tanning, electroplating and other industries.

Although heavy metals can be removed by a variety of technical methods (such as precipitation, ion exchangers etc.), these require chemicals and energy making them expensive in terms of running costs. That is why bio-processes are often advantageous in removing contaminants at low concentrations. Particularly of advantage for that purpose are constructed wetlands wherein a complex biocenosis of plants and bacteria and many additional physical and chemical factors can mediate the removal of such water contaminants.

In the framework of the partnership of BioPlanta, Teneria Europea, UFZ, and CIATEC, a treatment plant for tannery effluents based on wetland technology was designed and realized. The system was launched on 8th April 2005 in Leon. Per day up to 100 m^3 tannery effluent pretreated by flocculation can be treated by this system and reused again in the production line.



3 Selected reference projects

Construction phases of the first module of the treatment system for the Teneria Europea

a – excavation
b – laying out the line
c – filling with sand an
d – completion in December 2003

The multi-module system (April 2005)

4 Equipment

4.1 Phytotechnicum

Outdoor view of the phytotechnicum

Indoor view of the phytotechnicum

The investigation of the complex interactions in the rhizosphere among roots, microorganisms, soil and pollutants is a tricky matter. Such experiments require sophisticated analytical devices for measuring several chemical and physical parameters. Unfortunately, these devices (like gas chromatograph and mass spectrometer) are often not robust enough for field experiments. This is why experiments are conducted in a special phytotechnicum under conditions optimal for plants but also suitable for sensitive electronic devices.

4 Equipment

4.2 The *Planted Fixed Bed Reactor* (PFR) – A test system for the investigation of processes in the rhizosphere of planted soil filters

The Challenge

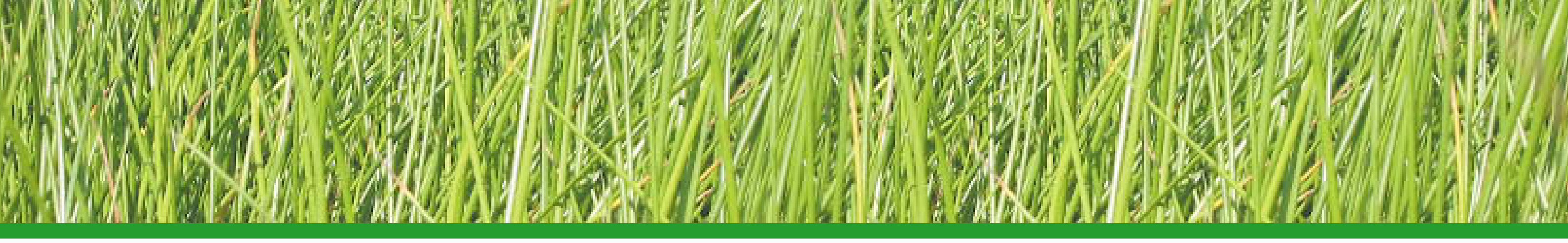
For the simulation of planted soil filters (constructed wetlands), a general approach for small-scale testing units does not yet exist, in contrast to those used e.g. for testing activated sludge processes. Thus, only black-box gradient-systems have been used in the past, which offered no possibility to investigate the specific interactions and the efficiency of the removal processes inside the rhizosphere in a more profound way. These test systems were often characterized by a non-optimum geometry and had no ideal hydraulic flow conditions. Due to these discrepancies, the experimental results of such test systems can hardly be compared.

The solution

In order to verify the appropriateness of wetland technology and to study the dynamics and interactions of the processes inside the rhizosphere, a planted gravel laboratory-system (PFR) with idealized flow conditions was developed. Permanently mixing the process water enables macro-gradient-free conditions to be achieved so that small changes of physicochemical parameters and in the composition of the process water can be determined and the overall system can be handled as a finite element of a real constructed wetland.

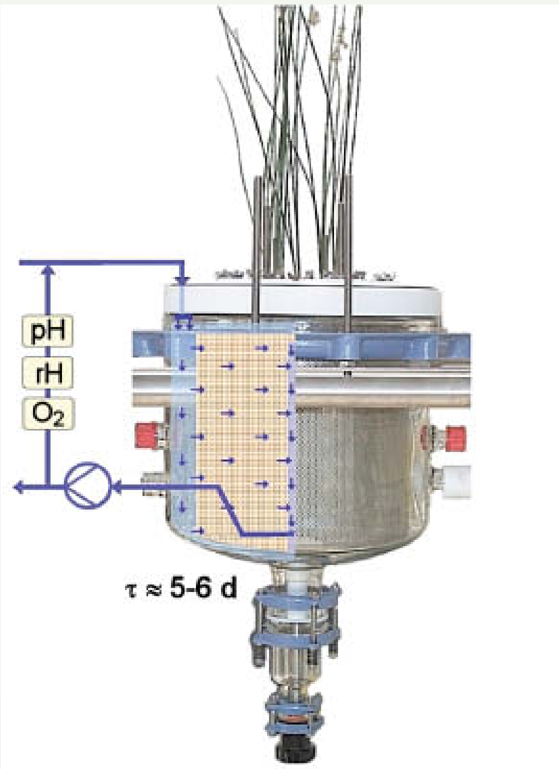
The principle of the reactor

The principle and the process scheme of the reactor are described in detail in Kappelmeyer et al. (2002) and Wiessner et al. (2005). The PFR is characterised by an ideal flow pattern avoiding short circuiting or preferential flow. The reactor consists of a 20 L glass vessel filled with gravel in a cylinder or basket of perforated stainless steel, which is planted with helophytes and through which the process water flows concentrically. The overall hydraulic flow results from pumping the wastewater into the outer space around the gravel bed and pumping the liquid out of the centre of the gravel bed. An inner circulatory flow for permanently mixing the process water inside the reactor was induced by pumping the process water out of the outlet back to the inlet in the outer space of the reactor. In order to achieve an ideal flow pattern, the reactor is operated with a high internal flow rate. Due to the reactor design, the circulation flow represents the actual concentration of the pore water inside the rooted reactor. The pH, the redox potential and the oxygen concentration can be measured in the circulation flow online. The hydraulic retention time can be adjusted in accordance with the turnover rates of the wastewater components. Transpiration by the plants can be measured by balancing the inflow and outflow amounts of water. The reactor is placed in a greenhouse and operated under defined environmental conditions.



4 Equipment

4.2 The *Planted Fixed Bed Reactor* (PFR) – A test system for the investigation of processes in the rhizosphere of planted soil filters



The Planted Fixed Bed Reactor – a test system for simulating rhizosphere processes in constructed wetlands at laboratory scale

Application

- Investigation of redox dynamics and contaminant turnover in macro-gradient-free systems
- Experimental planning device and testing unit for planted soil filters
- Assessment of the applicability of planted soil filters for the treatment of problematic wastewater
- Determination of parameters for the design and operation of planted soil filters for wastewaters that are difficult to treat
- Determination of the fate of certain contaminants in the complex system of planted soil filters, particularly using compounds labelled with stable isotopes
- Investigations into the distribution of gases (rhizosphere and leaf area) and assessments of emissions

Literature:

- Kappelmeyer, U., Wießner, A., Kuschk, P., Kästner, M. 2002. Operation of a universal test unit for planted soil filters – Planted Fixed Bed Reactor. Eng. Life Sci. 2, 311-315
- Wießner, A., Kappelmeyer, U., Kuschk, P., Kästner, M. 2005. Influence of the redox condition dynamics on the removal efficiency of a laboratory-scale constructed wetland. Water Research 39, 248-256

4 Equipment

4.3 Langenreichenbach pilot plant

At the end of 2000, a joint German-Mexican project was launched by various partner institutions to develop a simple and safe technology for the removal of pathogenic germs from municipal wastewater. Within the framework of this project, two constructed wetland pilot plants have been constructed in Langenreichenbach (Germany) and Mexico (near Mexico-City).

Scheme of Langenreichenbach pilot plant

Both plants have a similar process scheme and design comprising of fifteen 6 m^2 beds to treat municipal wastewater using different treatment techniques. The aim of the investigations is to optimise the operating mode of wastewater treatment regarding hygienic parameters (faecal indicator as well as pathogenic germs). Different wastewater treatment techniques are compared within each pilot plant as well as between the two sister plants in Germany and Mexico in order to study the effect of different climatic conditions.

Langenreichenbach pilot plant during construction – 2

Langenreichenbach pilot plant during construction – 1

Top view of the completed experimental plant

4 Equipment

4.4 The Greenhouse

Exposition experiments testing the effects of several contaminants (organic compounds and heavy metals) on plants are conducted in the greenhouse. Furthermore, in order to ensure the availability of fresh plant material for experiments around the year, we cultivate several emergent water-plant species (helophytes), which are kept in the greenhouse during the winter.
The main species cultivated are:

- *Acorus calamus*
- *Glyceria maxima*
- *Iris pseudacorus*
- *Juncus effusus*
- *Phragmites australis*
- *Typha latifolia*
- *Typha angustifolia*

Greenhouse and containers for the cultivation of helophytes

4.5 Microbiological laboratories

Molecular biological experiments to determine specific germs

Electrophoresis unit for molecular-biological characterisation of complex microbial cenoses

4.6 Chemical Analytical Devices

- HPLC; detectors: DAAD, fluorescence, RI; (Beckman)
- GC with headspace autosampler; detectors: FID, ECD, TCD; (Varian)
- GC-MS (Varian)
- GC for gas analysis (Varian); detectors: ECD, TCD, MS (Balzers)
- NO-detector (Eco-Physics)
- Ion chromatograph (Dionex)

In case of more complex analytical problems we consult the Department of Analytical Chemistry which provides highly experienced colleagues and the necessary analytical devices such as IC-ICP-MS, LC-MS-MS etc.

Gas chromatograph coupled to a high-resolution mass spectrometer in the Department of Analytical Chemistry

5 Selected publications

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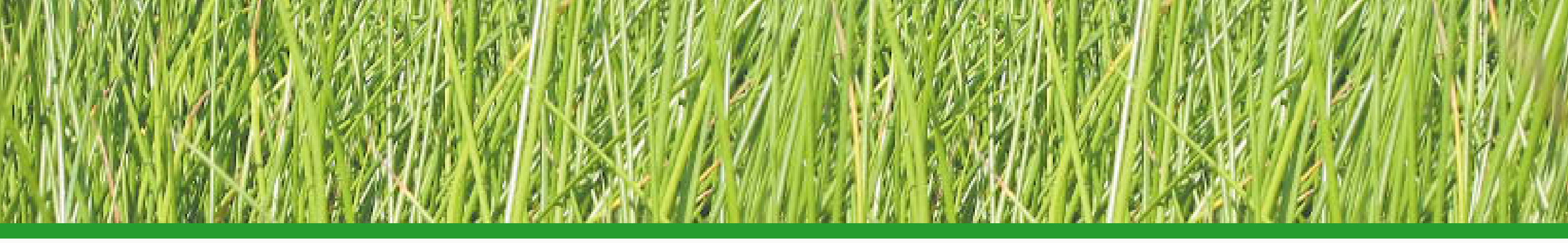

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6 UFZ – an overview

Sustained activities for the environment

Being a national and international centre of excellence, the Centre for Environmental Research Leipzig-Halle (UFZ) conducts research on sustainable land use and the protection of the natural resources of life for following generations.

Research focuses on densely populated regions markedly shaped by man – cities, but also large contaminated regions and mining areas – and near-natural spaces, in particular deserts and semi-deserts. The scientists tackle questions of biodiversity and ecological stability, deal with the protection of water resources, investigate the impact of environmental pollutants on human health and develop forecasting models for environmental changes and decontamination strategies. The Centre for Environmental Biotechnology (UBZ) was founded under the UFZ umbrella to form a hub for the development, application and transfer of environmental biotechnologies into practice.

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The UFZ was founded in 1991 and is a member of the Helmholtz Association of National Research Centres (www.helmholtz.de) and initiator of the PEER network (Partnership for European Environmental Research, www.peer-initiative.org), which currently embraces seven large European environmental research centres. The UFZ runs offices and laboratories in Leipzig, Halle and Magdeburg and employs about 780 people, including 450 scientists. It is funded by the Federal Republic of Germany (90 %), the Free State of Saxony (5 %) and the Bundesland Saxony-Anhalt (5 %).

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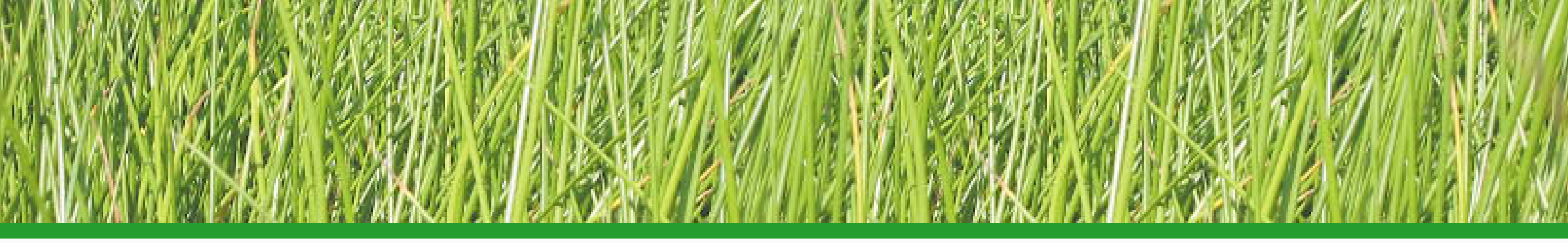

6 UFZ – an overview

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