Topic 2 - abstracts

This document contains the abstracts for topic 2. Topic 2 contains the sessions listed below. The abstracts are ordered by poster & session.

The complete programme and session overview can be found on our website at: https://aquaconsoil.com/aquaconsoil-2023/scientific-programme/

Session	**TOPIC 2: Soil-water-sediment system contribution to climate change adaptation and mitigation**
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2a1	Nature based solutions and other technologies for carbon sequestration and greenhouse gas mitigation strategies (e.g. rice fields, mangrove, constructed wetlands, etc.)
2b1	Restoring and maintaining quality and quantity of groundwater reserves
2sps1	Climate Change Adaptation in the United States Superfund Program: Insights from Climate Vulnerability Assessments at Contaminated Sites.
2sps2	AquaConnect: Circular water management for regional drought resilience.

Posters

ID	Name	Organization	Title
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113	Neus Bonet-Garcia	Universidade do Porto and Université de Limoges	Trace metal mobility in municipal sewage-sludge-digestate amended soil: The role of a bioenergy crop and its phytomanagement potential.
119	Richard Gill	Shell Global Solutions B.V.	Incorporating Resilience and Adaptation into the SuRF-UK Sustainable Remediation Framework
135	Jaume Puigagut	Universitat Politècnica de Catalunya	Cryoconcentration of phosphates contained in agricultural runoff: towards a sustainable strategy for phosphorus recovery in agriculture.
142	Daniel Kahuda	VODNÍ ZDROJE, a.s.	New possibilities for monitoring and rehabilitation of extraction wells
188	Carol Omara-Ojungu	Czech University of Life Sciences Prague	Microchar an organic biowaste used to remediate agricultural drought soil and increase biomass growth.
220	Anko Fischer	Isodetect GmbH	Isotopes meet mass flux – IsoFLUX as a new tool for precise quantification of pollutant degradation in contaminated aquifers
331	Lucie Krejcova	Cranfield University	Constructed wetlands as nature-based solutions for the removal of antimicrobial resistance (AMR)

Session 2a1

Thursday 9:00-10:30

Room D217

ID	Name	Organization	Title
345	Joshua Both	Hannover Milieu- en Veiligheidstechniek B.V.	Treating Complex Mixture of Contaminants in a Construct Wetland: the Importance of Alternating Hydrochemical Conditions for a Successful Application
218	Natàlia Blázquez-Pallít	LITOCLEAN, SL	Laboratory pot tests and field pilot study to determine the best approach to combine the phytoremediation of TPH contaminated land with the production of clean biofuels.

328	Cristy Medina-Armijo	IRTA - Institute of Agrifood Research and Technology	A microcosm assessment of novel strategies for mitigating metane emissions in paddy rice soils by using electroconductive materials
338	Olga Vounaki	Environmental Resources Management	Constructed Wetlands as a Sustainable Alternative to Traditional Pump and Treat Systems
409	Jan De Vos	**ABO nv**	LIFE NARMENA: Nature based remediation techniques for heavy metals in sediment - constructed wetlands

Session 2b1

Tuesday 11:00-12.30

Room D222

ID	Name	Organization	Title
15	Paul Frogner Kockum	Swedish Geotechnical Institute	Microbial degradation and dispersion of contaminants from fiberbanks through gas discharge
106	Jörg Frauenstein	Umweltbundesamt (UBA)	Water competition as a result of societal transformation and lignite phase-out in Germany - a complex challenge
120	Susanne Schomburgk	BRGM	Impact of groundwater table fluctuation on pollutant concentrations: how to adapt monitoring strategy to climate change?
144	Marjan Joris	iFLUX	Real-time monitoring networks with groundwater flux data to quantify and manage the dynamic water balance within the complexity of the present use of the area.
372	Nicolas Devau	BRGM (French Geological Survey)	Fate and mobility of PFAS in geomedia under saturated and unsaturated conditions: New insight on column experiments
223 – Backup	Silvana Quiton	Wageningen University	Synergies between micropollutant biodegradation and subsurface iron precipitation
316 – Backup	Phil Dennis	SiREM	Are Nitrogen Compounds Attenuating at Your Site? Implications for Site Remediation and Climate Change

Session 2sps1

Wednesday 11:00-12.30

Room D226

ID	Name	Orginzation	Title
421	Vanessa Van Note	United States Environmental Protection Agency	Climate Change Adaptation in the United States Superfund Program: Insights from Climate Vulnerability Assessments at Contaminated Sites.

Session 2sps2

Tuesday 11:00-12:30

Room D226

ID	Name	Orginisation	Title
424	Hans van Duijne	Deltares - WUR	AquaConnect: Circular water management for regional drought resilience..

Posters

Session 2 poster / Abstract title: Trace metal mobility in municipal sewage-sludge-digestate amended soil: The role of a bioenergy crop and its phytomanagement potential.

ID: 113

Key words: sewage sludge anaerobic digestate; trace metals; phytomanagement.

Submitter: Neus Bonet-Garcia

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Porto (FCUP/CIIMAR), Portugal. Researcher and assistant professor at Universidade do Porto.

Session: 2 poster

Abstract

Sewage sludge anaerobic digestate (SSAD) is a valuable by-product of the anaerobic digestion treatment process of wastewater. It presents an agronomic and soil conditioning interest for its richness in plant nutrients and organic matter. However, application of SSAD as a land amendment could result in the accumulation of potentially toxic trace metals initially present in SSAD into soils. This could be mitigated by the integration of phytoremediation approaches. The main objective of this study was to understand the impact of a bioenergy crop (switchgrass (Panicum virgatum)) on the migration and availability of trace metals along a soil profile after municipal SSAD soil amendment. For that, a greenhouse soil column (30 x 14 cm) experiment was conducted for 45 days to evaluate (i) the quantity of SSAD-borne trace metals transferred to the plant, (ii) the mobility of SSAD-borne trace metals along the different layers of a marginal soil profile over time, and (iii) the nature and metal-reactivity of the organic matter, during the phytomanagement experiment. An originality of the study comes from the multi-approach assessment of the mobile fraction of metals through a combination of diverse methods (sequential extraction, diffusive gradient in thin films (DGT) technique, soil solution analysis collected through rhizon samplers…) coupled with a fine bio-chemical characterization of the dissolved organic matter, as this later appeared, with quenching Three-dimensional spectrofluorimetric qualitative analysis tool, to be able to “bind” metals and participate to their transfer through the soil column. Results are expected to provide a holistic perspective of factors influencing trace metal mobility in soil during the phytomanagement process of a municipal SSAD amended soil. A deep understanding of the transformation and mobility of trace metals in soil profile after municipal SSAD amendment, and determining the phytomanagement potential of bioenergy crops, is of crucial importance to ensure a safe and sustainable municipal SSAD usage and management practices.

The circular economy approach for recirculating nutrients and organic matter in wastewater through anaerobic digestion and returning them to the soil in the form of digestate biofertilizer, coupled to nature-based solutions, such as phytomanagement, helps to address the current worldwide challenge to avoid further land degradation and promote land restoration. Ultimately this approach helps addressing the Sustainable Development Goal (SDG) 15.3 “Land Degradation Neutrality (LDN) and land restoration”.

Acknowledgments
This project has received funding from the European Union’s Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 861088.

Session 2 poster / Abstract title: Incorporating Resilience and Adaptation into the SuRF-UK Sustainable Remediation Framework

ID: 119

Key words: Climate Change, Resilience, SuRF-UK, sustainable remediation framework

Submitter: Richard Gill

Organization: Shell Global Solutions B.V.

Co-authors: Alan Thomas, ERM, Technical Fellow; Nicola Harries, CL:AIRE, Technical Director; and Paul Bardos, r3 Environmental Technology Ltd, Director

Session: 2 poster

Abstract

Climate change is one of or the biggest challenge facing society. It is driving changes to the climate system such as disturbance in the hydrological cycle, rising sea levels and more frequent extreme weather events. In the contaminated land sector, projects need to be able to adapt to the new and changing environment in a way that moderates the harm and exploits any benefits; but also be resilient with the capability to anticipate, prepare and respond to the multi-hazard threats presented by climate change and minimize the damage to social, environmental, and economic well-being.

Governments, regulators and practitioners have begun to consider the impact of climate change and subsequent risk management implications on both the fate and transport of contaminants and the influence of impacts on different remediation technologies. Aligned with these developments SuRF-UK has developed outline guidance about the current provision for incorporating climate change and broader considerations of resiliency in the context of the SuRF-UK Framework. There are several segments of SuRF-UK guidance that address resilience:

1. When carrying out sustainability assessment within a project lifecycle, consider the headline indicator category, “Project Lifespan and Flexibility” which includes four sub-indicators that directly address issues of resiliency to climate change, financial or institutional impacts (including: D. Ability to respond to changing regulation or its implementation, E. Robustness of solution to climate change effects, F. Robustness of solution to altering economic circumstances and G. Requirements for ongoing institutional controls)
2. When setting remediation specifications, consider Part A of the SuRF-UK Framework,– the extent to which resilience needs to be incorporated should be clearer at this part of the project; there are several UK-specific resources that could be used to inform a climate change vulnerability assessment to help define potential future risks

3. When selecting remediation options, consider Part B of the SuRF-UK Framework, – here it is possible to consider the vulnerabilities of the different selected technologies to impacts of climate change
4. Across all phases of project from investigation onwards, consider Sustainable Management Practices (SMPs) – these relatively simple, common-sense actions that can be implemented at any stage of a contaminated land project or portfolio of works; SMPs that enhance the resiliency of a project could include incorporating natural attenuation into the project strategy, this would ensure that the fate and transport of contaminants were considered in the event the primary risk management mechanism failed.

Ultimately, climate change and financial and institutional changes can introduce risks to projects and thereby undermine the effectiveness of certain risk management options. This presentation will describe how the SuRF-UK Framework allows evaluation of resilience to be built into projects through incorporation of indicators at an early stage of the project and at the point of remedial option selection. Furthermore, the framework allows for the adoption of SMPs that can be implemented throughout the project lifecycle to maintain durable and effective risk management in a dynamic environmental, economic and social context.

Session 2 poster / Abstract title: Cryoconcentration of phosphates contained in agricultural runoff: towards a sustainable strategy for phosphorus recovery in agriculture.

ID: 135

Key words: Phosphorus, metal slag, constructed wetlands, cryoconcentration,

Submitter: Jaume Puigagut

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Session: 2 poster

Abstract

Phosphorus (P) is a key element for agriculture, and mainly obtained from sedimentary rocks mining. However, sustainable P supply is currently at risk due to a substantial decrease of economically feasible mining sites available. Due to the decrease of P availability by means on conventional strategies, the European commission has added it within the list of Critical Raw Materials (European Comission, 2020). Therefore, phosphorus recovery and recycle in agriculture is necessary to ensure future sustainable crop production at current rates. Agriculture runoff is characterized by large amounts of water that have low phosphorus concentration. P recovery from agricultural runoff is no easy task, and sustainable and economically feasible strategies are generally linked to the use of nature-based solutions (NBS) (such as constructed wetlands). NBS are generally characterized by low P removal/recovery, and only when specific adsorption materials are used we obtain high P removal efficiencies (Altamira-Algarra et al., 2022). To this regard, by-products derived from the metal industry (generally known as metal slag) are very common specific reactive media coupled to NBS. Furthermore, the use of metal slag as soil amendment has been also described to provide essential elements for crop production (Das et al., 2019). However, metal slag for phosphorus removal/recovery works better at higher P concentrations. In this study, we aimed at assessing the potential use of a cryoconcentration process as a novel strategy to increase the efficiency of phosphorus recovery from agricultural runoff my means of NBS filled up with metal industry by-products. The application of cryoconcentration for contaminants removal/separation is gaining much attention lately (Drasdasnia et al., 2021).

However, no information is currently available on its use for sustainable P recovery strategies in the contrext of agriculture. The study is now undergoing. For the time being, we have started with agricultural runoff characterization and preliminary tests on phosphorus cryoconcentration have been carried out. The wastewater used runs in a drainage canal by the crop fields production of El Prat de Llobregat (Barcelona, Spain): The equipment employed is a progressive stirred freeze concentration apparatus equipped with indirect cooling that is generally used for food-industry concentration purposes (i.e tomato juice concentration). We will carry out several cryoconcentration batch tests in which optimal working conditions will be assessed by setting different experimental scenarios of freezing temperatures (-5, -10 and -15 °C), rotating speed (0, 500 and 1000 RPM) and freezing time (20, 40 and 60 minutes). After the selection of optimal conditions, adsorption test using iron slag of different sizes (5 mm and from 5 to 20 mm) will be carried out. Results from the adsorption tests will be later modeled according to Freündlich, Temkin and Langmuir isotherm equations to assess both the maximum adsorption capacity and lifespan of the materials employed.

Session 2 poster / Abstract title: New possibilities for monitoring and rehabilitation of extraction wells

ID: 142

Key words: pumping well lifetime; well rehabilitation, ultrasound, well clogging; skin effect

Submitter: Daniel Kahuda

Organization: VODNÍ ZDROJE, a.s.

Co-authors: Jan Kukačka RNDr., CZU Prague, DEKONTA, a.s., hydrogeologist; Daniel Kahuda PhD., CZU Prague, VODNÍ ZDROJE, a.s., hydrogeologist, Pavel Pech Prof., CZU Prague, scientist; Václav Ficaj Ing., CZU Prague, scientist

Session: 2 poster

Abstract

Purpose of the study
The declining supply of available groundwater resources increases the importance of extraction wells. To maximise the pumping yield, operators often avoid the sustainable groundwater management negatively affecting water quality and service life of pumping wells, mainly through ageing process. As part of the INV-FLOW project (2019-2020), a new apparatus for evaluating an extraction well's functionality by measuring the vertical water flow through the screen was designed and tested. The parallel ULTRA project (2017-2020) in cooperation with SONIC Technologies, GmbH carried out field tests of ultrasonic method for water well rehabilitation.

Methodology
The INV-FLOW apparatus consists of two electromagnetic induction flowmeters, two pneumatic packers, and a FC driven submersible pump. The pneumatic packers allow controlled flow through the gravel pack inside the extraction well. After an initial laboratory verification of the fundamental concept, the apparatus was tested in real conditions. Two pumping wells Hadačka HJ-3 and Hadačka HJ-4 were measured at a pilot site in Kralovice, Czech Republic. In comparison the HJ-3 was an aged well at the end of its service life, the HJ-4 was just newly installed. The results of pumping tests, well logging and visual inspections of the tested wells were used to evaluate INV-FLOW measurements.
Ultrasonic well rehabilitation was applied on Konojedy HV-1, Vlastislav MO-4 and Líšany R-3 wells with the aim to restore initial levels of pumping capacity. Magnetostrictive transducers with a total power of 7.5 kW were applied along the clogged well screens with a continuous pumping of the released sediments. The evaluations included visual inspections and pumping (tests before and after the application) as well as well logging. The change in additional resistance (skin effect) was evaluated as the main parameter to assess the

efficiency of the method, followed by specific yield and well efficiency.

Summary of the findings/results

Both the examined approaches were successfully tested in-situ.
INV-FLOW: In the new extraction well, HJ-4, a high proportion of water flowing through the gravel pack relative to the total pumping flow (93–97%) was indicated using the INV-FLOW apparatus at different pumping rates. In contrary, in the HJ-3 extraction well, screen and filter clogging contributed significantly to the limited water flow through the gravel pack. In the most affected parts of the HJ-3 extraction well (15–20 m b.g.l.), the proportion of water flowing through the gravel pack relative to the total pumping flow ranged from 10 to 20%.
ULTRA: Pilot tests of ultrasonic well rehabilitation lead up to improvement in all assessed hydraulic parameters. Visual inspections showed effective opening of well screens, hydrodynamic tests confirmed increase in specific yield and reduction of the skin effect.

Conclusions

The pilot tests confirmed the possibility of using the INV-FLOW apparatus to evaluate an extraction well's degree of clogging and incrustation and the effective rehabilitation of extraction wells with a higher degree of clogging. All pilot test findings are consistent with the previous laboratory results and showed good agreement between the measurement results and geophysical logging in the tested wells.

Significance/contributions of the study

The INV-FLOW and ULTRA apparatus may be primarily used by water supply companies operating extraction wells. Based on direct measurement by the INV-FLOW apparatus, the extraction well operator can evaluate the level of clogging or incrustation of the extraction well and decide on the extraction well rehabilitation or potentially end its operation. If rehabilitation of the extraction well is required, the ULTRA apparatus can be effectively applied. Both technologies can contribute to a reduction in both operational and maintenance costs.

Session 2 poster / Abstract title: Microchar an organic biowaste used to remediate agricultural drought soil and increase biomass growth.

ID: 188

Key words: Biochar, Nutrients, Drought, Biowaste, Carbon, Biomass growth

Submitter: Carol Omara-Ojungu

Organization: Czech University of Life Sciences Prague

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Session: 2 poster

Abstract

Agricultural drought caused by the changing climate is a major challenge faced in Europe, particularly from 2014 to 2018. The hydraulic properties of soil and its vulnerability to erosion are key factors affecting agriculture during drought conditions. The use of biochar in soil has been shown to improve soil water retention, nutrient distribution, crop production, soil stability, and microbial activity. This research project aims to use these benefits of biochar to mitigate the impact of agricultural drought on crop production. Regosol soil from a drought-prone area (Zvěřínek) and cambisol soil from another drought-prone region (Jevany SLP) were used in the experiment. The biochar used was a commercially registered soil additive produced by gasifying dry raw wooden chips with high moisture content. Microchar, made from a commercial biochar and vermitea (a liquid extract from vermicompost with high organic carbon and biological activity), was also used. A pot experiment was conducted using peas as the selected crop and five treatments were tested: control (Regosol soil without additives), soil mixed with biochar, Hoagland solution, microchar, and microchar mixed with Hoagland solution. The results showed that treatments with regosol and microchar were more nutrient-rich compared to cambisol and that biochar had positive effects on plant growth, biomass production, and soil moisture content. The leaching tests showed the pH and electrical conductivity of the water remained stable throughout the experiment. The study highlights the potential of using biochar to mitigate the impact of agricultural drought on crop production.

Session 2 poster / Abstract title: Isotopes meet mass flux – IsoFLUX as a new tool for precise quantification of pollutant degradation in contaminated aquifers

ID: 220

Key words: groundwater, passive samplers, CSIA, monitoring

Submitter: Anko Fischer

Organization: Isodetect GmbH

Co-authors: Goedele Verreydt, iFLUX sampling, enviromental contractor; Erik Bosmans, iFLUX sampling, enviromental contractor; Pieter Schrooten, Cornet Renard bv, enviromental consultant; Kevin Kuntze, Isodetect GmbH, enviromental contractor

Session: 2 poster

Abstract

Purpose of study
An important issue and necessity in the field of contaminated groundwater is knowing how to sustainably reduce the mass flux of pollutants in groundwater resources. The most important process for sustainable contaminant removal is degradation. Understanding sustainable mass flux reduction is necessary in order to correctly evaluate whether Natural Attenuation (NA) is a feasible and reliable solution for the cost-effective management of contaminated aquifers. Moreover, it is an important parameter to successfully undertake and manage biological and/or chemical groundwater remediation measures. Compound-specific stable isotope analysis (CSIA) is clearly the most conclusive method to precisely quantify contaminant degradation, as changes in isotope ratios are directly linked to this process and provide a sound source-plume characterization by the isotopic fingerprint.
Despite the urgent need for a good understanding on the extent of sustainable contaminant removal in groundwater reserves, cost-effective and conclusive approaches have been not available so far.

Methodology
We will present the first-time combination of contaminant flux measurement using iFLUX samplers and isotope analysis as a novel and highly innovative tool to verify and to manage sustainable mass flux reduction. The IsoFLUX tool allows the precise determination of in situ degradation rate constants combined with groundwater and mass flow data, which are key parameters for the modelling of the contaminant plume magnitude and behaviour in space and time. Besides the evaluation of pollutant degradation by isotope measurements, the contaminant mass input from different sources is important to evaluate the overall impact and quantify each source contribution. This allows deriving cost-efficient concepts for

migration risk management, contaminant source removal and water resource protection. IsoFLUX enables the assessment of contaminant flux from various sources. Thus, it can be applied as a forensic tool as well, which does not only include the identification or differentiation of multiple pollutant sources, but also their mass-flux dependent contributions to the overall groundwater pollution allowing the development a founded remedial cost partitioning.

Summary of findings/results and conclusions

The novel IsoFLUX samplers allow very sensitive and precise flux estimations and CSIA of groundwater pollutants like monoaromatics (BTEX), chlorinated solvents (CVOCs) as well as pesticides (e.g. phenoxy acids, desphenylchloridazone). Batch and dynamic laboratory tests revealed precise and accurate isotope analysis reaching significantly lower levels of detection in comparison to conventional sampling procedures. At representative field sites, contaminated with BTEX, CVOC and pesticides (2,4-dichloroprop), alpha testing of IsoFLUX samplers were successfully carried out. Interpretation schemes using the obtained flux and CSIA data complements the IsoFLUX approach enabling meaningful and sound source contribution assessment and degradation quantification. This revolutionizes the advancement of conceptual models the management, monitoring and remediation of contaminated aquifers.

Thus, IsoFLUX can significantly contribute to the risk assessment due to more reliable prediction of the time-related impact of groundwater pollutants on valuable receptors (e.g. drinking water wells, surface waters). The IsoFLUX provides information that can not be obtained via conventional groundwater measurements and analyses. This technology opens a more comprehensive insight into the actual migration and degradation of pollutants in groundwater, our most important natural resource for drinking water.

Session 2 poster / Abstract title: Constructed wetlands as nature-based solutions for the removal of antimicrobial resistance (AMR)

ID: 331

Key words: Co-metabolism, Emerging contaminants, Green infrastructure, Operation of NbS, Wastewater treatment

Submitter: Lucie Krejcova

Organization: Cranfield University

Co-authors: 1. Dr Tao Lyu, Lecturer in Green Technologies and Environmental Engineering MSc course director, Cranfield university, 2. Dr Pablo Campo Moreno, Senior Lecturer in Applied Chemistry, Cranfield university

Session: 2 poster

Abstract

Antimicrobial resistance (AMR) is found in people, animals, plants, and the environment, which has been deemed by the World Health Organization as one of the top 10 global public threats. The extensive use of antimicrobials, including antibiotics, antivirals, and antifungals, for human consumption and agricultural activities has induced a significant amount of residues in the water environment, which provides an ideal condition for the occurrence and proliferation of AMR. Through microorganism mutations and horizontal gene transfer processes, AMR can spread in water bodies even though antimicrobials are not present. Conventional Wastewater treatment plants (WWTPs) are not designed to remove such emerging contaminants and are always considered the key source and hotspot of antibiotics and AMR. With the UK national effort in the Chemical Investigation Programme, several typically used antibiotics, e.g. macrolides (such as erythromycin), have been detected with concentration over 0.1 µg/L in many WWTP effluents. It is expected that discharged effluents will trigger resistance in bacteria after being released to rivers or lakes causing toxic threats to ecosystems. Therefore, advancing the treatment technology and developing management strategy is of utmost importance in order to tackle this global threat.
Nature-based solutions (NbS), such as constructed wetlands (CWs), have been widely used as a low-cost, ecological, and aesthetical solutions for water and wastewater treatment. It has been well proven that NbS can eliminate various pollutants from wastewater, such as antibiotics or antibiotic resistance genes. Besides, NbS can also provide multi-benefits in terms of providing space for the biodiversity of various animal and plant species. The treatment performance of CWs varies depending on the environment, design, and operational conditions. Weather, temperature, pH, hydraulic loading rate, and hydraulic retention time can significantly impact the treatment efficiency of wetlands. Whether and to what extent can CWs as NbS mitigate AMR risks has yet to be systematically studied.

This study aims to summarize the evidence of using CWs as NbS for the removal of AMR through understanding the removal capabilities and mechanisms in order to propose the potential optimization strategy for the enhancement of AMR removal. A systematic literature review was performed by collating datasets from academic and grey literature databases. The objectives of this study are: 1) to compare the removal efficiencies of AMR in different types of CWs, 2) to identify the effects of plants, substrates, and operational conditions on the removal of AMR, and 3) to explore the potential correlation between AMR and nutrient removal via co-metabolism.

The results from current research indicated the vertical flow CWs performed better in AMR removal compared to horizontal flow and surface flow CWs. Moreover, the applications of the highly porous substrate and polyculture conditions could facilitate the removal of AMR. Regarding operational strategies, a lower hydraulic loading rate and higher retention time could lead to more efficient removal of resistance genes. However, most studies were conducted in small-scale systems with artificial wastewater influent, which leaves a huge knowledge gap that needs to be filled by implementing large-scale CWs. Further details will be introduced during the presentation.

With the results, this study can contribute to optimizing NbS and mitigating global AMR risks. The output will be the operational and maintenance management plan of CW to support public and ecosystem health. This presentation will be performed interactively by a roundtable discussion with experts from the field. The discussion will be led on how CW can significantly improve AMR elimination from wastewater with the aesthetical and ethical contributions.

Session 2 poster / Abstract title: Monitoring Xenoestrogens and Polycyclic Aromatic Hydrocarbons Contaminants Using the AhR/ER-CALUX Bioassay to Assess Potential Environmental Risks of Wastewater Reuse for Irrigating Crop Yield

ID: 73

Key words: Wastewater reuse, polycyclic aromatic hydrocarbons, xenoestrogens, CALUX bioassay

Submitter: Yiqi Su

Organization: Vrije Universiteit Brussel

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Session: 2 poster

Abstract

Reduced precipitation, lower crop yields, and alterations in water quality due to global warming and dry seasons have been affecting Belgian farmers for decades. To solve this problem, the reuse of treated wastewater presents significant advantages from an environmental point of view because it allows the recycling of treated water and limits the consumption of fresh water. However, such reuse needs to be strictly controlled to avoid any sanitary risk and pollution of the water table, because inorganic and organic micropollutants may still be present even after the wastewater is treated. In this study, we focused on polycyclic aromatic hydrocarbons (PAHs) and xenoestrogens (XEs) from industrial, domestic, and agricultural discharges. PAHs are known for their carcinogenicity and mutagenicity, while XEs can mimic endogenous estrogens and affect the endocrine system of living organisms. Our objective was to regularly monitor wastewater and groundwater to assess the potential environmental risks of wastewater reuse. Liquid-liquid extraction using n-hexane and solid phase extraction were used to extract PAHs and XEs, respectively. Then, the extracts were tested using an effect-based in vitro CALUX bioassay to detect PAHs and XEs activities in water samples. Biological equivalents (BEQs) of PAHs expressed as BaP equivalents ranged from LoD to 229 ng/L (median: 46 ng/L). XE-BEQs expressed as E2 equivalents ranged from 0.01 to 4 ng/L (median: 0.4 ng/L). Both medians are below the WFD environmental quality standards. Given the observed trends between PAHs in water and precipitation levels, the main source of PAHs in water appears to be wet deposition. In addition, there was no significant change in the activity of PAHs in groundwater at the 5% level before and after using wastewater for irrigation. The source of

XEs seems more scattered, which can be explained by irregular domestic and agricultural inputs. In conclusion, the reuse of wastewater for crop irrigation appears to be a satisfactory economic option from the point of view of PAHs and XEs contaminants. Regular monitoring using effect-based methodology to estimate the potential risk related to these contaminants offers a robust and relatively inexpensive screening compared to traditional instrumental analysis.

Session 2a1 / Abstract title: Laboratory pot tests and field pilot study to determine the best approach to combine the phytoremediation of TPH contaminated land with the production of clean biofuels.

ID: 218

Key words: petroleum hydrocarbons; soil contamination; phytoremediation; circular economy; biofuel.

Submitter: Natàlia Blázquez-Pallí

Organization: LITOCLEAN, SL

Co-authors: Francesca Audino, LEITAT, environmental researcher; Alba Catalán Merlos, LEITAT, environmental researcher; Nora Matanzas, LEITAT, environmental researcher; David Garriga, LITOCLEAN, SL, environmental consultant; Sonia Sanchis, LEITAT, environmental researcher; Carlos Herrarte-Marrón, LITOCLEAN, SL, environmental consultant; Marçal Bosch, LITOCLEAN, SL, environmental consultant

Session: 2a1

Abstract

The objective of the Phy2Climate H2020 Project is to combine the phytoremediation of contaminated land with the production of clean drop-in biofuels, thus, feeding into the circular economy principle, contributing to climate change mitigation, and working towards the restoration of natural resources. To prove the feasibility of such an approach, an industrial site located in Catalunya (Spain), contaminated by total petroleum hydrocarbons (TPH), has been selected as a case study for the development of several pilot tests, first at the laboratory, and later in the field.

At the laboratory, the pot tests aimed at optimizing the application of phytoremediation strategies through the investigation of 1) the most effective vegetative species in terms of TPH removal and their potential for biofuel production; 2) the amendments that would ensure proper growth of plants, and 3) potential nutrient deficiencies and pests. The amendments tested were compost, biochar, PGPR (plant growth promoting rhizobacteria) and common fertilizer, while Brassica napus (rapeseed), Helianthus annuus (sunflower), Sorghum sp. and Panicum virgatum (switchgrass) were the studied vegetative species due to their high efficiency for TPH removal and their potential for biofuel production. Thus, for the pot tests, different soil-plant-amendment combination scenarios were investigated. Monitoring included a complete soil characterization at the beginning and at the end of the experiments, and visual inspections every 15 days to monitor pests and phytopathologies, nutritional deficiencies, height, number of true leaves, and phenological stages. Lastly, after harvesting, both the above- and belowground biomass were sampled for energy crop characterization.

During the pot tests, pests were detected and morphological changes revealed growth differences among the species and scenarios tested. In terms of TPH removal, results ranged between 87% and 97% in all scenarios, including the control experiments, suggesting that soil remediation was mainly due to biodegradation driven by soil microorganisms rather than the plant species, and that microbial activity was not influenced by neither the plants nor their combination with the amendments. In all, results evidenced that the studied species were tolerant to TPH and that, for the purpose of this project, phytoremediation efficiency was not a key parameter for the selection of the species to be planted in the field. Consequently, the selection of the final plant-amendment combination was based on 1) the highest biomass yield for biofuel production, to comply with the specific objectives established by the project's framework; 2) the tendency to develop pests, and 3) the shape of the roots, since the development of well-branched roots generally leads to greater phytoremediation efficiency. For this reason, the combination of Sorghum sp., with the amendments PGPR, compost and biochar, was selected to be applied in the field.
The in situ pilot test, which is expected to last for 3 seasons and is currently ongoing, aims to confirm the feasibility of the selected strategy to reach the two objectives of the project: to clean up and to improve the quality of the affected soils to a state that would allow them to be used as arable land, and to produce the required biomass for clean biofuel production. The pilot is being monitored with the same methodology used at the laboratory, but expanded with an in situ periodic record of several climatic and physicochemical parameters, and an increased soil sampling regime. Such data will be used to assess the effect of the phytoremediation strategy on TPH removal and on enhancing soil quality by estimating the soil quality index (SQI). Lastly, each season, the harvested biomass will be analysed, dried, pelletized and shipped to the project's partners for biofuel production. Results of the pot tests, together with the up-to-date progress of the pilot test, will be presented at the conference.

Session 2a1 orals

Session 2a1 / Abstract title: A microcosm assessment of novel strategies for mitigating metane emissions in paddy rice soils by using electroconductive materials

ID: 328

Key words: Rice paddy fields, methane emissions, flooded soil, microbial community.

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Organization: IRTA - Institute of Agrifood Research and Technology

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Session: 2a1

Abstract

Purpose of the study
Paddy rice fields are one of the major anthropogenic sources of global methane (CH4) emissions. Rice straw incorporation into the soil after harvest in a flooded fallow season, causes the highest peak of CH4 emissions. In this respect, the utilization of alternative electroconductive materials (EMs), might be an attractive strategy to modulate the organic carbon flow across the soil microbiota. The presence of EMs in soil could promote direct

interspecies electron transfer (DIET). In this study, we have performed a microcosm experiment to evaluate the hypothesis that the addition of EMs in rice soils could mitigate CH4 emissions, by altering the microbial carbon utilization and CH4 emission pathways.
Methodology
Laboratory scale microcosms were incubated for 130 days both under anaerobic and mixed aerobic/anaerobic conditions. Different EMs (biochar, fungal-based melanin, and magnetite) were amended to these microcosms, and the results were compared unamended controls. All microcosms contained rice straw (3 %w/w) and water-saturated postharvest soil, both collected from paddy fields in the Ebro Delta (Spain). A moderate soil salt content of 0.6% NaCl to simulate sea flood events. Cumulative CH4 and CO2 production, the isotopic fractionation (CSIA) of these gases, as well as the COD of the flooded soil and its microbial community structure were analyzed. The later was performed by culture-independent molecular tools based on 16S/ITS of bacteria, archaea and fungi, as well as the quantification of total bacteria (16S rRNA), methanogenic archaea (mcrA) and sulfate-reducing bacteria (aprA) (N=4 replicates).
Results
Under strictly anaerobic conditions, melanin supplementation reduced CH4 emission by 24% and 31% after 55 and 130 days, respectively, compared with unamended controls. The addition of biochar and magnetite caused lower decrements in the CH4 emission, of 12% and 6% after 130-days, respectively. Stromberg's kinetic model revealed that unamended microcosms (controls) displayed a maximum CH4 yield (336.97 mL CH4/g COD) that was clearly higher than that of microcosms supplemented with EMs (300.0, 227.8 and 227.0 mLCH4/gCOD for melanin, biochar and magnetite, respectively). Globally, an acetoclastic methanogenic pathway seems to predominate (δ13C-CH4 from -50 to -65 ‰). Regarding the soil microbiota, EMs amendment was linked to a decrease in the number of mcrA genes, which coincided with the observed lower CH4 emissions. The 16S-metabarcoding characterization revealed that Methanosaeta, Methanosarcina and Methanocella were the main methanogens after rice straw amendments under strict anaerobic conditions.
Under mixed anaerobic/aerobic conditions, biochar amendment at 1% w/w lead to a 33% mitigation of CH4 emissions, after 130-days of the experiment. No effect on CH4 emission was observed when biochar was added at 0.5%, while magnetite caused an increase of CH4 emissions of 14%. On-going microbial diversity assessment and CSIA analysis of CH4/CO2 will confirm the magnitude and significance of the impacts of MEs, and potential DIET mechanisms in the soil, under different redox conditions.
Conclusion
The addition of melanin and biochar, as organic EMs, to postharvest paddy rice soil containing postharvest straw, was linked to a decrease of CH4 emissions under long term anaerobic and mixed redox conditions. Soil microbial interactions and the underlying mechanisms affected by the addition of EMs need to be further understood.
Significance/contributions of study
Soil amendments with organic EMs during the postharvest season in rice paddy fields, when straw is incorporated into the soil, could contribute to both mitigate methane emissions and improve soil quality and carbon sequestration.
Acknowledgments
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Session 2a1 / Abstract title: Constructed Wetlands as a Sustainable Alternative to Traditional Pump and Treat Systems

ID: 338

Key words: Constructed Wetland, Climate resilience, Mixture of contaminants of concern, Container pilot test

Submitter: Olga Vounaki

Organization: Environmental Resources Management

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Session: 2a1

Abstract

Olga Vounaki*, Charline Kaplan*, Mattias Verbeeck*, Paulo Valle*, Joshua Both**

Affiliation(s): ERM*, HMVT**

Background/Objectives. At an active industrial plant in Belgium, a multi-faceted remedial strategy has been developed to address a complex mixture of impacts present in both soil and groundwater. Contaminants of Concern (CoC's) included chlorinated solvents, chlorobenzenes, chlorotoluenes, nickel and PFAS (Per- and Polyfluoroalkyl Substances). Following assessment of the site in the context of the local regulatory requirements, remediation is required to mitigate groundwater off-site migration. The initial remedial strategy consisted of (i) installing a hydraulic containment barrier (Pump Treat system) at the down gradient site border to limit off-site contaminant migration, and (ii) a phased approach to remediate the major source zones in line with the BATNEEC (Best Available Technique Not Entailing Excessive Costs) principles.

To improve climate resilience at the site, such as promoting rainwater infiltration, and as part of the Belgian Water code incentivizing stakeholders to opt for a comprehensive and integrated water cycle management system, the remedial strategy was re-evaluated. To develop an integrated water resources management solution, the design was re-assessed considering nature-based alternatives that treat the contaminated groundwater extracted through the hydraulic containment barrier, facilitate the infiltration of rainwater and participates in maintaining local biodiversity.

Approach/Activities. A constructed wetlands is a nature-based substitute for traditional pump

and treat systems offering a low maintenance, low energy (the pumps would be solar powered) and low-cost solution with a high climate change resilience and high biodiversity preservation and restoration.

A small scale, container-based pilot test is currently ongoing on site, simulating the flow of water as in a full extent wetland. It is composed of three different compartments, varying in layers of soil matrix and on presence of water at the surface, to best assess the future full-scale architecture. Physico-chemical parameters are monitored bi-monthly, whereas water samples are collected monthly at the influent and effluents of all compartments and analyzed on CoC's and indicators of the microbial activity. The analytical data, as well as on field measurements such as weather data, will allow a thorough evaluation of the degradation rates of the CoC's, the viable treatment efficiencies and gather specific design information to size up a constructed wetlands housed in a container to large design.

Results/Lessons Learned. Data gathered during the constructed wetland pilot test will be evaluated to assess the feasibility of replacing the ongoing traditional pump and treat by a nature-based solution and performing a BATNEEC analysis. First pilot test results are promising, indicating excellent removal efficiencies of all CoC's even though the seasonal effects of the winter (less sunlight, lower temperatures) work to its disadvantage. The pilot test will be running until late summer 2023 to maximally assess the impact of external factors.

Session 2a1 / Abstract title: Treating Complex Mixture of Contaminants in a Construct Wetland: the Importance of Alternating Hydrochemical Conditions for a Successful Application

ID: 345

Key words: Constructed Wetland, complex mixture of contaminants, alternate oxygen conditions

Submitter: Joshua Both

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Session: 2a1

Abstract

Background: HCH production has been banned for many years, yet the residues from the production, processing and unprofessional storage of these pesticides pose an environmental problem in the form of leaching into surface streams and groundwater. Wetland systems are a passive option to prevent the spread of contamination. Within the European project LIFEPOPWAT, Wetland+® technology cascade prototype was built on the pilot site Hájek (CZE) to treat a daily flow of 260 m3 of drain water containing 100 µg. L-1 of HCH (δ-HCH dominance) and 600 µg. L-1 of chlorobenzenes (ClB). This system includes an aerobic sedimentation module, permeable reactive barrier, biosorption module and aerobic wetland. This report describes the performance of the last module occupying an area of 1830 m2. The wetland is designed as a high biodiversity one and is responsible for removing residual HCH and their transformation products.

Methodology: Sampling campaign in September 2022 concerned plant individuals at the end of their first vegetation season (after their reintroduction and winter hibernation). For sampling purposes, the aerobic wetland was divided into 4 parts (D1-D4). A total of six species of land plant and one species of charophytic algae (Chara) were selected from section D1 - Chara sp., Juncus effusus (JE), Typha latifolia (TL), Sparganium erectum (SE), Acorus calamus (AC), Glyceria fluitans (GF) and Lythrum salicaria (LS). The first four plant species mentioned above were subsequently sampled in the other sections (D2-D4). In each section, sediments and surface water samples were collected. Determination of individual HCH isomers and ClB in plant root and shoot biomass (the entire thallus of Chara), sediments and water samples were performed using GC/MS.

Results: The surface water samples show the gradual reduction in HCH and ClB

concentration in the flow direction (D1→D4). The total removal efficiency of individual isomers from surface water is as follows: α HCH - 72 %; β HCH - 6 %; γ HCH - 81 %; δ-HCH - 70 %; ε HCH - 39 %. This led to β HCH and ε HCH domination (78%) in the outlet isomeric profile. The removal efficiency for ClB was 98 %, with volatilization being the most probable reason.
The average HCH amount in plant biomass was the highest for AC (8.48 ± 1.27 µg. g-1dw), followed by Chara sp. (3.05 ± 0.83 µg. g-1 dw), GF (2.67 ± 0.38 µg. g-1 dw), SE (2.87 ± 0.36 µg. g-1 dw), LS (1.74 ± 0.22 µg. g-1 dw), TL (1.71 ± 0.47 µg. g-1 dw), and JE (1.62 ± 0.21 µg. g-1 dw). HCH amount was higher in roots than in the shoots, except for AC, where the concentration in shoots was five times higher than in roots. The relative abundance of the isomers corresponded to the sediment and water composition, i.e., ε-HCH together with δ-HCH dominated in most of the plants.
Unlike in water, the concentration gradients (D1→D4) of HCH and ClB were not present in the plants and sediments. The possible reasons could be the inhomogeneous sorption caused by different organic carbon content in sediment and periodic changes of preferential water flow that disabled the HCH gradients to establish.

Conclusion: This study presents results from a pilot site focused on the fate and distribution of HCH in the aerobic wetland module of the Wetland+® prototype. HCH uptake was found for all studied plant species. Maximum BCF was found for Acorus calamus and reached the value of about 200. The results of plants and sediments‘ HCH content did not, counterintuitively, follow the gradients observed in water. For the correct decision-making on the vegetation management of the wetland, vegetation mapping will be done prior to the next sampling campaign. Since the removal is a combination of a number of processes, the interpretation is uneasy. However, the selection of best-performing species could achieve higher removal efficiency.

Session 2a1 / Abstract title: LIFE NARMENA: Nature based remediation techniques for heavy metals in sediment - constructed wetlands

ID: 409

Key words: heavy metals, contructed wetland, nature based remediation

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Organization: ABO nv

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Session: 2a1

Abstract

The industrial legacy of western Europe has caused several problems with contamination. One particular issue that will be targeted in the LIFE NARMENA project is contamination with heavy metals in small watercourses that flow through nature reserves. While the source activities are often no longer present, the contamination remains in the sediment and on the banks of the stream. The sediment and banks act as secondary source zones, gradually causing further spreading of the stored contamination, exacerbating the problems caused by this heavy metal contamination. Beside human exposure, ecological exposure is an important issue not only in the streams itself but also in nature reserves through which they flow. Traditional remediation techniques for contaminated sediment typically rely on the removal of contaminated material. While this might be an effective technique in residential or agricultural settings, it is often not desirable in areas with a high nature value as significant ecological damage can be caused by such conventional techniques.
The objective of the LIFE NARMENA project, is to demonstrate less intrusive, nature-based remediation techniques to manage heavy metal contamination in flood-prone watercourses.

The remediation concept will be aligned with the general water and nature management and requires an integrated approach to deal not only with the environmental issues but also the economic and social implications. To facilitate this, the LIFE NARMENA project brings together a diverse consortium of stakeholders: relevant public organizations, nature NGO's and technical partners.

The project consists of three test sites where different nature-based remediation concepts will be demonstrated.
Two of the sites will be used to demonstrate the use of free water surface constructed wetlands. Both sites are primarily contaminated with cadmium, and additionally contain lower

traces of other metals (mainly mercury and arsenic). The contamination on both sites was caused by a combination of historical sediment deposition on the banks and significant seasonal flooding. The remediation concept consists of controlled inundation of the sites, hereby altering the geochemical conditions in the top of the soil/sediment, which results in a decrease in bioavailability and overall mobility of the contaminants.

For one of these two cadmium-contaminated sites, called the “Winterbeek”, the works started in the fall of 2022 and the constructed wetland will be finished in 2023.

The project started in autumn 2019. At the conference we will be able to share more details on the design of the nature-based remediation technologies, as well as results from the baseline measurements before and monitoring results from after the construction of the constructed wetland. We will also share information about how design decisions were made, especially with regards to bioavailability and ecotoxicological modeling.

Session 2b1 orals

Session 2b1 / Abstract title: Synergies between micropollutant biodegradation and subsurface iron precipitation

ID: 223

Key words: biodegradation, groundwater, organic micropollutants, iron precipitation, oxygen

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Organization: Wageningen University

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Session: 2b1 backup

Abstract

Groundwater is the main source for drinking water production in the Netherlands. Drinking water treatment plants (DWTPs) rely on groundwater because soil passage ensures consistent quality and to a large extent protects water sources from contaminants. However, recent reports evidenced that the quality of dutch drinking water sources is deteriorating 1. One of the main threats to the quality of drinking water production is the increasing presence of organic micropollutants (OMPs) in groundwater. The challenge to remove OMPs is forcing DWTPs to retrofit or update their treatment technologies to enhance OMP removal. Oxygen is a potent oxidating agent that can influence the water biochemistry for a technological advantage. Oxygen addition in the subsurface enhances OMP biodegradation2. On the other hand, oxygen is currently added as a standard treatment in some groundwater extraction locations for subsurface iron precipitation3. Dissolved oxygen (DO) in water can also be consumed by the oxidation of ammonium (NH_4^+) and dissolved organic carbon (DOC)4. Recently, it has been shown that, during iron precipitation, the formation of iron hydroxides and reactive oxygen species can interact with DOC and OMPs by producing further oxidation5. Therefore, the presence of DO can enhance the OMPs by either improving biological activity or by catalyzing chemical reactions. In-situ oxygen addition could be used synergistically to boost OMP biodegradation and precipitate iron. The aim of this study was to determine the influence of different oxygen dosing (high, frequent and low) on in-situ OMP removal. As groundwater usually contains DOC, NH_4^+ and iron, these parameters were evaluated in combination to determine how the oxygen addition influence OMP biodegradation. To this end, different sets of batch bottles were prepared

using anaerobic groundwater extracted from an agricultural area of the Netherlands. Each bottle consisted of 95 ml of groundwater and a headspace of 20 ml. For high and low oxygen conditions, bottles were spiked 2 and 0.5 mg O2, respectively. Frequency bottles were initially spiked with 0.6 mg O2 with a re-spike of 0.4 mg O2 on day 3, 7 and 14 resulting on a final cumulative amount of 1.8 mg O2. The presence of DOC, ammonium (NH4+) and iron (Fe2+) were evaluated as relevant parameters in conjunction to the oxygen conditions. DOC, NH4+ and Fe2+ were spiked at a final concentration of 3, 1 and 6 mg L-1, respectively. Four different bottles combinations were prepared in all three oxygen conditions: a) DOC+ Ammonium + Iron, b) DOC+ Ammonium, c) DOC + Iron, d) Ammonium + Iron.
All bottles were capped and incubated at 120 rpm at 20ºC for 21 days. Liquid and gas samples were taken on days 0, 1, 2, 7, 14 and 21. For each set, abiotic bottles were prepared to test any sorption. The bottles were spiked with a mixture of 23 OMPs, each at final concentration of 1.9 µg L- 1.
High oxygen conditions showed an enhanced biodegradation potential compared to frequent and low oxygen dosing. Initial availability of DO directly impacted the biodegradation as high initial oxygen conditions performed better than the frequent oxygen conditions despite having the same cumulative oxygen concentration. The presence of DOC also stimulated OMP removal, presumably by enhancing heterotrophic activity. On the other hand, nitrifying activity which was also limited by oxygen availability, did not show a clear relationship with OMP removal. Lastly, no oxygen competition was observed between iron precipitation and OMP removal at the iron concentrations we worked with (6 mg Fe+2L-1). The study provides fundamental knowledge on the influence of oxygen dosing on the degradation of OMPs in groundwater. Results also shed light on the combined influence of DOC, NH4+ and Fe2+ as relevant parameters found in concurrence in the groundwater chemistry. Ultimately, these results can be useful for DWTPs to adjust their current iron removal treatment to enhance OMP removal

Session 2b1 / Abstract title: Are Nitrogen Compounds Attenuating at Your Site? Implications for Site Remediation and Climate Change

ID: 316

Key words: Nitrogen, Molecular Tools, Groundwater Remediation

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Organization: SiREM

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Session: 2b1 backup

Abstract

Purpose of Study
Nitrogen compound contamination of surface water and groundwater originates from many sources including fertilizer application and production, human and livestock waste, and mining operations. Nitrate and nitrite are toxic to humans and are regulated in drinking water in the European Union where more than one third of groundwater sources exceed regulatory guidelines. Ammonium and nitrate contribute to eutrophication of natural water bodies, and nitrous oxide, produced by partial denitrification, comprises approximately 6% of global warming emissions.

Microbial processes can convert problematic nitrogen compounds into inert nitrogen gas, primarily via denitrification and anammox. Nitrification is also critical, functioning in tandem with denitrification to remove nitrogen mass. Dissimilatory nitrate reduction to ammonium (DNRA) can reduce nitrogen mass in water or soil via volatilization of ammonia. A holistic testing approach combining chemical, isotopic and molecular biological methods could assist decision making and optimization of remediation at nitrogen sites.

Methodology
A multiple lines of evidence approach was used to determine the potential for nitrogen compound remediation in groundwater including: 1) Quantifying major forms of nitrogen including nitrate, nitrite, ammonium and Total Kjeldahl Nitrogen 2) Quantifying microbes and microbial genes for denitrification, anammox bacteria, nitrification and DRNA using quantitative polymerase chain reaction (qPCR) tests. 3) Total organic carbon and volatile fatty acids analysis were used to determine if sufficient electron donor was available to drive denitrification or DNRA. 4) Compound specific isotope analysis (CSIA) targeting nitrogen

(□15N) and oxygen (□18O) stable isotopes was used` to determine if ammonium and nitrate transformations had occurred. Moreover, nitrate sources (e.g., atmospheric, mineral fertilizers, organic fertilizers, sewage) can also be identified based on isotope analyses.

Summary of Findings

A comprehensive suite of molecular, analytical, and isotopic tests (NitroGen™) was used to assess intrinsic nitrogen removal processes at a former fertilizer plant, site in North Carolina. The site was contaminated with petroleum hydrocarbons, naphthalene, and metals in groundwater. Ammonia exceeded regulatory standards in all locations, with a maximum concentration of 30.8 mg/L. The presence of nitrification, denitrification and anammox functional genes in groundwater was confirmed by qPCR tests and indicated multiple pathways for nitrogen mass removal that varied according to site location. The potential for transformation of ammonium was confirmed by the detection of nitrification functional genes and anammox bacteria and was confirmed by 15N enrichment using CSIA. Even though nitrate was undetected, denitrification genes and electron donors, were detected, supporting the possibility for denitrification. The data set provided compelling evidence that ammonia remediation was occurring at the site and likely utilized multiple pathways including nitrification/denitrification and anammox.

Significance

Once the existing pathways for nitrogen metabolism are understood decisions can be made if natural attenuation is sufficient to clean up a site, or if enhanced remediation is needed. Options to optimize nitrogen remediation include electron donor addition, to enhance denitrification or oxygen addition to enhance nitrification. Bioaugmentation has potential to introduce microbes with complete nitrogen pathways that enhance mass removal and reduce nitrous oxide emissions and global warming impacts. Effective monitoring of nitrogen metabolism and related parameters is an important first step to understand intrinsic bioremediation processes and to determine if enhanced bioremediation could improve system performance.

Session 2b1 / Abstract title: Water competition as a result of societal transformation and lignite phase-out in Germany - a complex challenge

ID: 106

Key words: lignite phase out, transformation, climate change, water deamand and supply, water management,

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Organization: Umweltbundesamt (UBA)

Co-authors: René Zahl Msc. UBA

Session: 2b1

Abstract

The planned lignite phase-out in Germany by 2038 is closely linked to water management challenges for the affected regions within a partly also transboundary river basin. Especially in Lusatia the affected area with a size of approx. 2,100 km², led to a water deficit of around 6 billion m³. With the cessation of lignite mining, these quantities of water from the mining pumping and drainage are almost completely lost as available water and will be reversed into water demands. In addition, Lusatia is already one of the areas with the lowest precipitation in Germany, with 500 mm/a, and the expected water shortages will be additionally overlaid by the effects of climate change. In addition to the quantitative problems, even the water quality is also characterised in particular by considerable iron and sulphate loads. Rapid flooding of former opencasts and integration into watercourse management can effectively reduce the load of iron and sulphate. However, water quality control competes with the possibilities of water quantity management. The sulphate pollution along the Spree will decrease significantly due to the reduction mining water discharge. Nevertheless, the iron load will increase markedly with the groundwater rerise and the declining volumetric flow rates in the water courses.
As a start the identification of quantity and quality-related potentials of the presented R project and strategy have been used to develop recommendations. The article exemplifies the interrelationships and dependencies and presents the holistic solution approach for the technical, administrative and political challenges for the region and the river basins. The data and model concept required for this purpose enables a balanced control of water supply and demand by means of a strategic forecasting tool with a forecast horizon up to the year 2100. On the supply side, it includes in particular the total surface runoff in the area under consideration, the shares of groundwater recharge and recharge as well as from all additional water resources. Therefor the water balances of groundwater and surface water are combined in a consistent model and an appropriate decision support tool will be

developed. In a sensitivity analysis, various options are evaluated by suitability, impact and effect.
(1) - Reduction of water demand in agriculture, industry, municipal water supply systems and the Berlin metropolitan region.
(2) - Increasing the water supply, e.g. through water transfers.
(3) - Optimisation of water availability by activating existing reservoirs, re-dimensioning supply pipes, optimising the interconnected management of reservoirs and water retention in the catchment area.
(4) - Technical measures such as control against diffuse substance inputs,
(5) - Management, organisation and communication through transnational management, qualification of forecasting tools.
The interim conclusion of the project is that in Lusatia, with its low-yielding surface waters, only water transfer is sufficiently capable of compensating for deficits. To be able to compensate less of water supply reserve storage areas must be expanded in order to be able to compensate less of water supply. In this respect, the importance of storage increases with climate change.
Crucial is river basin-related water management and targeted control, which requires appropriately commissioned structures and suitable decision-making instruments and responsibilities. The preservation of natural conditions, ecological protected areas (FFH, Natura 2000) and the quantitative and qualitative requirements of the EU Water Framework Directive for water bodies and groundwater bodies are the primary protection goals. In Lusatia, this relates in particular to the preservation of the Spreewald and iron hydroxide control measures.

Session 2b1 / Abstract title: Impact of groundwater table fluctuation on pollutant concentrations: how to adapt monitoring strategy to climate change?

ID: 120

Key words: groudwater quality, point source contamination, monitoring protocol, multi-parameter sensors, warning systems

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Organization: BRGM

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Session: 2b1

Abstract

Point sources of contamination frequently impact groundwater quality; for instance, two thirds of industrial contaminated sites in France are concerned by such an impact. Groundwater quality is thus monitored to observe the evolution and degree of impact. Most monitoring protocols correspond to point sampling in conditions of low and high groundwater table (generally early spring and early autumn). Fluctuations of contaminant concentrations, which are sometimes large with unexplained peaks, are regularly observed. It is therefore challenging to assess whether the situation is deteriorating and whether temporary high concentrations have been considered. This leads BRGM to question the current monitoring strategy, as part of its role in supporting local and national authorities by providing methods and tools such as monitoring groundwater quality in the vicinity of contaminated sites. The representativeness of groundwater monitoring downgradient of contaminated sites is more particularly addressed, especially near groundwater catchments for drinking water.
A state of the art and examples of known sites helps address the question. Understanding the relationship between groundwater levels and the fluctuations of pollutant concentrations appears necessary to improve the monitoring strategy. We assume that important concentration fluctuations are associated with extreme climate periods such as heavy droughts, floods or rainy periods. In a context of climate change, these periods are getting more frequent in Europe and worldwide. We also question the representativeness of the sampling period. To achieve this, we compare the sampling dates with the evolution of the groundwater table, looking in particular at lowest and highest levels. We focus more particularly on two pilot sites influenced by groundwater hydrodynamics. The monitoring data, available for several years and including extreme periods, are interpreted in detail. The first pilot site is a former landfill located in Nantes (western France), where the underlying

alluvial groundwater is polluted by leaching of waste due to rainwater infiltration. The second example is the catchment area of Lille in northern France: the chalk aquifer (Cretaceous) is strongly influenced by volatile organic compounds emissions from various industrial sites. The state of the art shows that the evolution of pollutants concentration is mainly explained by physico-chemical changes in the vadose zone of intermittent saturation above the groundwater table. Unusual variations with a very high groundwater table lead to physico-chemical or bio-chemical changes, that in some cases enhance the liberation/mobility of pollutants through desorption or dissolution. Higher groundwater table is considered to occur in early spring. For the last 20 years, these high levels appear however at different times of the year (from December to June), depending on very heavy rainfall or even floods.
These advances should lead to more effective protocols to improve monitoring strategies: Towards warning systems based on piezometric and/or conductivity thresholds, based on continuous monitoring using multi-parameter sensors, particularly upstream of vulnerable receptors such as drinking water catchments. These alerts could also be used to trigger quality monitoring campaigns to facilitate the detection and management of temporary concentration peaks observed at many contaminated sites.

Session 2b1 / Abstract title: Real-time monitoring networks with groundwater flux data to quantify and manage the dynamic water balance within the complexity of the present use of the area.

ID: 144

Key words: real-time monitoring, groundwater flow, flux, restoration, water balance

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Session: 2b1

Abstract

Introduction
The marshes in the old fortification of the city of Damme and the surrounding polder grasslands is a protected nature reserve. It is the habitat of protected bird species and of international importance for migrating and wintering birds. The nature reserve is surrounded by farmland and residential areas and water management is mainly determined by agricultural needs. After periods of intense rainfall, water is discharged to prevent flooding and water levels are regulated to optimize agricultural use. As a result, wet meadows and marshes are hardly flooded, even in winter which results in a loss of biodiversity. Climate change and especially reduced rainfall in summer is seriously impacting the water balance of the area. Drought becomes a major issue not only for biodiversity but also for agriculture.

Purpose
The main aim of the project is to get a detailed understanding of the water system (water balance groundwater flow), to develop a new climate proof water management, preventing damage to both agriculture and biodiversity from droughts and floods. This will require an evidence based management of water levels as well as more structural measures to store water.

Methodology
A pilot real-time groundwater monitoring network was installed in the area. Groundwater flow velocity and direction is measured, with the unique iFLUX sensors, 1 measuring horizontal flux in a well in the bank of the watercourse and 1 measuring vertical flux in the riverbed of the watercourse “Romboutswerve”. These are combined with a weather station and sensors measuring groundwater level in 10 wells and electric conductivity 5 in wells. Surface water levels are provided by third parties.

Summary of findings and results

The integrated analysis of the data of the meteo-station, the ground- and surface water levels and the flux data led to new insights in the dynamic interaction between ground- and surface water. The role of the main watercourse “Romboutswerve” which was always understood to be important for the irrigation is however rather draining the area and seepage from surrounding channels are more important in determining groundwater levels. The insights provided by the pilot help to explain the challenges to the different stakeholders and concerned municipalities, the province, local and Flemish authorities in charge of water and environmental management and agricultural organisations to cooperate and set up a further actions to restore the nature reserve and the water balance of the area. Further measurements taken will be managed with the help of the extended real-time water monitoring network.

Significance and contribution

Groundwater monitoring networks used today are restricted to a set of instruments measuring water levels. Groundwater levels are however the indirect result of the prevailing groundwater flow. An efficient water policy requires knowledge of groundwater flows and flow patterns. These are currently simulated using complex models that need to be calibrated for different scenarios. At present, these models lack reliable groundwater flow data. Facing climate change and increasing event of flooding and drought, urgent actions are needed to store water and replenish groundwater. Groundwater flow sensors provide real-time data from the site allowing a comprehensive water management respecting the needs of all parties in the area.

Future plan and follow up

With the acquired expertise and knowledge a test will be set up to infiltrate water in the elevated sandy creek ridge, by passive inundation. Groundwater flow and balance will be monitored in the creek ridge and the surrounding lower laying meadows with peaty soil.
At this time the real-time monitoring network is extended. The 18 groundwater level sensors, 12 ground water flow sensors and 7 sensor measuring level of the surface water allows accurate monitoring of the effects and to manage the in’s and out’s of the water system.

Session 2b1 / Abstract title: Microbial degradation and dispersion of contaminants from fiberbanks through gas discharge

ID: 15

Key words: Fiber sediment, gas emission, contaminant dispersion, in-situ measurments

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Session: 2b1

Abstract

Introduction: A large number of fiberbanks from pulp and paper industries are located in Swedish coastal areas of the Baltic Sea. There is still limited knowledge about the dispersion of contaminants from these fiberbanks. Lower sediment to water metal fluxes than expected were obtained in earlier in-situ flux study. In a risk assessment context it emphasize the importance of benthic in-situ flux studies together with analysis of total content of contaminants in sediments [1]. Furthermore, degradation of fiber-sediments leads to release of greenhouse gases [2]. When comparing two fiberbanks with similar pore water levels of PCBs, more than twice as high PCB fluxes were obtained from the one with the highest gas release [3]. The fact that increased gas discharge also leds to increased PCB fluxes gave the idea that gas emission may be an important contributing factor to contaminant dispersion from sediments. The aim of this study is to develop methods useful in environmental risk assessment of contaminated sediments.

Methods: This study was performed at Väja and Sandvikens fiberbanks located in Ångermanälven and at Köpmanholmen´s fiberbank located in the western part of Nätrafjärden, in the County of Västernorrland, north-eastern Sweden. To investigate the importance of gas mediated transport of both Hg and POPs and to sample gas emission, a field sampler was developed. The sampler is equipped with: (1) a filter holder for contaminants to capture contaminats from the gas; (2) gas sampling bags to measure the

gas-volume and (3) particle filters to measure the extent of gas mediated particle resuspension. The sampler is furthermore equipped with iron bars under the funnel that enable forced sampling. Forced sampling was developed to increases gas release with time from fiberbanks that furthermore enabled sampling of larger gas volumes. More gas in the gas bags means that more gas will pass the filter that captures contaminants from the gas. In turn it increases the chances of that more contaminants captured in filters also become detectable during analysis.

Results: We obtained a gas release of approx. 31000 L day-1 and 11 million L year-1 by multiplying the total gas flux 0.44 L m-2 day-1 by the area of the Väja fiberbank (70 000 m2). Using passive in situ sampling, the gas emitted from sediment was in average 58% of CH4 and 9% of CO2. This CH4 content is quite like earlier laboratory results of 56% CH4 [2]. However, with forced sampling, the CH4 content in the gas become even higher (76%) and together with the CO2 content (5%) greenhouse gases constitutes of 81 % of the gas emission compared to 72% of the gas emission in laboratory. The presence of Hg in the gas emission was approximately 1-3 ng/m3 at Väja and 9-12 ng/m3 at Köpmanholmen. HCB was also obtained in the gas emission that was measured to approximately 5 ng/m3 at Väja and between 4-6 ng/m3 at Köpmanholmen. Furthermore, gas facilitated particle resuspension corresponds to 1.2-4.5 kg particles/day at Väja. Preliminary analysis of particles trapped in particle filters also shows that the gas transported particles carry poly cyclic aromatic hydrocarbons.

Discussion and conclusion: Gas emissions from fiberbanks can be an important function for contaminant dispersion as we found different types of contaminants both in gas and on particles carried by the gas. The release of greenhouse gases with the gas emission from fiberbanks may also be underestimated in earlier laboratory experiments as we obtained higher levels in in-situ measurements in field compared to earlier laboratory experiments [2].

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[3] Dahlberg et al. (2021), J. Soils Sediments 21:1852–1865.
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Session 2b1 / Abstract title: Fate and mobility of PFAS in geomedia under saturated and unsaturated conditions: New insight on column experiments

ID: 372

Key words: PFAS, sorption, soil, leaching, equilibrium sorption coefficient

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Session: 2b1

Abstract

Purpose of study
Poly- and perfluoroalkyl substances (PFAS) have become major emerging contaminants of concern due to their widespread occurrence in the environment and potential for human health impacts. A major interest is to understand their fate and mobility in environment, which is mainly controlled by sorption process in geomedia. PFAS sorption is dependent on PFAS molecular structure, geomedia physical and chemical properties and chemical properties of the aqueous solution. Column experiments have been used to quantify PFAS sorption albeit they have been mainly done in saturated conditions targeting PFAS sorption on solid-water interface (SWI) but preventing to assess adsorption reactions on air water interface (AWI). This lack of knowledge could prevent to understand correctly PFAS fate and mobility in soil and unsaturated zone of the aquifer. The aim of this study is to assess accurately dependence of PFAS sorption to geomedia saturation based on column experiment.

Methodology

The experiment were conducted with 4 PFAS (PFOA, PFOS, PFHxS and PFBS). Column experiments in saturated and unsaturated conditions were carried out on the two different geomedia (sand and a soil). To characterize the hydrodynamic properties of the two geomedia, experiments with a non-reactive tracer were done. A 10-2M CaCl2 solution was used as background electrolyte. For each saturation conditions, 2 stages have been carried out: injection of input solution with PFAS, ii) injection of free-PFAS input solution. Two PFAS concentrations were used in the input solution either 5 mg L-1 for each PFAS mimicking the ones encountered in contaminated soil and a lower PFAS concentration (5 µg L-1 for each PFAS) similar to environmental concentration. Analysis for PFAS compounds has been carried out using liquid chromatography mass spectrometry (LC-MS).

Summary of findings/results

At high PFAS concentration, PFAS sorption was similar in unsaturated and saturated conditions for the two geomedia. PFAS sorption could be neglected on sand. By contrast, sorption differs according to PFAS molecular structure in the soil. PFAS compounds with longer chain, notably PFOS, were more sorbed. PFAS with longer carbon chain interact more with clay minerals and organic matter. Comparison between unsaturated and saturated conditions highlighted that PFAS are mainly sorbed onto surface of solid phases and sorption at AWI could be neglected.

At low PFAS concentration, saturation conditions as well as PFAS molecular structure impact their mobility in the two geomedia. PFAS with longer carbon chain were found to be sorbed on organic matter and clay minerals but also on quartz. Higher PFAS sorption was quantified under unsaturated conditions than in saturated conditions showing that sorption reactions on the AWI seem to play a key role at environmental PFAS concentration. This trend is greater for PFAS compounds with a longer carbon chain.

Conclusion

At high PFAS concentrations, values of the equilibrium constant coefficient depend on the amount of organic matter and clay material in soil and the carbon chain length of PFAS but saturation condition does not impact PFAS residence time. By contrast, sorption reaction onto SWI, hence saturation condition, are a main driver of PFAS mobility at low PFAS concentration. Compounds with the longer carbon chain are more sensitive. In addition, sorption of PFAS onto silicate minerals cannot be neglected at low PFAS concentration to assess correctly PFAS mobility.

Significance / contributions of the study

By demonstrating that PFAS sorption at AWI is concentration dependent, this study has improved understanding of PFAS mobility in unsaturated zone. The results reported herein highlight the value of conducting an integrated set of column experiments for investigating PFAS sorption processes and refine the conceptualization of PFAS mobility in environment.

Session 2sps1 orals

Session 2sps1 / Abstract title: Climate Change Adaptation in the United States Superfund Program: Insights from Climate Vulnerability Assessments at Contaminated Sites.

ID: 421

Key words: resilience, adaptive capacity, vulnerability, protectiveness

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Session: 2sps1

Abstract

In 2021, the U.S. Environmental Protection Agency (EPA) Office of Land and Emergency Management (OLEM) issued a directive recommending approaches to consider when evaluating climate resilience throughout the Superfund cleanup process for National Priorities List (NPL) sites that is consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, commonly known as Superfund) of 1980 and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) of 1968. Climate resilience planning through the implementation of this directive involves: (1) assessing the vulnerability of a remedial action's components, such as impacts of climate change on site infrastructure and the long-term integrity of the selected remedy, (2) evaluating adaptation measures that increase the system's resilience to a changing climate and ensure continued protectiveness of human health and the environment, and (3) the implementation of adaptation measures to ensure the long-term integrity of remedial actions and their protectiveness of human health and the environment. The U.S. EPA defines vulnerability as the degree to which a system or remedy is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. At Superfund sites, we are specifically focused on how changes in climate conditions may impact a remedy's protectiveness

This session will explain how the U.S. EPA Superfund program utilizes climate vulnerability assessments and available resilience tools as the first step in identifying, prioritizing, and implementing resilience measures to assure the adaptive capacity of the selected remedy.

Additionally, the session will take a deeper dive into several site examples that illustrate how climate adaptation is integrated into the Superfund program through assorted processes and tools used to conduct vulnerability assessments and mitigate climate change.

The interactive portion of the session will involve two parts - an exercise and a discussion. The exercise will involve a case study of a site where participants will use the information provided to determine how site-specific climate hazards may impact the selected remedy's vulnerability and the connection between the selected remedy's vulnerability and the potential loss of remedy integrity due to that vulnerability. The second part will be a group discussion on how agencies in attendance are adapting selected remedies to a changing climate and how assessing the vulnerability of a remedy might factor into building the adaptive capacity of the remedy.

Session 2sps2 orals

Session 2sps2 / Abstract title: AquaConnect: Circular water management for regional drought resilience.

ID: 424

Key words: Mitigation water scarcity, Digital tools aids, Physical/chemical and nature-based water treatment technologies, new mode of governance, collaborations

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Session: 2sps2

Abstract

Many regions worldwide are vulnerable to increasing threats to fresh water resources that are essential for ecosystems and societal functioning, incl. industrial and agricultural production. Addressing the specific challenges in water provision in the regions worldwide with a high variability and with an increasing negative trend in fresh water availability linked to global climate change is becoming more and more urgent. To mitigate regional fresh water scarcity, circular water management is essential to lower the pressure on precious fresh water resources. Regional circular water management requires innovative technological concepts and a revisioning of the regional governance aspects. These concepts include both digital tools for modelling of the regional water system and a combination of physical/chemical and nature-based water treatment technologies to make new water resources fit-for-purpose