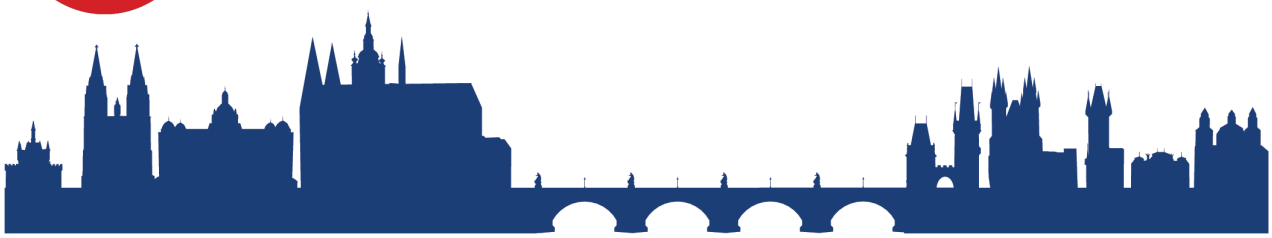
AquaConSoil

11 - 15 september 2023 | Prague



Topic 1 - abstracts

This document contains the abstracts for topic 1. Topic 1 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 1: Water and soil resource recovery in the context of Circular Economy and European Green Deal
Posters	-
1a1	Circularity approaches for wastewater-, soil- and sediment-based materials
1b1	Water reuse and artificial recharge
1d1	Re-use of soils and sediments - Management approaches and strategies
1d2	Re-use of soils and sediments - Assessment, characteristics and functionalities
1d3	Re-use of soils and sediments - Case studies
1sps1	New challenges call for new soil professionals
1sps2	National Competence Centre II BIOCIRKL – Biorefining and circular economy for sustainability

Posters

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139	Ipek Tezyapa	Cranfield University	Using Green Solvents For Resource Recovery From Industrial Sites.
153	Muhammad Merei	Czech University of Life Sciences Prague	Sustainable Drainage Systems as a water regime protection: An Investigation through analyzing ponding time.
181	Ebissa Gadissa Kedir	IIT Roorkee	Modelling Boundary Shear Stress distributions in compound channels with Secondary flows
199	Anja Enell	Swedish Geotechnical Institute	BALANCE - Treatment of low-contaminated soil with biochar produced from organic waste for sustainable resource use and circular economy
251	Tsira Beruashvili	Tbilisi State University of Caucasian Institute of Mineral Raw Materials	For soil health and plant nutrition, development technology for creation of biofertilizer.
320	Sopio Jalaghania	Ivane Javakhishvili Tbilisi State University, Alexandre Tvalchrelidze Caucasian Institute of Mineral Resources	The thermal waters cleaning from H2S with natural adsorbents
386	Jenny Norrman	Chalmers University of Technology	Mass management – indicators and key performance indicators for reduced climate impact in procurements
399	Christine Switzer	University of Strathclyde	Soil Transplant Method to Rehabilitate Soils Damaged by Contamination and Aggressive Remediation

Session 1a1

Thursday 09:00-10:30

Room D218

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72	Charlotte Colman	Arcadis Belgium	Circular use of wastewater and excavated soil on a building site: case study of the ponds at the Thurn & Taxis site in Brussels
228	Hazel Comyn	Ramboll	Reuse of Metal Impacted River Sediments
371	Aline Coftier	BRGM	Anticipating the evolution of trace element mobility in dredged sediments managed on land: a new methodology based on controlled weathering tests.
392	Ipek Tezyapar Kara	School of Water, Energy and Environment, Cranfield University	Metals recovery from metallurgical wastes using biometallurgy
396	Christine Switzer	University of Strathclyde	Smouldering Biosolids to Improve Their Circular Economy Potential in Agriculture
222 - backup	Juan Francisco Morales Arteaga	University of Ljubljana	Comparison of Different Chelator-Based Methods for Toxic Metals Removal from Sewage Sludge in Closed-Loop processes

Session 1b1

Tuesday 11:00-12:30

Room D217

ID	Name	Organization	Title
201	Katerina Tsitonaki	WSP Denmark	Investigation of PFAS in soil and groundwater under sewage sludge treated fields.
205	Alessia Ore	Wageningen University	Micropollutants transformation products formation in subsurface irrigation with wastewater treatment plant effluent: non-target analysis on a pilot case study
282	Ilse van Keer	VITO	Environmental risk analysis for the reuse of treated wastewater for irrigation purposes in Flanders

317	Mateusz Zawadzki	Vrije Universiteit Brussel	Water reuse for irrigation and groundwater recharge: time series analysis for subirrigation system performance assessment.

Session 1d1

Tuesday 16:00-17:30

Room D217

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14	Michiel Gadella	Ministry of Infrastructure and Environment, Rijkswaterstaat.	Soil Passports in the Netherlands – an instrument for the circular economy
54	Noémie DUBRAC	BRGM	Toward an efficient traceability for excavated soils in France
77	Jay Hall	Arcadis	Soil recovery and re-use on major infrastructure projects – what is needed to achieve positive outcomes
303	Lars Rosén	Chalmers University of Technology	Circular management of contaminated soil
308	Johan Ceenaeme	OVAM	From soil cure towards regenerative soil care in Flanders: ambitious new policy instruments

Session 1d2

Thursday 14:00-15:30

Room D217

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55	Léa Deceuninck	Haemers Technologies	In Situ Thermal Treatment of Japanese Knotweed, a solution to recover infested soils
104	Ville Kilponen	Ramboll	Construction of a development platform for a new urban district through the use of dredged material stabilized using recycled binder materials
175	Ingrid Rijk	Örebro University	Effects of biochar and peat amendments on recovery of soil functions in contaminated soil
341	Baptiste Sauvaget	eOde	Cartifond – Preservation of soil resources and reuse in an urban area. Establishment of soil background values for the Metropolis of Lyon from existing data according to the new French national methodology
370	Araya Negash	National Institute for Public Health and the Environmen	Soil and building material reuse: how blurring the lines may help regulation
90 - backup	Neus Bonet-Garcia	Universidade do Porto and Université de Limoges	Metal mobility in an anaerobic-digestate amended soil: the role of two bioenergy crop plants and their metal phytoremediation potential

Session 1d3

Wednesday 14:00-15:30

Room D217

ID	Name	Organization	Title
182	Charlotta Tiberg	Swedish Geotechnical Institute	Effects of biochar and peat amendments on metal solubility and uptake by grass and earthworms
253	Marco Gardini	Ramboll	Lime-cement stabilization to allow the reuse of geotechnically weak soils: managing possible drawbacks and

			strategies to deliver highly effective results.
278	Joke van Wensem	Rijkswaterstaat	LIFE CO2SAND Using clay to make farmland climate proof
309	Pieter Buffel	EnISSA	Volume estimate of VOC-containing materials in a landfill based on MIP soundings
369	Wouter van der Star	Deltares	The Delfzijl Mud Ripener: a pilot using marine soft sediment to construct embankments

Session 1sps1

Wednesday 09:00-10:30

Room D226

ID	Name	Organization	Title
270	Barry Versluis	Koninklijke NLingenieurs	New challenges call for new soil professionals

Session 1sps2

Tuesday 14:00-15:30

Room D222

ID	Name	Organization	Title
62	Olga Solcova	Institute of Chemical Process Fundamentals of the CAS	National Competence Centre II BIOCIRKL – Biorefining and circular economy for sustainability

Session 1 poster / Abstract title: Using Green Solvents For Resource Recovery From Industrial Sites.

ID: 139

Key words: Resource recovery; critical metals; green solvents, industrial sites.

Submitter: Ipek Tezyapa

Organization: Cranfield University

Co-authors: Dr. Stuart T. Wagland CChem, FRSC, FHEA, Cranfield University. Prof. Frederic Coulon, Cranfield University.

Session: 1 poster

Abstract

There are 325,000 past metallurgical sites in Europe with critical metal-rich wastes. The purpose of this study was to utilise a novel metal recovery process using green solvents to recover metals from past metallurgical sites. This could provide quick and local access to metals whilst remediating a large polluting legacy.
Two types of “green” solvents were tested – deep eutectic solvents (DES), using Choline Chloride as a hydrogen bond acceptor mixed with different hydrogen donors, Malonic acid, Ethylene glycol and Urea. These were studied at different ratios of acceptor to donator. The second green solvents were Chelating agents (CA), L-glutamic acid N N-diacetic acid tetrasodium salt (GLDA), Ethylenediamine-N,N'-disuccinic acid (EDDS), Nitrilotriacetic acid (NTA), were tested and buffered to pH. 4, 6 and 8. These solvents were batch tested using real-world past-metallurgical waste, blast furnace oxide slag (BFOS) was mixed at a 12.5% (w/v) . Samples were agitated (150 rpm) for 15 minutes and left to settle for 2 hours, before being filtered and analysed for metal content using ICP-MS.
Batch studies showed a consistent metal removal between the three DES at a 1:1 ratio. The ChCl-EG was most effective for metal removal, 61% of all metals removed. Lead was the most removed at 66% (Figure 1). The improved metal removal for ChCl-EG can be attributed to EG having more readily available electrons, increasing Eh, so more metals can be oxidised. Deep eutectic solvents at 2:1 had the least favourable metal removal due to increased electron competition from the electron acceptor, ChCl.
Figure 1 The percentage of metals removed is dependent upon solvent. DES at 1:1 ratio hydrogen bond acceptor to hydrogen bond donator. CA at pH 4.
The metal removal varied more in CA (Figure 1). Tests at pH 4 were more favourable for metal removal. The EDDS batch at pH 4 had a total metal removal of 46%, the highest of all CA batches. Metal removal was ordered; pH. 4 > 8 > 6. More tests are needed to ascertain

the change in removal between pH 6 and 8.
This study compared the metal removal capabilities of novel green solvents, DES and CA, from real world past metallurgical sites. A batch test of these green solvents has not been carried out on real world bulk waste material before, blast furnace oxidised slag was tested in this study. Results have shown that recovery of critical metals from past metallurgical sites using green solvents is possible, 61% of all metals present were removed in batch studies using DES. A varied metal suite can be removed, iron, lead and lithium, up to 60% of each metal was removed by most green solvents. Besides controlling the filling ratio and initial pH of some batches, there were minimal physicochemical controls on the system, i.e., all batches were carried out at room temperature and no buffering took place during the batch. This opens up several opportunities to optimise the removal of metals using green solvents. Such developments of the hydrometallurgical approach could be through continuous rinsing. This is a promising and cost-effective strategy for efficient metal removal. Establishing green solvents in real-world metalliferous waste will significantly reduce the potential environmental risk these sites pose whilst exploiting large resource recovery opportunities. Benefiting the circular economy of nations developing resource recovery, boost economic resilience and meet national and international strategies for net zero and the European Green Deal.

Session 1 poster / Abstract title: Sustainable Drainage Systems as a water regime protection: An Investigation through analyzing ponding time.

ID: 153

Key words: Sustainable Drainage Systems, circular economy, natural water management, flooding

Submitter: Muhammad Merei

Organization: Faculty of Environmental Sciences - Czech University of Life Sciences Prague

Co-authors: Jakub Štibinger CSc., CZU Prague, associate professor

Session: 1 poster

Abstract

Sustainable Drainage Systems (SuDS) are a key component of the circular economy. They mimic natural water management systems and are designed to slow down and clean water before it enters rivers and streams, which helps to reduce the risk of flooding and water pollution, while also improving the quality of the water for people and wildlife. SuDS are a perfect example of the circular economy principle in action, by mimicking natural systems, SuDS can help to reduce the need for costly and energy-intensive infrastructure, such as concrete drainage channels. They also help to reduce the amount of water that needs to be treated, which can save energy and reduce costs.

One of the main benefits of SuDS is their ability to slow down and clean water before it enters rivers and streams. By allowing water to infiltrate into the ground, rather than running off into drainage channels, SuDS can help to reduce the risk of flooding. This is especially important in urban areas, where the risk of flooding is often increased by the large amounts of impermeable surfaces such as concrete and tarmac. SuDS also help to improve the quality of water by removing pollutants such as oil and heavy metals. They can also help to reduce the amount of nutrients such as nitrogen and phosphorus that enter rivers and streams, which can cause problems such as eutrophication and algal blooms.
Another important aspect of SuDS is their ability to provide habitat for wildlife. They can help to create diverse ecosystems that can support a wide range of species, from insects to birds and mammals. This can help to improve the overall biodiversity of an area and can also provide valuable green space for people to enjoy.

Purpose: The main objective of this case study is to measure the effectiveness of SuDS in reducing flood risk by measuring ponding time.

Methodology and results: The study was conducted in an area with a history of flash flooding. The research methodology involved installing SuDS units in the selected area, and measuring the ponding time before and after the installation of SuDS. The findings of the study showed that the SuDS were effective in reducing the ponding time by an average of 20%, indicating a reduction in flood risk.

This case study shows that sustainable drainage systems are an effective way of reducing flood risk by slowing down and cleaning water before it enters rivers and streams. The study also highlights the importance of monitoring and measuring the effectiveness of SuDS in reducing flood risk, as well as the benefits of SuDS in terms of water quality and biodiversity.

In conclusion, sustainable drainage systems are an important component of the circular economy. They help to reduce the risk of flooding and water pollution, while also improving the quality of water for people and wildlife. They also provide habitat for wildlife, and can help to create diverse ecosystems that can support a wide range of species. SuDS can also help to reduce the need for costly and energy-intensive infrastructure, and can save energy and reduce costs. This study aims to provide a comprehensive analysis of the potential benefits of SuDS and their importance in the circular economy and urban areas.

This study is significant because it demonstrates the effectiveness of SuDS in reducing flood risk by slowing down and cleaning water before it enters rivers and streams. SuDS mimic natural water management systems and are designed to reduce the need for costly and energy-intensive infrastructure, such as concrete drainage channels. They also help to reduce the amount of water that needs to be treated, which can save energy and reduce costs. This study highlights the potential benefits of SuDS and their importance in the circular economy and urban areas.

Session 1 poster / Abstract title: Modelling Boundary Shear Stress distributions in compound channels with Secondary flows

ID: 181

Key words: Compound channels, Velocity distributions, Boundary conditions, Hydraulic parameters, Semi width ratio

Submitter: Ebissa Gadissa Kedir

Organization: IIT Roorkee

Co-authors: nan

Session: 1 poster

Abstract

The present study presents a five-parametric analytical model to determine the depth-averaged velocity and boundary shear stress distribution in prismatic compound channels. An analytical solution to predict depth-averaged velocity and boundary shear stress distributions in rectangular compound channels. The analytical solution to the streamwise depth-averaged momentum equation includes the effect of non-dimensional coefficient (β), secondary flow term (Γ), bed friction factor (f), secondary flow coefficient (k), and dimensionless eddy viscosity (λ) is presented. Thus, the analytical expression to determine the non-dimensional coefficient is developed. Different boundary conditions at the main channel and floodplains are presented and used to determine the integration constants. For model validation, extensive laboratory experiments have been carried out on a compound channel with a ratio of the total width of the channel to flood plain ranging from 1.6 to 3. In addition, the model is also validated with experimental data from Birmingham University. The analysis shows that the depth-averaged velocities are found to be sensitive to a shear stress-dependent model parameter. The performance of the present model is also compared with the earlier existing models, and the present model is found to perform better when compared to earlier models. Using the proposed model and derived expressions leads to better simulations of depth-averaged velocity in the present experiments and Birmingham University channels data. Thus, it promises to simulate the flow field and related characteristics in a better way. There may be a need for further evaluation of the proposed model in more complex environments or flow conditions in compound channels, and this part is preserved for future investigations. The application of the present model can be a powerful tool for sediment analysis, river engineering, flood control structures, modelling flows in complex channels, and designing and planning water resource structures that may benefit from expanding the proposed model. More investigation on this application is recommended and forwarded. It may be developed with more complex flow conditions, and the extension of the proposed model can be the subject of further investigations.

Session 1 poster / Abstract title: BALANCE - Treatment of low-contaminated soil with biochar produced from organic waste for sustainable resource use and circular economy

ID: 199

Key words: sustainable remediation; risk management; soil quality; detoxification; biochar

Submitter: Anja Enell

Organization: Swedish Geotechnical Institute

Co-authors: Anja Enell (1), Dan Berggren Kleja (1), Alf Ekblad (2), Hans Gustavsson (3), Sara Hallin (4) Ludvig Landen (5), Maria Larsson (2), Ingrid Rijk (2), Anna Sorelius (3), Cecilia Sundberg (6), Charlotta Tiberg (1); 1.Swedish Geotechnical Institute; 2. MTM Research Centre, School of Science and Technology, Örebro University; Sweden; 3. Helsingborg Stad, Sweden; 4. Department of forest mycology and plant pathology, Swedish University of Agricultural Sciences; 5. NSR AB, Sweden; 6. Department of Energy and Technology, Swedish University of Agricultural Sciences

Session: 1 poster

Abstract

Purpose:
Biochar produced from organic waste is used as a soil amendment due to its capacity to retain water and nutrients. Biochar can also effectively sorb heavy metals and organic pollutants, thereby reducing their mobility, bioavailability and toxicity, and lowering the risk for adverse environmental and health effects. Thus, biochar has a great potential to be a sustainable in-situ remediation method as it may both detoxify the soil and up-grade the soil quality. However, large-scale experiments studying long-term effects under field conditions are lacking. The overall goal of this study is to develop a framework for resource efficient treatment of contaminated soil using biochar, including methods for assessing 1) detoxification, 2) soil quality improvement and 3) environmental impact of various alternatives in a life cycle perspective.

Methodology:
In 2019, we initiated a field trial where effects of biochar on both ecological key parameters and contaminants were evaluated. During 2019-2022, the mobility of the contaminants (measured as soil porewater concentrations) was monitored together with various biotic and abiotic soil properties. In our new project, called BALANCE (2022-2025), we will use these data and new findings to provide knowledge about long-term effects of biochar. BALANCE includes four technical work packages (WP). WP1 will continue the monitoring of our full factorial field trial, where soils, contaminated with polycyclic aromatic hydrocarbons (PAH)

and metals, have been treated with 0%, 3% or 6% (w/w) biochar. Soil, grass, and soil porewater will be sampled in the autumn 2023, (i.e. four years after the field trial was established) and analysed for contaminants and soil quality parameters (focusing on the nitrogen cycle). The field trial will then be fertilized, and the sampling will be repeated in autumn 2024. WP2 studies the potential of biochar to decrease the risk for vapor intrusion of volatile PAH into buildings, using a new pilot scale trial, where soil pore gas will be surveyed during 2023-2024. WP3 will use data from WP1 and WP2 to provide guidance on how to assess risk reduction for humans and environment when multi-contaminated soils are treated with biochar. Finally, WP4 will assess circular re-source and environmental effects using life cycle assessment and a new framework for urban circularity.

Summary of findings/results:
So far, the field trial has shown that addition of biochar to multi-contaminated soil can decrease mobility and uptake of cationic metals, especially Cu and Hg, as well as PAH. More favourable conditions for earthworms and microorganisms, were provided already after one growth season, while plant nutrients were retained in the soil. Reduced metal concentrations in soil porewater of the field trial remained during 2019-2022. Environmental systems analysis showed that biochar treatment can save fuel and backfill materials and bring large reductions of CO2-emissions compared to traditional remediation (excavation and landfilling of soil).

Conclusions:
The treatment with biochar was effective after the first vegetation season. However, there are still important aspects that need further investigation to enable biochar use on a large scale. Here, BALANCE will give important contributions.

Significance/contributions of study:
Biochar as a remediation method has great potential to increase re-use of soil, reduce landfilling of soil, save virgin materials and store carbon in the soil, leading to a more sustainable use of land and waste resources. However, to enable large-scale use, there is an urgent need for good examples and a framework that can be used to assess potential benefits and risks of biochar application.

Session 1 poster / Abstract title: For soil health and plant nutrition, development technology for creation of biofertilizer.

ID: 251

Key words: Potassium, fertilizer, ecological. zeolite, trachyte,

Submitter: Tsira Beruashvili

Organization: Tbilisi State University of Caucasian Institute of Mineral Raw Materials

Co-authors: Shalva Malashkhia, Doctor of Technological Sciences, Head of the Scientific Biotechnological Department

Session: 1 poster

Abstract

Global climate change and agriculture are interrelated processes. Climate change can affect agriculture both directly and indirectly. For agronomy sector soil plays a vital role in crop production and meeting the nutritional requirements of a growing population. About 95% of our food comes from the soil. Soils store and supply 14 of the 17 essential plant nutrients. However, only healthy soils can supply these nutrients to plants(1).
Nitrogen fertilizers are often used to fertilize the soil and increase crop yields. which not only has a positive effect on the soil, but also their leaching as a result of irrigation or rain pollutes both surface and groundwater. often added pesticides and herbicides that have cumulative properties, remain in the soil, pass to the green plant, products, and finally enter the human body. When the soil ecosystem is polluted, they negatively affect the entire environment, increasing greenhouse gas emissions, which leads to climate change.
It is known that for the normal growth of the plant, it is necessary to add fertilizers containing nitrogen, potassium and phosphorus to the soil. Research has established that potassium, like nitrogen and phosphorus, belongs to the number of the main elements that are necessary for the growth and development of the plant. An insufficient amount of potassium in the plant cells leads to the accumulation of ammonia in it Therefore, along with nitrogen fertilizer, it is necessary to introduce potassium-containing fertilizers into the soil, which, in turn, balance nitrogen metabolism and significantly restore soil fertility. The limited of potassium raw materials and their high price make it necessary to find new alternative sources, to develop environmentally friendly and zero waste technologies for production potassium of fertilize.
Environmental pollution, t have put humanity in front of the search for alternative ways to use chemical methods for the transition to bio-farming has become obvious all over the world. In recent years, farmers in Georgia have also become interested in the production of bio-products. In order to better fertilize the soil and obtain products that are harmless to health, it was necessary to use environmentally friendly fertilizer. Since Georgia already had a

nitrogen fertilizer plant. It was planned to develop a technological process for an alternative environmentally friendly potash fertilizer, different from chemical fertilizers. In this direction, deserve interest the scientific-practical works performed by a group of scientists at Tbilisi State University In the conducted studies, potassium-zeolite fertilizer was obtained from the Black Sea water, concentrating potassium and adsorbing it on zeolite-clinoptilolite The technological process requires heating a large volume of sea water to 70-80°C, which leads to energy consumption and an increase in the cost of the fertilizer. There was a need to make changes in the technological process where local trachyte deposits containing potassium will be used for the production of environmentally friendly fertilizer instead of sea water(2). Scientists of the Biotechnology Caucasian Institute of Mineral Raw Materials y also used local trachyte ore to obtain potash biofertilizer from the microbiological method. Trachyte was treated with silicate bacteria in the technological process to separate potassium. The reproduction of silicate bacteria requires maintaining an optimal regime, conducting multiple fermentations. This prevents further commercial implementation of the developed technology (3). At this stage, an investment is needed for process improvements to create an alternative potash-zeolite fertilizer to make significant changes in agricultural systems. The introduction of environmentally friendly potassium-zeolite fertilizer into the soil, unlike the chemical fertilizers used, will lead to cardinal changes for the improvement in agricultural countries for soil improvement.

Session 1 poster / Abstract title: The thermal waters cleaning from H2S with natural adsorbents

ID: 320

Key words: Thermal water, Natural adsorbents, Cleaning, Clinoptilolite

Submitter: Sopio Jalaghania

Organization: Ivane Javakhishvili Tbilisi State University, Alexandre Tvalchrelidze Caucasian Institute of Mineral Resources

Co-authors: nan

Session: 1 poster

Abstract

Purpose of study
Thermal waters from commercial and ecological point of view are among the cheapest, most environmentally friendly, stable and inexhaustible energy sources. Their use plays a significant role in combating climate change and improving the atmospheric air.
Georgia is rich in geothermal waters, but hydrogen sulfide and soluble hydrosulfide ions with a content of 5-18% mg/l hinder widespread consumption of thermal waters. Moreover, the content of hydrogen sulfide makes 1mg/l, and the rest is HS-. Both forms of hydrogen sulfide are toxic.
The main goal of the proposed work is to choose and develop the adsorbents for uptake H2S and in future implement environmentally safe technology of purification and subsequent wide safe use of thermal waters.
It is known extraction of hydrogen sulfide from waters by methods of oxidation, chemical aeration by passing ozone or hydrogen peroxide, sorption using synthetic expensive adsorbents. These methods require large complex designs with multi-stage technology.
Methodology
Advantages of technology chosen by us: simple treatment plant, single-stage filtration process using local natural zeolite, developed technological process provides complete purification of thermal waters from sulfur compounds.
Activated carbon (AC) AU-3 and natural zeolite clinoptilolite (CL) in initial and modified forms were used as sorbents. Cation-modified forms of CL have been prepared by wet-milling method. The crystalline structure and content of prepared adsorbents have been studied by X-ray diffraction (XRD) technique, IR- and AAS methods. Clinoptilolite processing and initial adsorption studies were carried out under laboratory conditions, then on the small-sized pilot plant and finally on the complete cleaning system installed, where composite sorbent AU-3 and modified clinoptilolite were sequentially loaded.
Results

Adsorption experiments carried out varying the ratio zeolite: AC, composite: solution, duration of contact, granulation degree. The results obtained showed that modification of CL by ion-exchanging method with metal ions (Zn^{2+}, Fe^{3+}, Mn^{2+}, Cu^{2+}) has improved the adsorption capacity. Adsorption equilibrium reached in seven-fifteen minutes, and adsorption activity grows in a row: DeCL CL CuDeCL MnDeCL FeDeCL AC/CL. The sorption capacity ranged from 0.68 mg/g to 28.17 mg/g. pH of thermal water before sorption was 8.97 and in filtrates changed in very wide ranges – from 10.44 until 3.55 depending on type of modification.

The filter worked successfully for 20-22 days until the amount of slip reached 60%. The best results were got on using the sequence of adsorbents: activated coal AU-3 and then Fe-modified clinoptilolite. The filter worked 30 days without regeneration and both of adsorbents undergoes to regeneration with hot air at 1200C during 2 hours.

Conclusion and Significance

The use of environmentally safe water will contribute to the growth of the number of consumers of hot water supply, heat supply, and household services. The number of users in such sectors as agriculture will increase; balneal-curative tourism, sports and health complexes; cosmetics and pharmacology, perfumes. Consumption of electricity, cold water will decrease. Environmental situation of cities will improve. If purified thermal water is consumed in Tbilisi, more than 2.5 million tons of equivalent fuel will be saved, thereby reducing carbon dioxide content of the atmosphere in 6 times. This will have a significant environmental and economic effect.

Session 1 poster / Abstract title: Mass management – indicators and key performance indicators for reduced climate impact in procurements

ID: 386

Key words: Circular mass management, evaluation of mass management, indicators

Submitter: Jenny Norrman

Organization: Chalmers University of Technology

Co-authors: Yvonne Andersson-Sköld, The Swedish National Road and Transport Research Institute, Professor; Joakim Claesson, the Swedish Transport Administration, senior expert

Session: 1 poster

Abstract

The purpose of this study was to develop preliminary indicators and key performance indicators for procurement that can be used to set requirements and provide incentives that can be introduced in the Swedish Transport Administration's procurements to improve mass management, both in the planning of projects and in the actual execution. Future requirements and incentives should be possible to be used in procurements and thus contribute to entrepreneurs working more circularly, sustainably, and innovatively with mass handling than at present. One main purpose is that the procurement procedure should contribute to achieving the Swedish Transport Administration's goal: the infrastructure should be climate neutral by 2045. The work consists of an analysis based on international and national literature, mass management reporting and interviews. Based on the collected material, it appears that the regulations regarding excavated masses are not clear, and that the masses are classified as waste in most countries. This, in turn, leads to excavated masses not being recycled as much as is theoretically possible, nor as optimally as possible according to the waste hierarchy. To improve this, clearer incentives, indicators and key performance indicators are required, as well as accounting tools and guidance material from the Swedish Transport Administration. In this project, proposals for indicators and key performance indicators have been developed. In addition, an EXCEL-based prototype for how several of these indicators can be reported both before a procurement and to be used to follow up and evaluate mass management in a project has been developed. The report also provides suggestions for continued work to develop the prototype for evaluating mass management at the project level and from a socio-economic perspective.

Session 1 poster / Abstract title: Soil Transplant Method to Rehabilitate Soils Damaged by Contamination and Aggressive Remediation

ID: 399

Key words: soil restoration; soil contamination; aggressive remediation; plant growth trials

Submitter: Christine Switzer

Organization: University of Strathclyde

Co-authors: Ms Marcella McIlroy, Ms Caroline Hoekmann, Mr Mohammed Isa, Dr Andrew Pape, and Dr Charles W. Knapp, Department of Department of Civil and Environmental Engineering, University of Strathclyde, 75 Montrose Street, Glasgow G1 1XJ, United Kingdom

Session: 1 poster

Abstract

Soil contamination and aggressive remediation have lasting effects on soil physical and geochemical properties characteristics, and therefore reuse potential. Because of the harsh conditions of contamination and remediation, biological activity is significantly curtailed. Active restoration efforts are needed after remediation to restore biological function. During this restoration period, soils are vulnerable to invasive species. This work examines the use of soil transplants from healthy ecosystems to accelerate biological restoration as part of a wider restoration strategy.

Red clover (trifolium pratense) growth was examined in soil that had been contaminated with coal tar (5% by mass) and subjected to smouldering remediation in the laboratory. Smouldering destroyed >99% of coal tar content but also destroyed all soil organic matter and microbes that may have been present in the soil. Smouldering subjects soils to operating temperatures of 900-1100□C, so these losses were anticipated. Pot trials were conducted with red clover, a leguminous plant, to examine the restoration of nitrogen cycling functionality in remediated soils. Seeds were planted and the soil was inoculated with a compost tea to reintroduce a broad spectrum of beneficial microbes. Wild clover harvested in Glasgow and its roots with nodules were ground and turned into some of the soils to introduce communities of nitrogen fixing bacteria into the soil as well. Watering with chemical nutrient solutions containing carbon, nitrogen, phosphorus followed a variation on the Redfield ratio (106C:16N:1P). Carbon and phosphorus were supplied at 100% and nitrogen was reduced to trigger nitrogen fixation. Watering continued for six weeks after which plants were harvested for analysis. Shoot height, root extension, plant biomass, chlorophyll content, and number of nodules were recorded.

Plants grew in all treatment conditions. In pots that were not amended with wild clover, some variations in growth and particularly nodule formation were observed, suggesting a role for nitrogen concentration in triggering nodule formation. Amendment with wild clover resulted in greatly increased numbers of root nodules across all plants. Further, there was no observed link between nitrogen concentration and nodule formation. All experienced significantly more nodule formation; however, all of these pots were grown in nitrogen-limited conditions (50% N). These experiments show significant promise for biological restoration of formerly contaminated soils. Further work is underway on supporting plants and microbes through the transition from nutrient dependence to independence, enabling full biological restoration of contaminated and remediated soils.

Session 1 poster / Abstract title: Applying hydrocyclone separation for oil-contaminated soil treatment and reutilization of underflow stream soil in controlled low strength materials

ID: 67

Key words: oil contaminated soils, hydrocyclone separation, controlled low strength materials(CLSM)

Submitter: YiKuo Chang

Organization: Central Taiwan University of Science and Technology

Co-authors: Pai-Haung Shih, Fooyin University, Assistant Professor; Tung-Hsuan Lu, Li Shun Hing TECHNOLOGY CO., LTD., GM; Yi-Liang Shu, Central Taiwan University of Science and Technology, Assiatant Professor; Yi-Cheng Li, Central Taiwan University of Science and Technology, graduate student

Session: 1 poster

Abstract

In this work, we applied physical treatments for oil contaminated soils separations. A hydrocyclone was designed and was tested for high separation performance. The oil-contaminated soil slurry is configured with a solid-liquid ratio of 1:4, and after being fully stirred, the slurry is sent to a hydrocyclone with an inlet velocity of 7 m/s.
The separated soil from overflow stream showed a total petroleum hydrocarbon (TPH) concentration of 9,848 mg/kg and 92.4% particles in overflow stream were smaller than 63μm (63μm classified as fine soil). On the other hand, the separated soil from underflow stream showed a TPH concentration of 948 mg/kg, and 90.2% particles in underflow stream were larger than 63μm. It could achieve volume reduction goal of oil contaminated soils and could be an cost-effective improvement.Besides that, the soil from hydrocyclone underflow stream with low TPH-concentration was reutilized as fine aggregates used in controlled low strength materials(CLSM). The slump flow test, water soluble chloride ion content test, compressive strength test, CLSM TPH-content test were conducted to prove the suitable reutilization.

Session 1a1 orals

Session 1a1 / Abstract title: Comparison of Different Chelator-Based Methods for Toxic Metals Removal from Sewage Sludge in Closed-Loop processes

ID: 222

Key words: Sewage sludge, Toxic metals, EDTA, decontamination methods

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Session: 1a1 backup

Abstract

Wastewater treatment plants (WWTPs) generate large amounts of Sewage Sludge (SS) daily, presenting a global challenge for its proper management. This byproduct from WWTPs often contains essential plant nutrients such as C, N, P, and K. However, the presence of Toxic Metals (TMs) such as Pb, Zn, Cd, Cu, Mn, and Hg can result in environmental contamination and health issues, hindering its potential use as a fertilizer. However, remediation technologies can restore the valuable properties of SS for fertilizer purposes. The purpose of the study was to test several treatment methods, including SS washing, Microwave-assisted Acid Hydrolysis (MAH), and Hydrodynamical Cavitation (HC) for removing Toxic Metals (TMs) from different SS samples using EDTA as a chelating agent. Optimal conditions were determined for each treatment, and a series of sequential batches in closed-loop processes were carried out. To assess TMs removal efficiency, TMs in SS were quantified by flame-AAS (Varian, AA240FS) and (at low concentration) by graphite cuvette-AAS (GF-AAS, Agilent, 240Z AA) after acid digestion in aqua regia in a microwave oven (ISO 54321, 2020). The Anaerobically Treated (AT) SS was washed with EDTA activated with H2SO4 in a rotatory mixer at 20 rpm (Revolutions per Minute) for 1 h, resulting in an average removal of 28% Pb, 48% Zn, 35% Cu, 30% Mn, and 10% Fe over 5 batches. MAH performed at pH 3 at 100 °C for 1 h removed an average of 78% Pb, 76% Zn, 1% Cu,

17% Cr, 67% Mn, and 73% from Aerobically Treated (AET) SS in 5 batches. HC at 10 000 rpm for 30 minutes combined with EDTA activated by citric acid removed an average of 35% Pb, 68% Zn, 60% Cd, 45% Cu, 22% Mn, and 4% Fe from AT SS in eight batches. EDTA (measured according to Wang et al. (2013)) and process solutions were recycled in a pH gradient imposed by the addition of CaO and H_2SO_4, thus, no wastewater was produced, only solid waste (ReSoil® technology). On average, 36%, 42% and 46% of EDTA during SS washing, MAH and HC, respectively, was loss during the processes presumably by adsorption to Fe oxides-hydroxides in washed SS. Lost EDTA was replenished in a form of Na-EDTA at the beginning of each batch. Chemical properties (pH, Electrical Conductivity (EC), total P, N, C, organic C, P_2O_5, K_2O, and $CaCO_3$) were evaluated in washed SS and process solutions (pH, EC, Na, Pb, Zn, Cu, Cr, Mn, and Fe) to determine the effectiveness of TMS removal and the quality of SS washing. Most of the treatments did not have a significant impact on the chemical properties of SS, except for MAH, which caused a significant reduction in P and N. The results showed that although most of the TMs became more leachable after the remediation process, the levels did not exceed hazardous limits as defined by DIN 38414-S4 and the Council Decision 2003/33/EC, with the exception of Zn and Cu after MAH, which exceeded the hazardous limits. Nevertheless, the addition of Zero Valent Iron would mitigate the leachability of TMs. As a general conclusion, the removal efficiency of TMs changed from SS to SS depending on the treatment, concentration and speciation of TMs. Therefore, any of the studied methods could be used to remove TMs from SS. However, the removal efficiency might vary depending on the SS sample.

Overall, the study contributed to prove the feasibility of the novel SS washing process. Future studies of the scalability and cost-effectiveness of the methods need to be demonstrated at larger pilot scale using common industrial equipment.

Session 1a1 / Abstract title: Reuse of Metal Impacted River Sediments

ID: 228

Key words: Reuse, sediment, biodiversity, circular-economy

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Organization: Ramboll

Co-authors: Hazel Comyn Ramboll UK

Session: 1a1

Abstract

Reuse of Metal Impacted River Sediments
Philip Studds and Hazel Comyn
Topic number 1:
Purpose of Study: The Coal Authority, Environment Agency and DEFRA are working to address the widespread legacy of contamination from disused metals mines to deliver a cleaner water environment for people and wildlife. One part of the strategy is to construct check weirs within the polluted rivers to capture and subsequently remove metal impacted sediments, thus reducing the contaminant loading in the rivers. The check weirs require regular dredging to ensure they work at optimum efficiency. The dredged sediment was historically disposed to landfill, often as hazardous waste due to the high lead and zinc content. This approach involved transport of the sediment via minor country roads to landfill facilities >100km away. This had a significant carbon impact from lorry emissions and caused severe disruption to local communities to the point where the benefits of improving river water quality were outweighed by the negative impacts. Ramboll challenged the waste classification process to consider the excavated sediment as a resource rather than a waste and developed solutions to reuse the dredged sediment locally and is a perfect example of Circular Economy within contaminated land management.
Methodology: Ramboll carried out a sampling, testing and assessment programme to characterise the sediment, including the grain size fractions, metal species, and contaminant concentrations. Ramboll carried out enhanced waste classification and human health and environmental risk assessments to explore options to reuse the sediment in a safe and sustainable way. Ramboll used our SURE tool to perform a sustainable remediation assessment. The SURE tool considers and evaluates the environmental, social, and economic dimensions (i.e., the sustainability) of different remedial options, to help communicate key decision-making factors to stakeholders.
Summary of Findings/Results: Potential reuse options were identified which included;
- Using the coarse fraction within gabion baskets to improve river bank stability

- Using the gravel fraction for footpaths
- Using the fine fraction to create a calaminarian grassland nursery

Using the detailed risk assessment, Ramboll were able to demonstrate the materials were suitable for these reuse options. The CL:AIRE Definition of Waste: Industry Code of Practice (DoWCoP)1, allows the reuse of the dredged sediment as a construction material for development projects.

To reuse materials through the DoWCoP approach requires the waste producer to establish lines of evidence to demonstrate:

i) Protection of human health and the environment;
ii) Suitability for use without further treatment;
iii) Certainty of Use; and
iv) Quantity of Material.

Ramboll demonstrated these factors to the EA's satisfaction, thus avoiding tortuous waste regulations. By using the DoWCoP approach, material which was previously being sent to hazardous landfill could be reused safely and sustainably locally to create the enhanced biodiversity grassland feature. This approach was untested and although the principals of the project followed common sense and science, the key element of the project was to adequately demonstrate suitability of use and give the Regulator confidence to consider the excavated sediment as a resource rather than a waste.

Conclusion: This is an excellent example of contaminated land management practices that enhance soil health and local biodiversity, whilst reducing the negative economic, social and environmental impacts associated with the previous approach. This project demonstrates a safe, sustainable and circular use of excavated sediments. The mitigation solutions used were simple, easily implemented and required little technology or specialist equipment. This work aligns with the vison of the EU Soil Strategy for 2030, the European Green Deal and also contributes to the UN Sustainable Development Goals.

Session 1a1 / Abstract title: Anticipating the evolution of trace element mobility in dredged sediments managed on land: a new methodology based on controlled weathering tests.

ID: 371

Key words: dredged sediment; on land management; trace metal elements; weathering tests.

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Organization: BRGM

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Session: 1a1

Abstract

Each year, dredging activity in France moves approximately 1.8 million m3 of sediment in rivers in the public river domain (CEREMA, 2021, ISBN: 978-2-37180-537-8) and approximately 50 million m3 in port and estuarine environments (CEREMA, 2020, ISBN: 978-2-37180-483-8). About 40% of the sediments from rivers are managed on land. For marine sediments, only a few percent of the total volume is dredged from the aquatic environment and brought to land, but this represents hundreds of thousands of m3, because of the huge volumes displaced by human activity. To increase the recovery of land-managed sediments, it is therefore essential to have methods to quantify the levels of contaminant release that may occur as a result of these biogeochemical transformations. Current methods are not suitable. They are generally based on batch leaching tests, such as EN 12457-2, which aim to reach a solid/solution equilibrium after 24 hours of contact, or, more rarely, on column tests, such as EN 14405, which aim to deplete the soluble pool by eluting the solid sample at a constant speed. These tests do not generate oxidizing conditions and do not stimulate enough microbial activity to reproduce the phenomena occurring in natural conditions over a long time. The study proposed here aims at understanding and predicting the long-term release dynamics of Trace Metal Elements (TMEs) from a panel of 7 different sediments, from marine and inland origin. This study is based on a controlled weathering method, adapted from humidity cell device and protocol described in ASTM D 5744 – 96 standard. This is a kinetic weathering method, which consists in subjecting solid samples to successive humidification and drying periods to accelerate natural weathering rate and formation of secondary mineral phases. It enables the collection and analysis of leachates throughout the experiment. Experimental conditions are similar to those observed at the surface of materials deposit but with faster dry-wet cycles. These tests are coupled to a thermo-statistical modeling, which takes into account the geochemical processes and allows

to decompose the time series of the controlled weathering test. This modelling allows to predict the concentrations of TMEs in the leachates, and to specify the geochemical parameters (e.g. pool of TMEs associated with organic matter, Fe and Al oxides, etc.) having a significant role to explain the dynamics of the concentration of TMEs during the controlled weathering test.

The results of this study show that for all the sediments, most of the TMEs evolve in the direction of a decrease over time. A strong variability of the results is noted according to the chemical element considered, as well in term of temporal evolution and/or of measured concentrations. This is particularly identified for Cd, Cu and Zn. Indeed, the concentrations of these elements vary by several orders of magnitude between sediments. For the other chemical elements (As, Cr, Ni and Pb), the range of concentrations is less marked between sediments. Simulations of the temporal evolution of TMEs concentrations in leachates collected during the controlled weathering test indicate that for all the elements studied, most of the predicted concentrations are consistent with the measured values. Depending on the observation considered, the confidence interval associated with the predicted value is either of the same order of magnitude as the standard deviation associated with the measurement or it is one or more orders of magnitude larger.

In conclusion, this study has shown that the mechanisms controlling the evolution of TMEs fluxes are identical in the different sediments, at varying intensities. The use of this type of approach would allow the establishment of limit values for the management of sediments managed on land, whether they are of marine or inland origin.

Session 1a1 / Abstract title: Metals recovery from metallurgical wastes using biometallurgy

ID: 392

Key words: Acidithiobacillus ferrooxidans, bioleaching, metallurgical wastes, metal dissolution, biohydrometallurgy

Submitter: ipek tezyapar kara

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Session: 1a1

Abstract

The metallurgical industry produces by-products, such as Basic Oxygen Furnace (BOF) sludge and dust and goethite, which contain various metals, including heavy metals, critical metals, and rare earth elements. These by-products are often discarded due to their high zinc content and the absence of adequate regeneration processes. To address this issue, a study was conducted to investigate the use of bioleaching to recover metals from BOF sludge and dust and goethite. Acidithiobacillus ferrooxidans was used to bioleach various metals, including zinc (Zn), lead (Pb) manganese (Mn), iron (Fe), aluminium (Al), lithium (Li), cobalt (Co), yttrium (Y) and cerium (Ce). The total concentrations of the elements were 419 g/kg and 261 g/kg in BOF and goethite material respectively, and the highest concentration was for Fe at 390 g/kg and 162 g/kg, respectively. Four variables at three different levels including solid concentration (1, 5 and 10% w/v), energy source concentration (1, 2 and 3% w/v for BOF optimisation; 2, 3 and 4% w/v for goethite optimisation), inoculum concentration (1, 5 and 10% v/v) and pH (1.5, 1.75, and 2) were evaluated using L9 Taguchi orthogonal array design. Abiotic control and chemical control experiments were performed using growth medium (2% energy source) and deionised water, respectively, using 1% solid concentration at pH 1.75 without inoculum. After 14 days of bioleaching, the highest metal recovery for the BOF material was achieved under the condition of 1% solid concentration, 1% energy source concentration, 1% inoculum concentration, and pH 1.5. For goethite, the best overall condition was 1% solid concentration, 4% energy source concentration, 10% inoculum concentration, and pH 2. We were able to recover metals such as Zn, Mn, Al, Li, Co, Y, and Ce from the materials. Over 78% of the iron was preserved in the residues of both BOF and goethite materials. The BOF material could potentially be used as a secondary iron resource in the iron and steel industry after recovering Zn, Mn, Al, Li, Y, and Ce by bioleaching, as the

zinc content was reduced to below 1%. Further studies are needed to recover elemental metals from the leachate.

Session 1a1 / Abstract title: Smouldering Biosolids to Improve Their Circular Economy Potential in Agriculture

ID: 396

Key words: circular economy; wastewater treatment; biosolids; smouldering; phosphorus recovery

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Session: 1a1

Abstract

Organic biosolids from municipal wastewater treatment and agricultural residues contain significant amounts of phosphorus and other nutrients. These materials are already reused extensively in agricultural applications; however, these applications do not make best use of biosolids' nutrient contents. In addition, their long-term use may cause environmental damage through nutrient loss, eutrophication of receiving waters, soil degradation, and contamination in the form of micropollutants and heavy metals that can ultimately impact grazing animals and food crops. For example, use of sewage sludge as fertiliser is one of several working hypotheses to explain recent detection of low levels of polyfluoroalkyl substances (PFAS) in a fruit juice product in the USA. Organic biosolids provide natural aggregation points for beneficial nutrients and harmful pollutants. Further treatment processes are urgently needed. Treatments should seek to maximise reclamation of nutrients and treatment of pollutants to enable a sustainable circular economy. Smouldering treatment of biosolids offers a key opportunity to meet all of these goals simultaneously.

Smouldering is a flameless combustion phenomenon that uses the energy inherent within a combustible material as fuel. Pioneered as a remediation process for hazardous organic liquids in soils and other inert porous media, this process was more recently adapted to treatment of faeces and biosolids. Sewage sludge from a wastewater treatment plant in London, Ontario, Canada, was obtained to examine the effects of smouldering on nutrients; potentially toxic elements (PTEs); polychlorinated dibenzo dioxins and furans (PCDD/Fs); and PFAS. The sludge already contained all of these substances in detectable quantities so no further amendment with compounds of interest was required. Sludge was mixed with

sand, additional carbonaceous fuel, and/or calcium amendment and smouldered to study the effects of treatment conditions on pollutant load and availability. Process emissions were monitored. USEPA Methods 1313 and 1314 were employed to study leaching of potentially toxic elements and nutrients from solids before and after treatment.

Smouldering offers two possible pathways for phosphorus recovery. Smouldering of biosolids bulked with sand oxidised and destroyed approximately 75% of input biosolids, yielding residual ash that was rich in phosphorus and effectively concentrated non-volatile PTEs. Leaching studies showed that retained phosphorus was primarily inorganic and released slowly from residual ash, unlike the parent sludge, making residual ash potentially attractive as a soil amendment. The same leaching studies also showed minimal release of other PTEs of concern, suggesting that smouldering may have oxidised and effectively sequestered them in residual ash. Co-smouldering with woodchips as supplemental fuel increased the total energy of the system, oxidised approximately 80% of input biosolids, and mobilised approximately 80% of total phosphorus via process emissions where it can be recovered. The remaining 20% was easily leached from residual mixed ash.

Alongside beneficial phosphorus recovery, robust smouldering destroyed >99% of PCDD/Fs initially present in biosolids with no detectable PCDD/Fs in process emissions. Some PCDD/Fs are observed in emissions during weak smouldering at levels below those observed in incineration and easily treated with the same technologies. Robust smouldering effectively mobilises partly destroys and partly mobilises PFAS compounds from biosolids. Calcium amendment is required to destroy PFAS and mineralize its fluorine content.

Life cycle assessment is underway to holistically examine the impacts of smouldering biosolids as part of a circular economy. Smouldering generates CO_2 as process emissions; however, some or all of this CO_2 may be offset by increased yields of plants grown in amended soils.

Session 1a1 / Abstract title: Circular use of wastewater and excavated soil on a building site: case study of the ponds at the Thurn Taxis site in Brussels

ID: 72

Key words: Wastewater, circular economy, soil re-use, sustainable water management, remediation

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Session: 1a1

Abstract

Purpose of study
The Thurn Taxis site is an old industrial site, including a former railroad freight station. It's known and appreciated in Brussels for its remarkable industrial heritage. The entire site is in the process of being upgraded into a new sustainable urban district where various buildings will be constructed for residential, leisure, commercial and office use. The redevelopment benefits an especially densely populated and socially diverse neighborhood in Brussels. This site consists thus of many different construction projects, all conducted in different stages. The presented study focuses on one part of the Thurn Taxis site that was recently redeveloped into a big recreation area with ponds. An excavation of 10.000 m³ of soil was performed, and the quality of this excavated soil was evaluated for reuse in other projects. 6000 m³ of water was supplemented to fill the ponds, the feasibility of sourcing this water from the wastewater of another project was researched.
Methodology
A field study was conducted where soil and groundwater samples were taken, spread across the site. Analytical techniques such as HS-GC-MS and ICP-MS were used for the identification and quantification of a ream of possible pollutants. Water and soil that did not meet quality standards was treated (on-site active carbon filter for water, off-site heat treatment for soil). These actions were along the way combined with regulatory issues such as permitting and complying with pollution standards for soil, groundwater, wastewater, and surface water.
Summary of findings/results – Conclusion
In the excavated soil, many different zones could be identified that were polluted with asbestos, invasive plant species, heavy metals, diesel oil, and polycyclic aromatic

hydrocarbons. By properly delineating the problem zones, these soils could be treated in limited quantities and the reuse of good quality soil was optimized.
The wastewater that would be used to fill the ponds exceeded Brussels pollutions norms. Chlorinated compounds and heavy metals were removed by on-site treatment. Surface water quality parameters such as pH, dissolved oxygen, nitrates, phosphates, biological and chemical oxygen demand showed that the water was suited for use in a pond. Now that the pond is filled, a collection system for rainwater will be used to refill losses by evaporation.
Significance / contributions of study
The reuse of soils on-site removes the need of new resources but also the transport required to supply them and remove the excavated soil. Keeping (good quality) soil in place as much as possible ensures the conservation of its biodiversity and ecosystem services.
Ameliorating the quality of the wastewater and subsequently rerouting it (it would have otherwise been discharged into the sewer system) is a prime example of sustainable water management.
Sourcing soil and water for a construction project from waste flows is often not the easiest or cheapest method, unfortunately. Nonetheless, efficient communication and willingness to find sustainable solutions by either the contractor, the soil expert, the project developers, and the concerned government agency made it work.

Session 1b1 orals

Session 1b1 / Abstract title: Investigation of PFAS in soil and groundwater under sewage sludge treated fields.

ID: 201

Key words: Recirculation, Groundwater, PFAS, sludge,

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Session: 1b1

Abstract

Purpose of study
This work aimed to investigate whether the utilization of sewage sludge on agricultural land can result in elevated PFAS concentrations in soil and groundwater.

Methodology
Field investigations were carried out at the CRUCIAL experimental site (Copenhagen University) which has been intensively treated with sewage sludge from an urban wastewater plant since 2003.

- Three types of field plots were investigated; (1) sludge-treated field, which has received a high dosage og sludge, corresponding to 75 years of treatment, (2) accelerated sludge-treated field, which received an extremely high dosage corresponding to 200 years of treatment , and (3) control area, which did not receive sludge.
- The geology at CRUCIAL consists of a sandy clayey till with pockets of wet sand/gravel layers. The claytill is underlain by a wet sand/gravel aquifer that starts in approx. 9-11 m bgs. after which a limestone aquifer starts. The water level in the aquifer is lower than in the sand lenses, thus vertical transport is expected.
- 10 screened boreholes were drilled to varying depths (8-18 m bgs.). Soil samples were taken at 0.3, 0.5 and 1 m bgs. and then for every meter to the final depth of the boreholes. The soil samples were analyzed for PFAS 22 (detection limit 0.5 µg/kg TS).
- Water samples were extracted from pockets of groundwater in sandlenses at 5-6 m

bgs and from the top and bottom of the sandy aquifer at approximately 9 and 18 m bgs. Water samples were analyzed for PFAS 22 (detection limit: 0.3 ng/l)

- Archive samples of the applied sludge from 2003 until 2022 were analyzed for PFAS 22 detection limit 0.5 µg/kg TS).

Summary of findings/results

- None of the soil samples exceeded the Danish EPA soil criteria of 10 µg/kg for PFAS4 (PFOA, PFOA, PFNA, PFHxS) and 400 µg/kg TS for PFAS 22. PFAS was only detected in soil samples from topsoil (0-1,0 m bgs). Maximum concentrations were 11 µg/kg for PFAS 22.
- PFAS were detected in only 3 out of 14 of the water samples. Up to 4.9 ng/l was for the sum of PFAS 4 (PFOA, PFOA, PFNA, PFHxS) in groundwater pockets at 5 m bgs. (type 2 test field) and 0.88 ng/l for the sum of PFAS 4 in the sand reservoir. The detected concentrations of PFAS in groundwater are below the Danish EPAs quality criteria for groundwater of 2 ng/l for PFAS 4 in 2/3 of the samples. PFOS was the dominant substance in water.
- The levels of PFAS 22 in the sewage sludge has decreased from 113 µg/kg TS for PFAS 22 in 2003 down to 42 µg/kg TS by 2020 and down to 8.9 µg/kg TS in 2022.
- The detected levels of PFAS in the groundwater are approx. 525-1650 times lower than the expected values that can be calculated based on the measured soil concentrations and equilibrium calculations. This is most likely due to much greater binding in the soil than expected.
- Based on PFAS soil concentrations, the mass of PFAS in soil was estimated to approximately 2 times greater than the added amount of PFAS from sludge. One possible explanation is unidentifiable or non-extractable PFAS in sewage sludge which are converted into PFOS and other PFAS 22 substances. There is a lot of uncertainty associated with the mass balance calculation, partly due to the low number of soil samples and sludge samples and as to which extent PFAS exists in the soil in concentrations below the detection limit.

Conclusion and significance of this study

Overall, based on this study, it can be concluded that there is leaching of PFAS into groundwater under the sludge-treated fields, but this leaching is much lower than what was theoretically expected. This is one of very few studies on the effects of the spreading of sewage sludge on agricultural land regarding PFAS. There is still a need for more studies to understand at what extent PFAS from sludge treated fields can leach into groundwater with several different soil types and several types of sludge.

Session 1b1 / Abstract title: Micropollutants transformation products formation in subsurface irrigation with wastewater treatment plant effluent: non-target analysis on a pilot case study

ID: 205

Key words: Biodegradation, Micropollutants, Effluent reuse in agriculture, Transformation products, Non-target analysis

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Session: 1b1

Abstract

Population growth and climate change are promoting the use of alternative water sources to tackle freshwater scarcity (J. E. Drewes, 2009). Wastewater treatment plant effluent (WWTPe) is of predictable quantity and monitorable quality (Navarro et al., 2015; Revitt et al., 2021) and its intentional reuse could contribute to satisfying the demand for irrigation water (FAO, 2022; Narain-Ford et al., 2021). There is already a significant de facto reuse of WWTPe, which is often discharged in the canals, scarcely diluted in case of low flow, and withdrawn for irrigation (J. E. Drewes et al., 2017; Roex et al., 2021). However, WWTPe contains organic micropollutants (OMPs) (Posselt et al., 2020), so if discharged into surface water (SW) bodies and subsequently reused, it could expose crops and farmers to OMPs and may result in contamination of drinking water (DW) sources (Narain-Ford et al., 2022). Engineered systems offer the possibility to use WWTPe in a more responsible way. An example is sub-surface irrigation (SSI), where the WWTPe is provided to the agricultural field through underground pipes, avoiding direct exposure of crops and workers (Bartholomeus et al., 2016). This system can be beneficial to the crop because it supplies water and nutrients (Navarro et al., 2015). Moreover, SSI may reduce the pollution of SW and DW sources as in the soil many OMPs can be degraded (Narain-Ford et al., 2022; Navarro et al., 2015). OMPs' fate during soil passage is however not clear, as biodegradation often leads to the formation of transformation products (TPs) that can be more hazardous than the parent compound (PC) (Sinclair Boxall, 2003). Many TPs are

unknown, and known TPs are often overlooked in monitoring programmes due to, e.g., the lack of analytical methods (Brunner et al., 2019). Current technological advancements in high-resolution mass spectrometry allow the identification of unknown compounds, including TPs, through non-target analysis (NTA) (Helmus et al., 2021), but more studies are needed to unravel the fate of TPs in the environment.

The present research focuses on an SSI-equipped agricultural field located in Haaksbergen (NL). Here, parallel pipes provide WWTPe to the field at a depth of 1.20 m. The system has been monitored since 2015 to follow WWTPe infiltration and OMPs' fate. Previous studies identified the wells that mostly receive the WWTPe and followed the behaviour of WWTPe-deriving OMPs, showing that the OMPs' fate depends on their characteristics, drought conditions and the proximity to the SSI pipes. The highest removal efficiency was observed in between pipes and higher TPs formation was detected in drought periods due to increased microbial activity (Narain-Ford et al., 2022).

In this study, we analyse NTA data collected in Haaksbergen during the years 2016-2021. The aim is to identify TPs formed during OMPs biodegradation and to link their formation to the field conditions. The dataset includes samples of the WWTPe, a reference field and the wells with the highest removal efficiency. Data analysis is done through patRoon, an R-based software that predicts degradation pathways using, e.g., metabolic logic, structural and mass spectra similarities between PCs and TPs (Helmus et al., 2022). Suspect screening is included in the workflow so that a list of 89 OMPs previously detected in the field is used as a PC list to sift for their TPs. The data processing produces reports showing the detected TPs and the predicted PC-TPs pathway. The results are then manually verified to identify the TPs formed and link them to the sampling event in the field.

Our results provide information on the effect of SSI with WWTPe under real field conditions. We identify previously unknown TPs and the conditions influencing their formation, contributing to filling the knowledge gap on OMPs' fate in the environment. Moreover, the results can be used for a better design of WWTPs to remove OMPs generating potentially dangerous TPs.

Session 1b1 / Abstract title: Environmental risk analysis for the reuse of treated wastewater for irrigation purposes in Flanders

ID: 282

Key words: Reuse, treated waste water, irrigation, risk analyses

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Organization: VITO

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Session: 1b1

Abstract

To combat droughts and water scarcity, also in Flanders several projects, with support of the Flemish government, study the reuse of treated wastewater with respect to for instance aquifer recharge, and irrigation purposes in general. At present, effluent originating from urban (UWWTPs) and company wastewater treatment plants in general ends up in a watercourse. Consequently, there are still many opportunities for reuse, if one avoids the risk of spreading pollution.

Parallel to the implementation of the European Reuse Regulation on the reuse of effluent in irrigation applications in the Flemish legislation by the Flemish Environmental Agency (VMM), a site- specific methodology is being developed for the associated risk analysis and risk management in environmental media.

Key elements in the risk analyses and risk management of the reuse of treated wastewater are the origin of the waters delivered to the wastewater treatment plant, the quality of the effluent treated and offered for reuse and/or irrigation, the scope of the reuse, the expected pollutant load per hectare of receiving soil, and site-specific parameters including hydrogeological parameters.

To develop a methodology for site specific risk analyses a literature study was performed with respect to the existing Flemish and EU legislation, international risk management plans and on-going applications, together with an evaluation of sources and emissions of UWWTP and a detailed chemical characterization of some UWWTP located in the Province of Limburg.

According to existing public data and the 1st screening results, parameters that require specific attention regarding the risk analyses are nutrients, chloride, pesticides, pharmaceuticals and PFAS. Subsequently the possible impact of the reuse of treated wastewater on soil and groundwater was calculated for a theoretical case using the F-Leach model, a process-based transport model, that takes into account transport by infiltrating rainwater, sorption and degradation.

On the basis of the results obtained a methodology has been developed to carry out an adequate risk analysis in the framework of the reuse of treated wastewater. The site-specific character of the methodology helps with focusing the risk management to the relevant parameters and thus avoids excessive costs for chemical analysis in cases where reuse is feasible. Hereby, the developed methodology maximizes the reuse opportunities.

Session 1b1 / Abstract title: Water reuse for irrigation and groundwater recharge: time series analysis for subirrigation system performance assessment.

ID: 317

Key words: water reuse, groundwater, wastewater, time series analysis

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Session: 1b1

Abstract

Amidst increasingly frequent extreme drought events occurring worldwide, anthropogenic pressure on water resources is expected to grow. Even countries historically putting more efforts into flood prevention and phreatic groundwater drainage are apprehensively monitoring their more than ever vulnerable water resources and searching for ways to conserve them. Next to a reduction of freshwater consumption in sectors like industry or agriculture, the idea of water reuse as a countermeasure to drought is gaining interest and political traction. However, legislation allowing for safe water reuse practices requires a solid scientific foundation. The EU's new regulations on minimum quality requirements for water reuse are now being implemented by member states which need to know the potential and risks of water reuse in the regional context.

Project Grow was set up in 2019 to investigate the environmental effects of reusing treated domestic wastewater in the agricultural sector in Flanders, Belgium. At the centre of the

project is an experimental field in Kinrooi, Western Flanders, where effluent is applied near the crop root zone through a subirrigation system. The system launched in the spring of 2022 and has been continuously operating. It is expected to stay operational throughout the growing season and winter of 2023.

Groundwater levels at the site are closely monitored with automatic data loggers installed in 21 monitoring wells distributed across the investigated field and its vicinity. Effluent and groundwater are under an extensive quality monitoring program with monthly sampling campaigns.
To simulate the aquifer response to subirrigation, a typical process-based, distributed, transient-state flow model has been developed. However, the amount of data allowed the application of data-driven modelling using the time series analysis software Pastas. In this approach, the model is trained using time series of recharge and stages of nearby rivers and groundwater levels collected before the subirrigation began. Comparison with a control subset of observed heads showed that our approach could be successfully applied to short, high-resolution time series.

Further, the groundwater levels were simulated throughout the growing season when the subirrigation system had operated at high capacity. The model trained only with the natural forcings did not predict any sudden changes during the irrigation, whereas an increase in groundwater heads was apparent in observations. With an increasing span of overlapping time series of groundwater level responses to subirrigation, the model becomes more capable of accurately predicting the change in groundwater level caused by a unit volume of injected effluent. Therefore, it could become an effective tool for subirrigation system performance assessment and potentially help schedule subirrigation rates. Before the beginning of the growing season of 2023, the model development included experimentation with other input time series, like remote sensing-derived crop indices, and determining the minimal time series resolution needed for good model performance to optimize future monitoring scope.

Session 1d1 orals

Session 1d1 / Abstract title: Soil Passports in the Netherlands – an instrument for the circular economy

ID: 14

Key words: soil reuse, soil passport, soil investigation, environmental guarding, soil health law

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Co-authors: nan

Session: 1d1

Abstract

The Netherlands have a well-functioning market for the reuse of mildly contaminated soils and sediments. Annually over 100 million tons of soils and sediments are reused in the Netherlands. This market is established after the issuing the Soil Quality Decree in 2008 which implemented the soil policy principles of fit for use and stand-still, thus resulting in reuse standards for different soil functions. In order to operationalize this policy a sophisticated system of soil passports is in place. It is a system with five different types of Environmental declaration of Soil Quality which can be regarded as a soil passport. These different types represent different procedures for establishing a reliable impression of the quality of soils and sediments that are excavated and reused. Procedure and type of passport for excavated sediments in the Port of Rotterdam for example differs from those of excavated material from a sand mining pit. For several designated activities that are executed in the process of drafting and issuing a soil passport, a system of mandatory certification and governmental approval is set up. Critical activities such as soil sampling or soil analyses is restricted to performance by governmental approved companies.

For a well-functioning regulated market, the importance of a reliable system of soil passports is not to be underestimated. Soil passports are used for the purpose of assessing if the application of soil complies with the soil reuse standards at the application site. This is not only important for the owner of the application site or the competent authority that is in charge of soil protection. It is also very important for the reuse market and therefore the circular economy as a whole. If a reused soil is applied and does not meet the soil reuse standards the societal support for the reuse of mildly contaminated soils can collapse. The

alternative of primary materials is up for grabs. The reuse of soils is 5 to 10 times less expensive than the disposal or treatment of soils. This is on the one hand a financial incentive for the circular economy but on the other hand a major threat. People are tempted by this huge price difference to reclassify their severely contaminated soils to reusable soils and issue a falsified soil passport. Effective environmental guarding is therefore essential.

In 2022 the legislation for investigating soil quality and the issuing of soil passports in the Netherlands has been fully revised, in order to diminish different interpretations of the legislation and in order to be coherent with the New Act on Planning and Environment. The system of mandatory certification and governmental approval for conducting critical activities has been evaluated. Several suggestions for strengthening this system and intensifying environmental guarding will be implemented in 2023 and 2024. Finally yet importantly, the omnium presence of diffuse PFAS contamination has its effect on both the development of soil reuse standards and the incorporation of upcoming contaminants within the procedure of issuing soil passports.

In the presentation the Dutch system of soil passports, the system of mandatory certification and governmental approval and the incorporation of upcoming contaminants within soil passports will be explained in depth. The importance of this system for the circular economy will be adressed as well as some incidents that stipulate the importance of compliance to the regulations and the fragility of a created market for reusable soils. The presentation will be interesting for several participants of different EU member states. Within the EU Soil Health Law, soil passports are seen as a welcome instrument to boost the circular economy and enhance the reuse of soils within the EU.

Session 1d1 / Abstract title: Circular management of contaminated soil

ID: 303

Key words: Circular economy, re-use of contaminated soil, soil classification, statistical sampling theory

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Organization: Chalmers University of Technology

Co-authors: Prof. Jenny Norrman, Chalmers University of Technology

Session: 1d1

Abstract

In remediation of contaminated sites and in urban development and infrastructure projects, large volumes of contaminated soil must be handled. In Sweden, only a minor fraction of this soil is re-used after treatment and most of the soil is disposed of. At the same time large volumes of virgin soil and rock must be quarried and used for filling and ground work. Increased re-use of controlled and treated contaminated soil materials therefore entails a substantial potential for reduced transports, reduced volumes of materials for disposal, and a more sustainable handling of contaminated soil. Thus, an increased and environmentally safe (including human health) re-use of contaminated soil would be an important contribution to an improved resource management that characterizes a circular economy.
The overall aim of the project was to identify improved possibilities for increased re-use of contaminated soil masses. To meet the overall aim, the project investigated the societal benefits from an increased re-use of contaminated soils, studied what obstacles that need to be overcome to realize these benefits, and developed an innovative method for classification of soil masses for an environmentally safe re-use. The project was multi-disciplinary integrating engineering, natural science and behavioral sciences. It was performed in collaboration between academia, authorities and private companies.
Main recommendations from the project to facilitate a more circular management of contaminated soil include: (1) Increasing the time for temporary storage of soil from 6 months to 5 years to improve the demand-supply balance and remove an important obstacle for environmentally safe (including human health) re-use of controlled and/or treated contaminated soil, thereby reducing the amount of soil at disposal sites; (2) Removal of the exception from disposal tax on contaminated soil to increase the economic viability for re-use; and (3) Preparation of a reliable and widely accepted method for classification of proper uses of soil with respect to its environmental and technical quality. A classification method based on statistical sampling theory was developed to provide users with a tool for identifying proper ways of re-using contaminated soil with a high and explicitly shown degree

of reliability. As a result, there is now a method that will provide a more sustainable management of the by volume largest waste type in Sweden.

Session 1d1 / Abstract title: From soil cure towards regenerative soil care in Flanders: ambitious new policy instruments

ID: 308

Key words: regenerative soil care, soil management practices, healthy soils, natural capital, awareness

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Organization: OVAM

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Session: 1d1

Abstract

From soil cure towards regenerative soil care in Flanders: ambitious new policy instruments

In today's world full of societal challenges, soil as a natural capital is heavily exploited and under pressure. This is caused by pollution and other soil threats (such as soil sealing) in combination with an increasing competition for space. As a result, soil health and thus the soil services are affected. Prevention of further soil and land degradation, sustainable and regenerative soil management and restoration of soil degradation is an urgent yet complex task. Clearly, a transition from our current destructive way of dealing with the natural resources towards a symbiotic system in which all humans live in balance with the natural environment is urgently needed.

In Flanders, the soil decree is since 1995 an important instrument for the realisation of the Flemish policy on soil contamination: it provides a thorough curative approach to manage soil contamination and to support the sustainable management of excavated soil materials via a track and tracing methodology. However, as we are facing new challenges the need to move from soil cure towards soil care is emerging.

OVAM, as public administration responsible for soil contamination management, believes that the ambition to preserve and restore soil health needs an increase in societal awareness and social involvement resulting in a soil care movement.

We use soil and land stewardship as a mobilizing action perspective of soil care. Soil and land stewardship is not only focussed on the sustainable and balanced use of our natural resources but goes much further. It also aims at achieving a shared responsibility of all actors towards soil care. To achieve this, OVAM is working on 3 levels: 1) raising societal awareness on the importance of healthy soils and soil care, 2) offering regulatory

frameworks and knowledge to apply this soil care in such a way that this leads to 3) more soil care in practice considering different contexts, target groups and spatial scales: from micro- over meso- to macro-scale (area effect).

To set soil and land stewardship in motion, several instruments have been developed and others are still under development. During this presentation we will focus on two concrete instruments developed so far: the ‘soil certificate 2.0’ and the guidelines for ‘good’ soil management practices:

- Soil certificate 2.0: Currently the soil certificate is a legal instrument to protect future land owners by informing them on soil quality and soil contamination in case of land transfer. With the soil certificate 2.0, OVAM will provide additional placebased information and maps for each parcel and its surroundings. Information on how to practice soil care will be provided, fostering a shared responsibility and ownership.
- Development of guidelines for ‘good’ soil management practices to advice all actors on how to take of their soil during their activities. This framework aims to facilitate legal anchoring of a duty of soil care at a later stage.

To conclude, we see soil care as a necessity to preserve, restore and regenerate soil health by increasing social awareness and co-creative involvement of stakeholders. Like in every stewardship approach, clear rules or guidelines embedded in a target oriented and guiding regulatory framework are needed. A framework that is supporting the caretakers and penalizes those who cause harm.

By introducing this approach, we contribute to the transition towards life supporting soil care. Together we pave the soil care pathway and engage each stakeholder to create added value for society, seeing soil within a broader system view as a living system. Because after all… soil needs to be considered and treated as a common good, just like air and water.

Session 1d1 / Abstract title: Toward an efficient traceability for excavated soils in France

ID: 54

Key words: traceability, excavated soil, TERRASS, RNDTS, soil passport

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Organization: BRGM

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Session: 1d1

Abstract

Each year in France, nearly 130 million tons of soil are excavated for infrastructure and development projects. A significant portion of this waste is still stored in landfills, while other sites purchase backfill materials for their developments. To address this issue, the French government set an ambitious target in 2015 to recover 70% of construction waste as part of the Energy Transition Law for Green Growth (LTECV).
Additionally, major land developers and public services struggle with the lack of control over the flow of excavated soil. They lack visibility on soil quality and flow traceability in a context of highly constrained urbanisation context, making it difficult to meet the regulatory goal of "zero net artificialization" outlined in the 2018 French Biodiversity Plan.
The circular economy offers a solution for achieving regulatory objectives and meeting the needs of developers.

The TERRASS application, developed by the French Geological Survey (BRGM) for the Ministry of the Environment, is a public tool that aims to help public works actors manage excavated soil and make traceability asked by European and French regulations easier. It allows:
- producers and receivers of excavated soils to connect,
- project managers to delegate soil management, keeping control with an exhaustive vision (characterization, tracking, ...) because they remain legally responsible until the final disposal,
- traceability of soil flows at different scales thanks to the emission of soils follow-up forms, at work or site scale,
- a sharp vision of soil movements by all decision-makers in order to optimize management.

The French National Register of Soil and Sediments (RNDTS), developed in 2022, aims to meet new regulatory objectives established as part of the AGEC law (anti-waste for a

circular economy) which transposes the European directives of 2018 and 2019. All soil flows with a volume greater than 500 m3 must be declared by the producer, sorting/transit facility, and receiver. This obligation increases the need of excavated soil traceability. It is expected to have between 50 and 100 million declarations per year in this tool.

Although the methodology for the management of excavated soil has been initiated in 2013 in France to facilitate, encourage and supervise the recovery of excavated soil while preserving human health and the environment, obstacles remain. The TERRASS application is not widely used, as most soil flows are managed through closed networks (word of mouth or through soil traders or dealers and private applications within large companies).
Since January 2023, the TERRASS application is connected to the RNDTS in addition to its previous missions, making it easier to fill in the mandatory declarations.

The new regulatory requirements associated with the RNDTS should encourage actors to improve traceability and promote the circular economy of excavated soil. The coming year is expected to improve the conditions for the recovery of excavated soils in France. The TERRASS application in conjunction with the RNDTS will be able to track soils from excavation to recovery and may even respond to the concept of a soil passport, expected in future European law on soil health.

Session 1d1 / Abstract title: Soil recovery and re-use on major infrastructure projects – what is needed to achieve positive outcomes

ID: 77

Key words: Soil re-use; Soil function; Data; Soil Planning

Submitter: Jay Hall

Organization: Arcadis

Co-authors: nan

Session: 1d1

Abstract

Soils are a diverse component of terrestrial ecosystems, providing a wide range of ecosystem services that are important for our environment, society and economy, including food production, water regulation and climate regulation. This provisioning of ecosystem services has resulted in their overuse and exploitation from many different users, often exceeding the boundaries of the natural system. In the UK alone vast quantities of soil end up in land fill (it is estimated that the annual cost of soil degradation in the UK is £1.2 billion), in part due to the existence of stringent waste regulation compared to non-existent legislation focused on the wide range of soil ecosystem services which come from healthy soils. But there is also a strong element here of a lack of understanding of soils and soil forming materials, how they can be re-used by matching soil characteristics to the requirements of the proposed following land use and how to ensure the long-term sustainability of their required functions.

The EU Soil Strategy for 2030 sets out a framework and concrete measures to protect and restore soils, and ensure they are used sustainably. It includes the concept of soil health, a term which is gaining wider usage although probably remains a poorly or mis-understood term. Any framework for soil resource recovery and re-use has to have a basis in the understanding of natural soils and their variability (horizontally and vertically), soil function, soil health and recognition of the central role soils play in supporting the sustainable delivery of the full diversity of land management and stewardship activities.

This study will present the detail of what processes and expertise are required to ensure full recovery and re-use of topsoil and subsoil resources, using the major infrastructure projects High Speed 2 (HS2) and Sizewell C Nuclear New Build as examples. Through the project lifecycle the information, data and expertise required to ensure the baseline soil resource conditions are fully understood, clear methodologies for soil handling and storage are developed and holistic solutions for soil resource re-use are found will be explained.

On HS2, a linear major infrastructure project, the importance and value of the digitisation of

the soil survey data will be shown, highlighting the importance of making the data available across all project teams. The approach to topsoil and subsoil re-use will be highlighted, including the development of route-wide and landholding-specific Soil Resource Plans, and examples provided of how soil re-use is being planned for a range of post construction land uses, including agriculture, landscape planting and ecological mitigation. How this is supervised and controlled on site will also be detailed.

On Sizewell C Nuclear New Build the focus will be on how soil survey information is being used to support the development of a land use change strategy to deliver Biodiversity Net Gain, delivering a land use change from intensive arable to extensive grazing to promote the development of habitats in keeping with the natural landscape character of the area.

These two project examples demonstrate that, with the right expertise, it is possible to achieve a full understanding of the soil resources present and to use this knowledge as a platform to maximise the re-use of the soil materials to maximise the delivery of post-construction ecosystem services. This understanding of the approach and the information and expertise required is hugely significant – there is clear evidence that without this, projects can fail to deliver the foundation on which so many other projects outcomes require (for example landscape planting, ecological mitigation and flood risk reduction). Holistic solutions and project outcomes require the basis of a full understanding of the soil system, how it functions and how topsoil and subsoil re-use can support successful outcomes.

Session 1d2 orals

Session 1d2 / Abstract title: Construction of a development platform for a new urban district through the use of dredged material stabilized using recycled binder materials

ID: 104

Key words: circular economy, contaminated dredged sediments, mass stabilization, recycled binder materials. environmental risk assessment

Submitter: Ville Kilponen

Organization: Ramboll

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Session: 1d2

Abstract

Purpose of study

The city of Turku is a coastal city in Finland with significant shipyard industry. It is estimated that by the year 2029, approximately 1 million cubic meters of dredge spoil will form during water construction works in the area. The utilization and disposal of dredged masses in the area is challenging because Turku archipelago is an important area in terms of natural values. To protect the valuable marine nature, the City of Turku has decided to stop sea disposal of dredge spoil.

Lauttaranta is a site in Turku, where circular economy will be promoted in the pre-construction. This is done by offering a utilization site for the dredged masses, which will also be stabilized using recycled binder materials, such as powerplant ash and waste gypsum. The pre-construction of the area has an environmental permit, but the limit values in the permit are based on threshold and guideline values. Due to the harmful substances contained in the materials to be utilized, a permit change and a site-specific risk assessment is required.

The aim of this study was to determine the technical and environmental requirements for the dredge spoil and recycled binder materials used in stabilization, so that the pre-construction

of the area can be carried out as sustainably as possible.

Methodology

The technical and environmental properties of the dredge spoil and stabilized materials were investigated in a pre-testing experiment. The most important technical requirements identified were >150 kPa compressive strength and 1*10-7 m/s water permeability.

Based on the pre-testing, harmful substances that would exceed the permit values were identified. Based on the construction plans, three separate conceptual models were made for the risk assessment. The objective of the risk assessment was to determine the total concentration and solubility limit values, which would not cause surface water EQS to be exceeded in the receiving water body.

The sustainability of different options was evaluated using a sustainability assessment tool SURE by Ramboll, which estimated the effects of different implementation options against UN SDGs.

Results

Several recipes studied in the pre-testing met the technical requirements and depending on the dredge spoil, 20-50% of the commercial cement could be replaced with fly ash.
Based on the risk assessment, the total concentration of Cr, Cu, Ni, Pb, Zn and V exceeded the total concentration limit value and solubility limit values needed to be evaluated for As, Cr, Cu, Mo, Ni, Pb, Sb, Se, V, DOC and the phenolic index.

Conclusion

The conclusion of the risk assessment was that the use of recycled binder materials in the stabilization of dredged mass is possible without causing risks to environment and health. The risk-based limit values for utilization are considerably higher than the permit limits due to the low water permeability of the stabilized materials and small amount of water separated during the sediment drying phase.
Compared to alternative solutions for pre-construction, environmental impacts are significantly lower and overall, the solution to use dredged masses and recycled binder materials for pre-construction promotes best the realization of sustainable development goals.

Significance

By using dredge spoil and recycled binder materials, it will be possible to utilize approximately 680,000 t of dredged spoil and 128,000 t recycled binder materials in the next 10 years. Presented implementation method will significantly reduce the need for cement stabilization, thereby avoiding the resulting CO2-emissions and landfill disposal of the power plant ash. With presented solution the use of pristine soil and sea disposal of dredged masses will be avoided, resulting in sustainable construction of a new urban district in an archipelago with valuable natural values.

Session 1d2 / Abstract title: Effects of biochar and peat amendments on recovery of soil functions in contaminated soil

ID: 175

Key words: biochar; soil contamination; field trial; ecological quality; nitrogen cycling

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Session: 1d2

Abstract

Purpose of the study
Soils in urbanized areas are often moderately contaminated. It is not sustainable to replace all these soils by virgin materials. Instead, we need to develop more resource effective methods for management of soils. Contaminated soils may also be restricted in their functioning, such as providing a favorable environment for microorganisms and their ability to cycle nutrients that can sustain plant growth.
Biochar produced from organic waste is used as a soil amendment to improve soil quality due to its capacity to retain water, air and nutrients. It can also sorb pollutants in the soil, hence lowering the risks for negative environmental and health effects. In addition, carbon is sequestered in the soil.
Different aspects of using biochar to stabilize pollutants and simultaneously improve soil quality was studied within the project Biochar - from organic waste to resource for treatment of contaminated soil (2018-2020) and is now continuing within the project BALANCE (2022-2025).
This specific part of the study aims to adress how the soil nitrogen (N) cycle in a contaminated soil benefits from soil amendments of biochar, peat and their combination.

Methodology
Two levels of biochar (2.8 and 5.6% w/w) and peat (1.5 and 2.9% w/w) were applied to a soil

contaminated with metals and PAH to study the effects on the plant-soil ecosystem and the chemical behaviour of the contaminants. The biochar was produced from forest residues by pyrolysis at 750°C. A full factorial field trial was designed with three replicate cultivation beds for each treatment in a randomized design (i.e. in total 27 beds), and all beds were sown with ryegrass.
To assess the effect on the general soil quality and effects on soil N cycling, we measured plant and soil C and N elemental and stable isotopic composition (δ15N, δ13C), abundance of microbial communities as well as abundances of different N cycling microbial guilds, and performed basal- and multiple substrate induced respiration.

Summary of findings/results
In this first year of the field trial, biochar radically reduced the solubility of PAH and decreased metals in the soil porewater.
At the same time, peat and biochar amendment increased the C content and C/N ratio of the soil, and this was accompanied with an increased microbial biomass and basal respiratory activity, but a decreased grass biomass and leaf N content. Changes in the δ15N signatures of leaf, root and soil indicated that more N was retained in the soil microbial N cycle. Biochar and peat amendments also increased abundances of denitrifying and N2O reducing organisms, while effect on various nitrifying guilds were less consistent. Together, plant productivity, shoot N content and stable isotopic profile indicated that the availability of N was reduced by biochar, but not (as much) by peat.

Conclusion
We demonstrate that soil pollutants and N are immobilized simultaneously, while microbial capacity to perform important soil functions is improved, creating a more favorable environment to microorganisms. Ongoing research at the field trial will demonstrate if the beneficial effects of peat and biochar amendment will remain.

Significance / contributions of study
Sustainable solutions for soil remediation are needed to reduce the need for eternal landfilling. Many biochar studies have shown beneficial effects for plants and microorganisms in unpolluted soils, but large-scale field trials with multi-contaminated soils are scarce. Our carefully designed field trial contributes to understanding of when and how biochar can be used to improve contaminated soil. An important next step is to verify the sustainability of biochar treatment over time, verifying both the impact on contaminant behaviour and soil biological quality. As we continue to follow up the field trial, valuable knowledge about such long-term effects will be gained.

Session 1d2 / Abstract title: Cartifond – Preservation of soil resources and reuse in an urban area. Establishment of soil background values for the Metropolis of Lyon from existing data according to the new French national methodology

ID: 341

Key words: Urban soil, pedo-geochemical background, statistic, threshold values

Submitter: Baptiste Sauvaget

Organization: eOde

Co-authors: Hélène Demougeot-Renard, eOde, Geostatistician

Session: 1d2

Abstract

Good knowledge of quality of the soils of a region is the basic tool for protecting them and preserving their functions while authorising urban renewal operations. Constitution of reference systems in the form of pedo-geochemical background values allows an optimised management, with the relocation of soils without degrading the chemical quality of the receiving sites during development projects.
In France, the guides for recycling excavated soils off site (Coussy et al., 2020b, 2020a) require assessing soil quality by comparison to pedo-geochemical baselines. The first level, national, gathers relatively low threshold values authorising the reuse of soils on the entire metropolitan territory. To be able to regenerate larger areas while protecting the chemical and sanitary quality of soils, a second level is proposed corresponding to local pedo-geochemical baselines, which can be higher than the national thresholds.
For determining these local reference values, statistical and geostatistical approaches are possible. The first consists of calculating a statistical threshold from a representative set of background values. This "baseline" is described in the guide for determining background values at the scale of a region (ADEME, 2018) and is obtained by calculating the upper inner fence over a range of values representative of the natural or anthropized pedo-geochemical background of a geographical entity.
The second approach uses geostatistics and may be implemented in sectors with large amounts of data and major challenges, such as districts, metropoles or regions with high development.
Since 2010, the Metropolis of Lyon has gathered data on the chemical quality of soils in a database, which have been collected in the context of development projects carried out on its territory. This database is currently one of the most extensive in France, with nearly 6000 soil samples and related chemical analyses. From 2018 to 2022, eOde established baselines for the natural and anthropized pedo-geochemical backgrounds of the metropolis

according to the national methodology, with the financial support of the ADEME.
A preliminary stage was required to prepare data, consisting essentially of:

- Eliminating the outliers representative of soils heavily polluted by former industrial activities,
- Assigning the data to the natural pedo-geochemical background – in situ natural soil that is not directly impacted by human activity, or to the anthropized pedo-geochemical background - displaced soil (backfills) or in situ soil impacted by diffuse inputs linked to human activities.

The two obtained datasets were then processed separately:

- Baselines were calculated for 14 pollutants over the whole territory as the upper inner fences of the distributions, after spatial declustering and correction of the effect of high percentages of censored data by a novel method of discretisation,
- Baselines were calculated by coherent geographical entities defined according to land use and geology when proportions of censored data exceed 75% or in the absence of spatial structure, i.e. for Mo, Sb, Se, PAHs and PCBs in both natural and anthropized backgrounds,
- The methodological choices were validated by tests all along the process, such as univariate and multivariate analyses of variance for dividing data into groups.

This study was useful, not only to provide soil background values for Lyon Metropolis, but also to test and adjust the methodology described in the French national guide of 2018. Some computation steps appear to be mandatory for getting ranges of representative background values in all regions, while others could be more specific to the territory, its historical and current occupation and its geology.
The presentation will provide details of the methodology used, the raw results obtained from the data processing, as well as the operational reference values retained by the Lyon Metropolis.

Session 1d2 / Abstract title: Soil and building material reuse: how blurring the lines may help regulation

ID: 370

Key words: Reuse, soil, building materials, evaluation framework

Submitter: Araya Negash

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Session: 1d2

Abstract

In its attempt to meet its goal of having a circular economy by 2050, the Netherlands is stimulating the reuse of soils, sediments, waste streams and building materials. The products derived from reuse (i.e. remediation processes, flocculation processes etc.) are termed secondary building materials. Because extraction of primary soils and sediments come at a significant environmental cost, the use of secondary building materials, where possible, can be a means by which the demand is reduced. Additionally, the use of secondary building materials can decrease the burden on landfill sites and future generations. There is therefore utility in using secondary building materials and recognition of this utility is evident in the increasing number of secondary building materials available on markets.

The use of such secondary materials is however not without risk. This is illustrated by the deterioration of soil and water quality at some locations where these have been applied in the Netherlands. An example is the salinization of soil and groundwater at a location where thermally remediated soil was applied. In Dutch legislation a distinction is made between building materials and soils. This distinction translates to regulatory differences and, therefore, also differences in quality criteria and the way quality is assessed. Consequently, the classification of a secondary building material, as one or the other, can determine whether it may be applied. This classification does not always ensure that risks are identified adequately because the classification determines the quality criteria and assessment methodology. For example, classification of a product as soil leads to less stringent assessment with regards to leaching of contaminants. Classification dependent evaluation is one of the reasons why, within the Netherlands, cases arise where the application of secondary building materials have led to adverse effects on the environment despite regulatory compliance.

In 2021 a study was conducted to evaluate the environmental impacts associated with

thermally remediated soil. Part of the study investigated the legislation and quality criteria used to determine applicability. One of the outcomes was an evaluation framework applicable to building materials. The evaluation framework is classification agnostic, and, therefore, the evaluation of a secondary building does not depend on its classification. The framework is focused entirely on the evaluation of the environmental impact of the applied material. The proposed method relies on multiple criteria, with each criteria being coupled to a specific soil function/use-case. The more criteria a secondary building material fulfills, the larger the freedom of use and more it approximates a natural soil. Fulfillment of the most stringent criteria - being able to support soil fauna – for example, indicates that the secondary building material is no different to a natural soil. The criteria are partially based on those already present in current regulation, but also include new criteria such as the influence on porewater pH or soil salinity. A clear benefit of this proposed evaluation method is that it relates the quality of the building material to its functional use and the surrounding soil and water quality. The method makes it possible for a building material to be applied in certain situations, where environmental risks are less likely. It thus departs from the binary outcomes of usable or not-usable and increases the possibilities for use while minimizing risks. It may also potentially act as a stimulus for the upcycling of a secondary building material, as a higher quality equates to more use-cases.
We would like to present this evaluation framework. In the presentation we will describe the case studies that revealed points of improvement with respects to current regulation and the considerations made during the development of the evaluation framework.

Session 1d2 / Abstract title: In Situ Thermal Treatment of Japanese Knotweed, a solution to recover infested soils

ID: 55

Key words: Japanese Knotweed, ISTT, invasive species, reuse of soil

Submitter: Léa Deceuninck

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Session: 1d2

Abstract

An invasive species is a species that is not native to a specific location (an introduced species), and that tends to spread to a degree believed to cause damage to the environment, human economy or human health.

The invasion of environments by exotic plants has an important economic impact: it contributes to the reduction of agricultural yields, to the erosion of banks where they settle - which can lead to flooding - and causes infrastructural damage. Building land with an invasive species suffers a strong depreciation in value. Today, many efforts are being made to restore colonized areas.

An example of an invasive species that is currently rampant, especially in Europe, is the Japanese Knotweed (Fallopia Japonica). Japanese knotweed, native to eastern Asia, is an herbaceous plant introduced into Europe at the beginning of the 19th century as an ornamental, forage and honey plant. In a new environment without pathogenic, parasitic or phytophagous species able to regulate its expansion, the Japanese knotweed is today among the 100 most problematic species in the world, listed in the Global Invasive species database.

The competitive advantage of Japanese Knotweed, leading to the disappearance of native species and the reduction of biodiversity, can be explained by different points:

Japanese knotweed is a plant that establishes itself in wetlands and spreads mainly vegetatively, by means of rhizomes. Its root system forms a dense and relatively deep

horizontal network.

The Japanese knotweed has an abundant foliage with leaves having large surfaces. These thick leaves do not allow light to pass through, which gives it a shading property towards competing species.

Moreover, the Japanese knotweed produces allopathic substances based on phenolic derivatives causing the necrosis of the neighbouring plants.

There are a variety of control methods for invasive plants, such as Japanese Knotweed. Most control techniques target the aboveground biomass, the most common control being mowing. Other techniques have been developed: deployment of an opaque tarp over the plants to restrict access to light, thermal weeding, biological control by insertion of herbivorous predators, etc. However, these techniques have not proven to be very effective due to the plant's ability to regenerate new plants from the developed root and rhizome system.

Another means of control is heat treatment. Indeed, the underground parts of invasive plants are sensitive to high temperatures. It has been shown that 50°C for 3 days or 80°C for 1 day is the lethal time-temperature combination for a Japanese Knotweed rhizome.

Haemers Technologies, in partnership with the Katholieke Universiteit Leuven (KUL), has conducted laboratory test and pilot project targeting Japanese Knotweed. This article presents a system to control invasive plants by heating, targeting the underground parts of the plants and in order to prevent their vegetative and sexual reproduction; The Smart Burners™ system is used for In -Situ Thermal Treatment (ISTT) to completely remove the invasive species of concern by heating affected soils. After the study, no re-growth of Japanese knotweed was observed on site nor in laboratory conditions, indicating that the thermal treatment is effective in eradicating Japanese Knotweed.

Session 1d2 / Abstract title: Metal mobility in an anaerobic-digestate amended soil: the role of two bioenergy crop plants and their metal phytoremediation potential

ID: 90

Key words: anaerobic digestate, soil reclamation, trace metals, phytoremediation, bioenergy crops

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Session: 1d2 backup

Abstract

Anaerobic Digestion (AD) is one of the most economical and effective treatment technologies for multiple feedstocks, including the organic fraction of municipal solid waste (MSW). AD of MSW generates two potentially valuable end-products: renewable energy source in the form of biogas, and MSW anaerobic digestate, hereafter referred to as digestate. Digestate presents a soil conditioning interest for its richness in plant nutrients and organic matter, resources that can be recycled back to the soil and help give response to the current declining quality of soils around the world. However, application of digestate as a land amendment could result in the application and accumulation of digestate-borne pollutants into soils, in particular trace metals (TMs). There is a need of finding strategies for digestate safe use and land disposal, while meeting regulatory and quality requirements. Phyto-management approaches are cost-effective and ecologically responsible nature-based solutions that could be integrated to remediate soils after digestate amendment. Energy crop plants are especially good candidates for their known high-rate biomass production, adaptability to different conditions and capacity to accumulate TMs. At the same

time, these plants could benefit from fertilizing properties of digestate. Understanding the role of bioenergy crops in the migration and transformation of TMs in the soil environment after digestate amendment is of great significance for implementing adequate digestate management practices and risk-control strategies.

Two non-food bioenergy crops (Panicum virgatum and Pennisetum alopecuroides) were evaluated for their capacity to recover soil amended with TMs contaminated digestate. For that, 90-day vertical soil column mesocosm (60 x 20 cm) experiments were performed to assess (i) the impact of digestate application on a marginal soil health, (ii) plant effect on digestate-borne TMs mobility along the soil profile (measuring total metal concentrations and fractionation in different soil layers by atomic absorption spectroscopy (AAS)), and (iii) plants growth performance and TMs uptake capacity (metals in plant tissues determined by AAS). Results showed that TMs were mostly confined in the 0-20 cm soil horizon over the course of the experimental period, migrating from the digestate amended soil layer to the layer underneath, while no evidence of movement to deeper soil layers was detected. TMs migration in top layers was reduced when Panicum virgatum and Pennisetum alopecuroides were present, suggesting a phytostabilization effect. TMs accumulation potential was only observed for Panicum virgatum with Pb. Both plants growth was positively affected by digestate amendment, which suggest an improvement of soil fertility. Obtained results provide insights into plants role during phytoremediation of TMs contaminated digestate and plants potential to promote the reuse of digestate as soil amender. Although the current findings cannot be extended to all soil, bio-amendment types, and field situations, it is expected that they will contribute to the body of knowledge regarding the potential benefit of digestate and their impact on soil attributes and the use of phyto-management technologies as an economically green alternative to increase the safety of such practices. Ultimately, this approach helps walking towards the achievement of the Mission Board's proposal to the European Commission, ensure 75% of soils are healthy by 2030 for food, people, nature, and climate (EC, 2020).

Acknowledgments
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Session 1d3 orals

Session 1d3 / Abstract title: Effects of biochar and peat amendments on metal solubility and uptake by grass and earthworms

ID: 182

Key words: Field trial, Biochar, Metals

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Session: 1d3

Abstract

Purpose
Soils in urbanized areas are often moderately contaminated. It is not sustainable to replace all these soils by virgin materials. Instead, we need to develop more resource effective methods for management of soils, preferably methods that can be applied in situ.
Biochar produced from organic waste is used as a soil amendment to improve soil quality due to its capacity to retain water, air and nutrients. It can also sorb pollutants in the soil, hence lowering the risks for adverse environmental and health effects. In addition, carbon is sequestered in the soil.
Different aspects of using biochar to stabilize pollutants and simultaneously improve soil quality was studied within the project Biochar - from organic waste to resource for treatment

of contaminated soil (2018-2020) and is now continuing within the project BALANCE (2022-2025). This specific part of the study had two aims, 1) to investigate biochar effects on metal mobility and uptake in grass and worms and 2) to evaluate the use of a standardized batch test to assess metal solubility in biochar amended soils.

Methodology

Two levels of biochar, 2.8 and 5.6% (w/w), and peat, 1.5 and 2.9% (w/w) were applied to a soil contaminated with metals and PAH to study the effects on the plant-soil ecosystem and the chemical behaviour of the contaminants. The biochar was produced from forest residues by pyrolysis at 750°C. A full factorial field trial was designed. Three cultivation beds for each treatment and the reference were randomly placed in three rows (i.e. in total 27 beds). Beds were sown with ryegrass and two suction lysimeters were installed in each bed.

Soil, grass and soil solution was sampled after the first vegetation season. Metal and nutrient contents as well as soil properties, grass biomass and the uptake of contaminants in earthworms were analyzed. Batch tests with 0.001 M $CaCl_2$ were performed on soil from all cultivation beds.

Summary of findings

Addition of biochar decreased the solubility and uptake of several metals, especially cationic ones. The concentrations of Cu, Hg and Zn in soil solutions were reduced to 13, 30 and 43%, respectively, of the concentrations in untreated soil. Biochar was less efficient for elements in anionic form and even increased the soil solution concentrations of e.g. As and Cr. On the other hand, peat generally did not affect cation concentrations in but decreased anions.

Additions of biochar (and peat) provided more favourable conditions for vegetation, earthworms and microorganisms, while nitrogen availability was reduced.

The concentrations in batch tests did not always correspond to the concentrations in soil solution. Especially concentrations of Fe, Al, Pb and Hg were higher i leachates from batch tests, the main reason probably being "extra" mobilization of Fe-Al colloids in the batch test that bind metals.

Conclusion

In general biochar and peat improved soil quality and decreased the mobility and uptake of cations. Amendments with just biochar only decreased the mobility of cationic metals, but combined with peat there was a potential to also decrease anions. Care should be taken when assessing the mobility based on batch tests where leachates are filtered with 0.45 µm filters. The concentrations of several metals may be overestimated compared to the soil solution measured in situ.

Significance

Although numerous studies have investigated leaching and uptake of metals from biochar amended soils, large scale field trials with multi-contaminated soils are scarce. Our field trial contributes to understanding of when and how biochar can be used to improve soil quality in contaminated soils. In addition, we identified artifacts when using batch test to evaluate contaminant leaching. An important next step is to verify the sustainability of biochar treatment over time. The newly started project BALANCE, will enable us to follow up treatment effects during six years, including effects of NPK fertilization.

Session 1d3 / Abstract title: Lime-cement stabilization to allow the reuse of geotechnically weak soils: managing possible drawbacks and strategies to deliver highly effective results.

ID: 253

Key words: stabilization, disposal costs, soil-swelling, chemical improvement, sulfates, foundations

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Organization: Ramboll

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Session: 1d3

Abstract

The fast change of the regulatory framework all around the world, that pushes towards a more sustainable use of natural resources, overlaps with a widespread rise of disposal costs for any sort of polluted soils due to the enhanced complexity to develop new disposal areas. These two main factors amplified by the love for our Earth, stimulated Ramboll to develop and perfectionate the promising technology of soil stabilization through different mixed compounds. On this purpose, this work focuses not only on effectiveness of lime-stabilization, but also on different factors that may either positively or negatively impact on the technology performance.
The last study conducted, that represents the upfront development of this technology, was carried out to smoothen the disposal cost impact of a huge redevelopment project in the northern part of Italy; the study has thoroughly analyzed 6 soil samples to determine their suitability to the purpose. Since previous studies highlighted that reactions may occur between sulfates in soil and calcium hydroxide (CaOH) and aluminates (Al(OH)4-) present in the lime-cement mix, sulfates content was determined to avoid the negative effect of a destructive soil swelling. Furthermore, to define the mix lime percentage, humic substances content was measured. Geotech and chemical analysis outcomes allowed to design 2 mixes at different lime-cement percentage to be mixed with soils. Hence, unconfined compressive strength (UCS) and California Bearing Ratio (CBR) were measured for natural and stabilized soils after two maturation periods of 7 and 28 days each.
As easily foreseen, despite samples different responses, higher cement content mix showed better results. The UCS generally increased for stabilized soils and higher values were observed after 28 days of maturation (from 2,3 to 9 times higher than natural soils). Also, UCS increment was correlated to the percentage of grains passing the 0,063 mm sieve, showing a parabolic trend. The highest values were observed between 40-42% of grains

passing the mesh size. The CBR values of natural and stabilized soils were compared showing an increment after 28 days of maturation (from 3,11 to 7,98 times higher). As the lifting index showed, both sandy (up to 90,55%) and silty (up to 40,99%) samples were positively affected.

In conclusion, an overall improvement of geotechnical properties has been observed by applying lime-cement stabilization. However, many factors contribute to the success of this technique: in fact, findings show that geochemical characteristics like moisture content, dry fraction, humic substances etc., cannot be ignored in the definition of the most suitable mix design. In particular, the presence of humic substances requires the addition of a little lime percentage (1%) to counter the possible inhibition of hydraulic binders. Moreover, criticalities due to sulfates in soils should be considered since if sulfates are present in significant percentage, those could invalidate stabilization effectiveness. To limit these effects, specific work conditions (low C3A cement, high moisture percentage, pH regulation etc.) should be applied in the preparation and addition of the mix design. Lastly, the increasing UCS for samples with a low-medium percentage of fine fraction of grains (up to 42% passing through a 0,063 mm sieve) grants feasibility of this technique for certain soils and suggests an innovative starting point for a more efficient definition of the mix design.

Soil stabilization literally transforms geotechnically non suitable soils in high-performance soils ready to be reused either for buildings or infrastructures foundations when also the environmental characteristics allow it. The awareness that this sustainable technique, as any other chemical improvement, requires a thorough analytical study to be acquainted with its variables is the first step to drive the process to be successfully applied.

Session 1d3 / Abstract title: LIFE CO2SAND Using clay to make farmland climate proof

ID: 278

Key words: Clay, Climate, Resilience, Farmers, Value Model

Submitter: Joke van Wensem

Organization: Rijkswaterstaat

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Session: 1d3

Abstract

As a result of climate change we are increasingly facing long periods of drought and extreme rainfall. This has major implications for agriculture practices on relatively poor sandy soils. Much of this farmland lies in the so-called European sand belt, which stretches from Flanders in Belgium to well into Poland. It is known, for instance from sandy areas regularly flooded by rivers, that clay particles enhance not only the fertility of sandy soils, but also improve their resilience, and thus strengthen their ability to cope with climate change. In the LIFE CO2SAND project we are applying this 'clay-in-sand' principle in five demonstration fields, where the effects of the clay addition are being monitored. We are also committed to scaling up this practice in the Netherlands and spreading our experience and knowledge within the European sand belt.

At the demonstration fields, all interested parties are welcome to view and discuss these 'field labs'. Farmers can apply for clay addition on their sandy farmland. In lowland areas, clay is extracted from nature restorations and infrastructural works, carried out by, for instance, Rijkswaterstaat (RWS). This clay is often suitable for the improvement of sandy soils, but has so far usually been disregarded for this purpose. In cooperation between Province Gelderland and project partner RWS, matches are being made between the supply of clay and the demand for clay by individual farmers. Besides improving poor sandy farmland, a second important goal of the project is to reuse extracted clay from works as valuable as possible. To this end, a value model has been developed, which weighs the different beneficial effects of the clay application elsewhere in the region against the possible negative effects such as the presence of diffuse contamination in the clay and carbon emissions from transporting the clay over longer distances.

The project started in 2021 and builds on previous experience with clay in sand. It will take some years before we can reliably measure the results in the field. We expect higher water

conservation in droughts, additional carbon sequestration, higher crop yields, less leaching of fertilisers and minerals and better use of released top soil. All this improves the sustainability of infrastructure works and farming practices on poor sandy soils, the latter also economically.
The presentation will focus on the practical implementation of the project, the successes and hurdles to overcome, and the value model.
LIFE CO2SAND receives funding from the European Union (LIFE20 CCA/NL/001625) .

Session 1d3 / Abstract title: Volume estimate of VOC-containing materials in a landfill based on MIP soundings

ID: 309

Key words: Landfill volume estimation MIP

Submitter: Pieter Buffel

Organization: EnISSA

Co-authors: Herman Brangers, Witteveen+Bos, project manager

Session: 1d3

Abstract

The subject of the study concerns part of a large abandoned industrial site. The site is situated in an interesting location from the point of view of urban expansion. As a result, the site is currently part of a larger redevelopment project. A landfill site was operated on the sub-site until the mid-1970s. The exact quantities and nature of the dump material are not known, although it appears that chemical waste (drums) was deposited there in addition to domestic waste. The ground level near the former dump is about 3 m higher than the surrounding area. The dump material was applied on top of a partly excavated swamp area and is ca 8 m thick. Below this, the subsoil consists of sand. At 9 m-mv there is a gravel layer. A clay layer is expected at a depth of 20 to 25m.
The dump material was previously investigated by drilling, cased excavations and trial trenching. However, due to the nature of the material, representative sampling and analysis was not evident. Despite strong sensory observations during the performance of some of these sampling activities, the presence of VOCs in the material sometimes proved difficult to demonstrate quantitatively in the analyses.
Based on some test trenching and accurate sorting of the material recovered, an estimate of the distribution of the landfill material according to necessary processing method was made. This showed that a certain fraction of the material contains very high levels of VOCs corresponding with very high processing costs. This is only a limited sample and it is unclear how these ratios would compare over the entire volume of the landfill.
In the context of evaluating different redevelopment scenarios and designing appropriate management or remediation strategies, a more accurate estimate of the volume of highly contaminated material was needed. In order to be able to make such an estimate, a sampling strategy was sought that would allow a sufficient number of measuring points to be achieved through reproducible sampling.
40 MIP soundings were placed on the landfill in a grid of 25x25m. This in-situ detection approach allows evaluation of the amount of VOC throughout the landfill profile. This method allows relatively fast screening and also limits the influence of loss of VOCs due to

volatilisation during sampling or due to sorting, separation of materials as a function of pretreatment for analyses. The results of the MIP measurements were then interpreted in combination with some soil air measurements and the already available data from previous research. The applied MIP system (EnISSA) uses GC-MS detection, which allows individual VOCs to be quantified and also differentiate by composition. The results of the MIP soundings were processed in a 3D visualisation application.

Based on the combined measurement strategy, a zone was delineated in the north-east corner of the landfill in which the presence of (damaged) drums containing chemical waste is to be expected (high levels of benzene and xylene). A volume estimate of this zone was determined in the 3D model. Besides this zone, high levels of VOCs were also found in some scattered, isolated soundings. Possibly these are discrete zones with one or more damaged drums. However, due to the specific nature of the occurrence of the waste, it is difficult to conclude that intact drums do not occur (for the time being) at the locations with low presence of VOCs.

Conclusion

Thanks to the high data density, the risk of misjudging the highly contaminated fraction was greatly reduced. The zone with the presence of already highly contaminated material was depicted much more accurately based on the extensive data set, reducing the uncertainty on the remediation costs.

Session 1d3 / Abstract title: The Delfzijl Mud Ripener: a pilot using marine soft sediment to construct embankments

ID: 369

Key words: Beneficial Use of Sediment, Ems Dollart, Mud Ripener, Sediment to Soil

Submitter: Wouter van der Star

Organization: Deltares

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Session: 1d3

Abstract

Dredged sediment from the Ems-Dollart estuary is generally disposed off in the direct vicinity on sea. As part of the programm Eems-Dollard 2050, pilots take place to remove the sediment from the system and create beneficial use cases on land. In the Pilot Mud Ripener the soft sediment is transformed into clay soil that fullfills the requirements for embankment design in the Netherlands.

The research took place in two ripening pilots: one on the Salt Marsh (Kleirijperij Kwelder) and one in-land (Kleirijperij Delfzijl). Both locations consisted of 100x100 meter plots in which initial height, drainage systems, reworking frequency, effects of plants and effects of dilution with freshwater was tested on a field scale. The plots were filled (relatively) homogeneously in 2018, and ripening took place from 2018-2021. In 2022, the material was used to strengthen 700 meters of a nearby embankment.

During the pilot monitoring took place on the development of -amongst others- water content, organic matter content, salt content, Atterberg limits, bed height, environmental parameters and development of vegetation. Furthermore the erosion resistance of the material was tested in the Delft Delta Flume. The development was used to adapt a mathematical model that can be used to design initial bed height and evaluate the effects of weather conditions (such as dry summers)

From 2023 evaluations are taking place to scale up the procedure and the material on the dyke is monitored for the next 3 years.

In the presentation we present the results of the pilot, and discuss the best way to design large scale ripening.

Session 1sps1 orals

Session 1sps1 / Abstract title: New challenges call for new soil professionals

ID: 270

Key words: EU Soil Strategy, circularity, re-use, T-shaped professional, cooperations

Submitter: Barry Versluis

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Co-authors: Koninklijke NLingenieurs - Expert Network Soil and Subsoil (consisting of Witteveen+Bos, TAUW, Sweco, RHDHV, Arcadis, Antea Group)

Session: 1sps1

Abstract

How the Netherlands is building a new generation of soil professionals to meet the challenges of the EU Soil Strategy. In this session we take a look at one of these challenges. We will use it to give an idea of what the soil professional in the Netherlands needs to have in order to meet these challenges. We would like to exchange insights and tips with experts from various countries.
Part 1 introduction of the theme: the need of a changing professional [10 min]
-We start with a short introduction in which we touch upon the importance of soil in societal processes and make the link that this is recognized in the EU Soil Strategy. Dealing with the soil strategy requires different skills from the soil professional: it requires much more cooperation in the chain (knowledge institutions, government, business). In doing so, it is important to link the importance of soil to the major societal challenges and to consider soil as part of a larger system.
-We are aware of this in the Netherlands and we see developments in this in all sorts of areas, we would like to illustrate this in the first place using one of the important themes within the EU Soil Stategy, namely the theme of circularity. Reducing the use of raw materials and sustainable reuse of used materials.
-Using 3 examples, we show that in this theme we need to take a broad view of soils, not only looking at chemical soil quality, but also including aspects of physical soil quality and biological soil quality. Also, not just substantive knowledge of soils, but also looking at adjacent fields of work: in the case of circularity, this often involves coordination with spatial developments and water quality.

We come up with 3 telling examples of circular use of soils in the Netherlands, but these examples are not only instructive, but also recognizable and applicable in other countries. [20-25 min]

1. The case study Markerwaddden: floating silt is used to build islands. Positive effect on water quality, physical challenges and nature developments go hand in hand;
2. case study Equi-ash: the residual stream of bottom ash is utilized; example of a useful application and also CO2 sequestration as a bonus
3. case study reuse of contaminated soil; this can be a chemical contamination (f.i. PFAS) or an excavation of nutrient-rich topsoil for nature development and reuse of excaved soil.

In all cases emphasize the knowledge and skills that the soil professional should have within these projects: the T-shaped professional. (Of course we will explain what this is.)
Concluding section where we indicate what we are doing in the Netherlands to arrive at this T-shaped professional. The key word here is Cooperation. We mention the 3 most important collaborations [10 min]:

1. the collaboration with education. This is where the soil professionals of the future are formed. We call this the KOBO-HO initiative;
2. collaboration in the chain between policy - knowledge - businesses. We indicate how this takes shape through networks and joint actions .
3. collaboration with other fields: strengthening networks in the regions where the soil professional must work together with experts on spatial development, water, energy and ecology.

For each of these 3 collaborations we show what is happening in the Netherlands, and discuss which obstacles to overcome (e.g. procurement rules, communication) And as said before, these examples are also interesting for other countries
Part 2: interactive session [45 min]
-we introduce a panel of about 5 persons: the speakers of part 1, supplemented with representatives of certain groups, e.g. KOBO-HO, knowledge institution etc.
-we ask the audience via Kahoot/Menti a number of questions related to these new challenges
-after each question we ask the panel to reflect on the question and answers
-After each reflection allow 1 or 2 short responses from the room. We do this depending on the time available in a few rounds
- Short conclusion by the panel and closing

Session 1sps2 orals

Session 1sps2 / Abstract title: National Competence Centre II BIOCIRKL – Biorefining and circular economy for sustainability

ID: 62

Key words: circular economy, waste, energy, fuel, chemistry, bioactive, sustainable, technology, product

Submitter: Olga Solcova

Organization: Institute of Chemical Process Fundamentals of the CAS

Co-authors: Moderators: Olga Solcova, ICPF CAS Prague, leader of the project, chemist; Lenka Wimmerova, CZU Prague, environmentalist

Session: 1sps2

Abstract

Proposal for a free session:
National Competence Centre II BIOCIRKL – Biorefining and circular economy for sustainability

Moderators: O. Solcova and L. Wimmerova

Summary:
The BIOCIRKL centre is focused on the effective and circular utilization of various kinds of waste. Part of the waste is originated in agriculture, animal production, and forestry. Apart from the biological waste, the waste from various discarded constructions, electrical facilities, and plastic materials is also processed following the principles of the Circular Economy (CE) by environmentally friendly technologies addressing individual parts of the European Green Deal (EGD), such as environmental sustainability free of toxic substances, healthy and environmentally friendly food supply systems, reduction of energy demand, reducing CO2 emissions in building industry or affordable and sustainable energy for the general public. The centre BIOCIRKL contributes to the development of the Circular Economy in the Czech Republic. Thematically, it is focused on meeting the Sustainable Development Goals (SDGs) by 2030, especially goals 7 - affordable and clean energy, 12 - responsible production and consumption and 13 – climate measures.

The proposed presentations:

- National Recovery Plan of the Czech Republic
- Circular reprocessing of animal waste
- Biowaste as a valuable source of bioactive compounds
- Sustainable energy and waste derived fuels
- Sustainable and green chemistry

Significance:
The NCC II Biorefining and circular economy for sustainability (BIOCIRKL; 2023-2028) directly follows the NCK BIOCIRTECH, carried out in years 2019-2022. The NCK BIOCIRTECH centre covered the extensive issues of processing waste biomass in environmentally friendly ways in accordance with the CE principles, whereas NCK II BIOCIRKL further expands this topics with regard to addressing current societal issues ensuring sustainability and prosperity. BIOCIRLK is linked to the major Czech research centres, such as the Centre of Competence BIORAF, the Unipetrol Research Centre, and the CzechGlobe 2020 Centre, and its activities are carried jointly by 20 organisations, from which are 9 universities or research institutes and 11 companies, which significantly accelerates the practical aspects of the activities and increases the application potential of developed technologies and products.

Interactions:
The session is proposed as series of 10-minute presentation followed by a 10-minute discussion with the audience as discussion rounds or brainstorming using an interactive board.

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