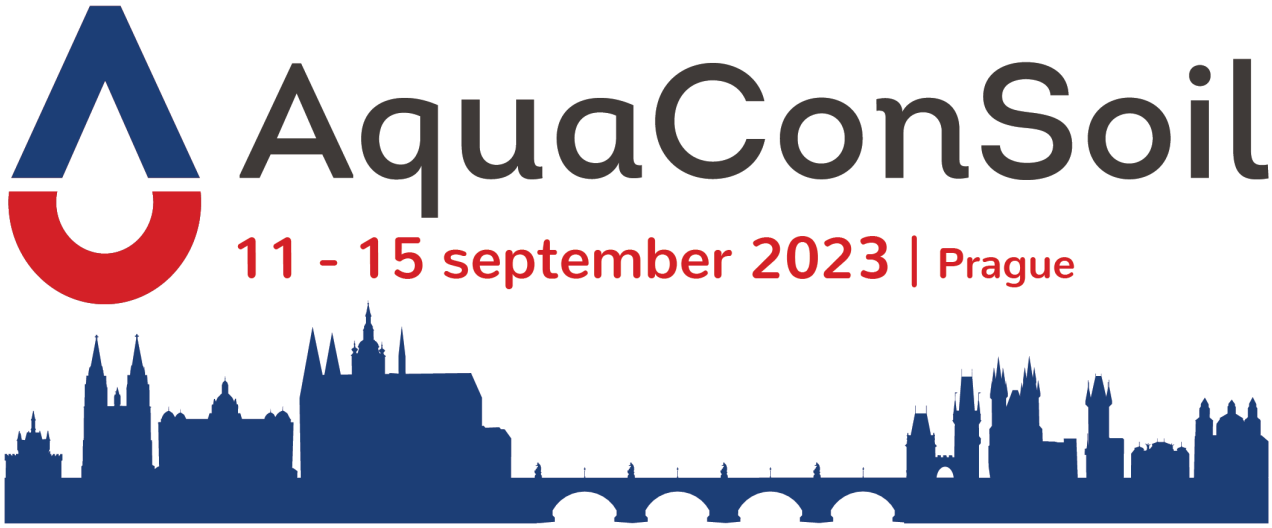

Topic 4 - abstracts

This document contains the abstracts for topic 4. Topic 4 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 4: Water and soil in the digital world
Posters	-
4a1	Sensing, monitoring and data - session 1
4a2	Sensing, monitoring and data - session 2
4a3	Integrate soil, water and sediment
4a4	Artificial Intelligence
4sps1	GWSDAT - GroundWater Spatiotemporal Data Analysis Tool: Overview and Tutorial Session

Posters

ID	Name	Organization	Title
17	Julian Bosch	Intrapore	High-resolution investigation of hydraulic anisotropies in contaminated groundwater systems with Intrasense® to enhance the effectiveness of in situ remediation
59	Lara Speijer	Vrije Universiteit Brussel and Vlaamse Instelling voor Technologisch Onderzoek	Integrating groundwater flux measurements in groundwater modelling of drought adaptation impacts: case study on sub-irrigation of treated wastewater in Kinrooi (Belgium)
60	Ying-Chu Chen	National Taipei University of Technology	Effects of Fish Mortality from Water and Air Quality Data Simulation
61	Zuzana	CZU, Prague	Advanced techniques of NN predictions in the current hydrological field
155	Andreas Sahyoun Sørensen	WSP Denmark	A comprehensive online monitoring of the groundwater level in the municipality of Gladsaxe
159	Krzysztof Kowalski	Capital Region of Denmark	Using data to tackle pump and treat plants performance
167	Jasper Schmeits	TAUW group	INVENTORY OF LEAKAGES UNDERGROUND INDUSTRIAL PIPELINES
285	Ilse van Keer	VITO	ASSESSMENT TOOL FOR MONITORING GROUNDWATER CONTAMINATION BY HEAVY METALS IN THE BELGIAN CAMPINE AREA
336	Paulo Valle	Environmental Resources Management	Using Real-Time Monitoring to Understand the Variability of TCE Concentrations in Indoor Air in a Site in Belgium
342	Marta Fernandez-Gatell	Universitat Politècnica de Catalunya	Application of a novel bioelectric-based respirometry technique to assess electroactive microbial growth in horizontal subsurface flow treatment wetlands

352	Klaus Mosthaf	Technical University of Denmark	Characterization of contaminant spreading from a point source in an aquitard/aquifer system combining 3D numerical modeling and high-resolution vertical concentration profiles
368	Daniel Okholm	WSP Denmark	Using tTEM for contaminated site investigations – part 1
410	Mariusz Czop	AGH University of Science and Technology / InTecH2O	The use of advanced numerical modelling to select the optimum remediation method for an extensive plume of contaminants in the former Zachem Chemical Plant in Bydgoszcz (North Poland)

Session 4a1

Tuesday 11:00-12:30

Room D226

ID	Name	Organization	Title
127	NIEF Nathalie	TOTALENERGIES	SAW sensors for BTEX detection in groundwater
179	Espen Eek	Norwegian Geotechnical Institute	Improved data quality with sensor based real-time monitoring. Quality assurance of a complete (sensor to dashboard) in situ real-time monitoring system for environmental parameters related to excavation production and transport of soil and rock
198	Meritxell Grau Butinyac	T.E. Laboratories	Rapid evaluation of nitrate from soil pore water for real-time decision making in a drip irrigation agricultural system of Southern Spain
208	Fabio Canova	Eni Rewind	Coupling hydro-stratigraphic and numerical 3d models with in situ sensors to improve the environmental sustainability of groundwater containment systems and assess full scale remediation strategy
248	Tom Wuyts	Group Van Vooren	Sensors, the Internet, and Automated Data Collection and Response Triggering for Vapor Control and Remedial Optimization

Session 4a2

Wednesday 14:00-15:30

Room D222

ID	Name	Organization	Title
116	**Richard Gill**	**Shell Global Solutions B.V.**	Quantitative and qualitative comparison of field-based analytical technologies for petroleum hydrocarbons determination in soils
158	**Andreas Sahyoun Sørensen**	**WSP Denmark**	Field registration of enviromental data and online automatic processing
259	**Joep Kelderman**	**TAUW**	Introducing Environmental Twins: A central insight in a (bio-)diverse environment

380	**Uwe Hiester**	**reconsite GmbH**	Automated risk and sustainability management for ISTR
406	**Ewa Kret**	**AGH University of Science and Technology / InTecH20**	An intelligent system for analyzing environmental data to support the management of green areas in urban space on the example of the city of Krakow (Poland)

Session 4a3

Tuesday 16:00-17:30

Room D226

ID	Name	Organization	Title
128	Markus Hjort	Concawe (Scientific Division of European Fuel Manufacturers Association)	Overview of the Concawe LNAPL Toolbox, a New Web-based Decision Support System for Managing LNAPL Sites
254	Roberta Sauro Graziano	Ramboll	Field Data Management from a Groundwater remediation plant through Power BI software
337	Charline Kaplan	Environmental Resources Management	Power BI as an Innovative Analytical and Visualization Tool in a Short-Term Remediation Project
339	Claire Faucheux	eOde Sàrl	Cartorisk – A method and computation tool to map spatial variation of health risks and find a best compromise for regenerating brownfield sites
367	Flemming Jørgensen	Central Denmark Region	Using tTEM for contaminated site investigations – part 2
401 – Backup	Claire Faucheux	Geovariances	Added value of iterative sampling and Geostatistics for the characterization of a small but complex industrial site

Session 4a4

Thursday 14:00-15:30

Room D218

ID	Name	Organization	Title
57	Ignacio	SARPI Veolia & Bordeaux University	Evol' a methodology for determining the error of contaminated soil volume with deep neural networks and interpolation models
89	Xiaoming Wan	Chinese Academy of Sciences	Establishment of the regional all-for-one customization model of black soil granary
99	Ysaline	Haemers Technologies	Accurate mean soil temperature estimations in the context of thermal desorption
204 - withdrawn			
349	Christos Tsakiroglou	Foundation for Research and Technology Hellas - Institute of Chemical Engineering Sciences	Remediation of oil-drilling cuttings with ozonation in bubble flow reactors, and process simulation with a machine-learning approach

Session 4sps1

Thursday 11:00-12:30

Room D226

ID	Name	Organization	Title
44	Wayne Jones	Shell	GWSDAT - GroundWater Spatiotemporal Data Analysis Tool: Overview and Tutorial Session

Posters

Session 4 poster / Abstract title: A comprehensive online monitoring of the groundwater level in the municipality of Gladsaxe

ID: 155

Key words: Webportal, Realtime monitoring, sensor data, sharing of data

Submitter: Andreas Sahyoun Sørensen

Organization: WSP Denmark

Co-authors: Claus Frydenlund Bsc., Gladsaxe Municipality

Session: 4 poster

Abstract

There have been installed 40 modems which connects to the classical pressure transducer "diver" in the municipality of Gladsaxe. All data is sent to a new web portal build by WSP which handles and displays sensor data. The web portal is called "vandportalen.dk" and is free to view and use for the public. Sensor data is connected to all sorts of free governmental data such as meteorological data.

When one site handles the collection of data from rivers, lakes, marine areas, groundwater, and meteorological data, it will be easier to make better analyses. The sharing of bot real-time and historical data will help the consulting firms by preventing doing the same work twice. The webportal can help making a sensorbased monitoring a widespread solution thereby giving access to better data. When data is full and representative a "real-time" isopotential map for the groundwater is put on top of the map.

The website is run by WSP I collaboration with municipalities, the Danish EEA and private actors. For some of the user's data is made private for their use only while most of the municipalities shares their data freely.

Today the municipality of Gladsaxe use the monitoring in their daily work for infiltration permissions, placements of wells and much more. Consultants are given access to the data and thereby starts with better data thereby being able to provide a better service.

Session 4 poster / Abstract title: Using data to tackle pump and treat plants performance

ID: 159

Key words: Chlorinated Solvents, operation and maintenance, sand filter, GAC filter, energy consumption

Submitter: Krzysztof Kowalski

Organization: Capital Region of Denmark

Co-authors: nan

Session: 4 poster

Abstract

Purpose of study
The Capital Region of Denmark operates around 40 groundwater pump-and-treat systems using granular activated carbon (GAC) filtration and, in some cases, sand filtration as a pre-treatment step. The operation and maintenance of the plants requires monitoring of the quality of the treated water and the process parameters. For many years, large amounts of data have been collected and now they can be employed to provide new insights into plant design and operation. However, there is a need to develop an appropriate methodology for data collection and processing to ensure that the information gathered is of value in the evaluation aimed at refurbishing, optimising or even retrofitting plants to reduce operating costs. The aim of this study is to present the possibilities offered by the analysis of historical data and to lay the foundations for new methodologies that can assist in the O of pump and treat systems.

Methodology
An example of data from 10 pump and treat plants, collected in a period 2020-2022, is presented in Table 1, where records are collected from different sources:

- Plant effluent analysis results - the sum of chlorinated solvents parameter, ∑CH, was used because it is a parameter that is easily obtained for all operating plants without distinguishing between the degree of dichlorination of a pollution source.
- Annual volumes of contaminated groundwater treated,
- Annual electrical energy consumption data.

In addition to the data presented, there are also records relating to plant maintenance, e.g. dates of replacement of activated carbon media, and analysis of other water parameters such as iron, manganese and non-volatile organic compound (NVOC) concentrations, which are important factors in the design of the pre-filtration step for GAC filtration.
Results

Easy manipulation of the data obtained helps to present the performance of different systems regarding the annual records of treated water, energy consumption and chlorinated solvent load, Figure 1. One can see an underrepresentation of large plants with capacity 50,000 m3/year, but it should be mentioned that data collection and analysis is ongoing, and more plants are planned to be included in analysis.

Combining annual records with GAC maintenance records allows analysing GAC capacity and performance by comparing volumes treated and contaminant loads for different periods between GAC replacements.

For example, in Figure 2 the GAC capacity is shown in relation to the concentration of pollutants in the influent and the EBCT time of the GAC, expressed as the size of the bubbles. A trend can be seen as GAC capacity increases with influent concentration, with the presence of outliers requiring further analysis.

Another example, Figure 3, shows the correlation, expressed as Pearson correlation coefficient (p), between energy consumption per volume treated, groundwater NVOC concentration and GAC capacity as bed volumes treated between media changes. It can be said that the energy consumed has a strong positive correlation with NVOC, i.e. higher NVOC results in higher kWh/m3, which can be explained by NVOC deposition on sand and activated carbon filter materials, resulting in higher energy consumption for groundwater pumping. However, moderate negative correlations between energy consumption and GAC beds are not as easy to explain and require more sophisticated analytical methods.

Conclusion

The combination of the above data sets provides an unusual opportunity to analyse treatment processes in detail, not only to optimise but also to evaluate the costs and benefits of pump and treat remediation in general. Work on the methodology for analysing data for routine O evaluations aims to explain the relationship between plant design, groundwater quality and plant performance.

Significance

In addition to operational purposes, the information gathered can also be used for remediation evaluation in terms of sustainability factors. Providing

Session 4 poster / Abstract title: INVENTORY OF LEAKAGES UNDERGROUND INDUSTRIAL PIPELINES

ID: 167

Key words: Chemical industry; underground pipelines; leakages; technology; prevention

Submitter: Jasper Schmeits

Organization: TAUW group

Co-authors: nan

Session: 4 poster

Abstract

Study objectives
Industrial site increasingly face challenges regarding possible leakage in underground pipelines / sewage systems. Such a possible leakage can have a threat to environmental impact (emitting solvents to the subsurface) or safety issues (leaching sand under construction and possible collapsing of industry). Every location needs a tailor-made solution in detecting the locations of the leakage points and how to reduce the environmental impact done.

We conducted an inventory on what is known on these kind of cases and what the impact could be for the industry. Furthermore we see all different kind of technological solutions arising that can be used to get insight in the state of a pipeline and allocate (potential) leakage points.
Methodology
To encounter the impact of these challenges we have made an inventory on what kind of information is available on leakages from pipelines. This kind of data is mostly only available on public domain systems. An inventory for cross-country oil pipelines show that spillage causes can be grouped into five main categories: mechanical failure, operational, corrosion, natural hazard and third party. The amount of spillages are decreasing over time due to the increasing amount of inspections. Furthermore; replacement is needed because of the end-life time effects and new underground structures are needed because of the energy transition.

On an industrial level, many chemical plants within the European market segment are also outdated and the underground pipelines need to be replaced, even transitioning in adapting to the energy transition or regulatory aspects (like placing pipelines above ground) are enforced. The challenge in the public domain is great, but the potential and the consequences can be even greater for industrial sites.

Outcome findings/results

The inventory of the industrial market is more difficult, as companies keep these kind of data confidential. Based on our experiences it doesn't mean that the issues aren't there. But in contrast to the public domain the potential risk on an industrial site could even be bigger if you look at it from a risk assessment perspective (risk = probability x effect). Reducing risk go in hand by decreasing the probability of occurrence or reducing the effect. The probability of a leakage is depending on several aspects (sort of piping, type of transport liquid, environment, endurance, etc.), insight in these kind of difference could lead to insight in predicting the time of probability-assessment (end-life determination). Increasing the amount of inspections lead to more insight of the state of pipelines and immediately decreases the effect of the risk and in-time it creates awareness for the end-life determination. By executing these inspections we are able to create risk-based surveys of leaking underground piping in the chemical industry.

Each situation has its own challenges and therefore it needs a broad overview of possible technologies in detecting these kinds of leakages. Traditional technologies with camera-inspections or excavating surrounding soil are mostly used, but new technologies are developed for getting insight in these kinds of issue. The application of certain technologies is depending on the local situation. Based on a broad knowledge on (the development) of these kinds of technologies we are able to prioritize them into an action plan in which costs and speed are compared to changes of success and local impact. Our goal is to create that strategy that is most efficient in the situation of the industrial client.

Conclusion

This inventory helps us detect those industries with possible issue upcoming. Waiting until the leakages occur, cause situations that needed to be highly prioritized and cause a lot of more (financial) impact on the continuation of the business. Earlier insights in future risk create room in planning, downgrading impact and staying compliant to authorities.

Session 4 poster / Abstract title: High-resolution investigation of hydraulic anisotropies in contaminated groundwater systems with Intrasense® to enhance the effectiveness of in situ remediation

ID: 17

Key words: in situ remediation, high resolution site characterization, in situ flow measurement

Submitter: Julian Bosch

Organization: Intrapore

Co-authors: Marc Schöttler, Phrealog, hydrogeologist

Session: 4 poster

Abstract

Purpose of study. Knowledge of the local, small-scale hydraulic anisotropies of pore and fracture aquifers is the fundamental starting point for the planning and design of all hydraulically effective measures such as groundwater remediation, or groundwater lowering in the course of construction measures.
In the context of groundwater remediation, it is important to understand the pollutants subsurface movement, in order to be able to carry out the decontamination measures in a targeted manner and as economically as possible. Any remediation investigation program should therefore focus on the pollutants and their local displacement pathways on a fine scale, so that anisotropies can be detected.
Here, we present real-world examples of a range of remediation sites, where high-resolution investigation of hydraulic anisotropies in contaminated groundwater systems with Intrasense® greatly enhanced the effectiveness of in situ remediation measures.
The aim of our investigations was to verify assumed anisotropies and to characterize them spatially, hydraulically, physiochemically and with respect to their pollutant load. In addition, the inflow regime of the remediation well should also be determined. The results are to be taken into account in the framework of a target-oriented adaptation of the remediation measures.

Methodology. The definition of anisotropies in aquifers depends on the task and thus on the scale of observation. Thus, the investigation strategy and the scope of the data to be determined must be individually adapted to the task and coordinated with each other. Typically, the hydraulic, hydrodynamic and physicochemical conditions were investigated by the Intrasense® method. In addition, their connection to the overall aquifer and to the regional environment was described.
The investigation program included fine-scale representation of the hydraulically effective

units, high-resolution pressure level measurements, and in situ flow direction and flow velocity measurements using the Phrealog®-system. Conventionally, the groundwater discharge in an area of interest is generated from the elevation differences of the groundwater pressure level in GWM. These regional, two-dimensional data are usually not sufficient for site-specific questions, since they do not provide the required small-scale resolution for the accurate derivation of flow movements in the area and over the depth. Therefore, flow direction and flow velocity measurements were performed in situ in the different units of the aquifer systems. These measurements were combined with physicochemical fingerprinting and other measurements, to yield a 3D-dataset of local groundwater anisotropies.

Investigation results. From a wide range of remediation sites, we are presenting various examples on how the Intrasense® high resolution site characterization helped to increase in situ remediation effectiveness. Among the examples are the detection of deviation groundwater flow directions within a remediation zone, the detection of strong vertical pollution displacement with groundwater monitoring wells, and the detection of deep groundwater currents below a remediation zone. All these hydraulic anisotropies went undetected with conventional monitoring of the groundwater table.

Conclusions and significance. Detailed Intrasense® investigations of aquifer systems were carried out. As a result, hydraulically effective anisotropies of the aquifer could be confirmed and their effect on remediation areas could be described. Strongly anisotropic conditions, which were undetected before, reduced the effectiveness of in situ remediation application, and in some cases also the effectiveness of pump and treat systems. Intrasense® investigations findings are based on reliable knowledge of the local, fine-scale flow situation of the groundwater. The spatially and temporally highly resolved measurement of the flow situation is not possible in the presented quality with conventional

Session 4 poster / Abstract title: ASSESSMENT TOOL FOR MONITORING GROUNDWATER CONTAMINATION BY HEAVY METALS IN THE BELGIAN CAMPINE AREA

ID: 285

Key words: Belgian Campine area, Heavy metals legacy, non-ferro industry, groundwater, evaluation tool

Submitter: Ilse Van Keer

Organization: VITO

Co-authors: Dr. Nele Desmet, VITO, Hydrologist; Dr. Jan Bronders, VITO, Hydrogeologist-BD; Lorenz Hambsch Msc, VITO, Software; Engineer; Ramses Nys, VITO, Software developer; Petra De Clercq, OVAM, Project coordinator brownfields

Session: 4 poster

Abstract

The Campine region, located in the northeastern part of Flanders (Belgium) and the southeastern part of the Netherlands, is polluted with heavy metals due to former activities of non-ferro industry smelters. The observed soil, ground and surface water pollution of mainly zinc and cadmium, has a regional character and covers an area of 700 km2. To meet the obligations of the EU Water Framework Directive (WFD) a groundwater monitoring network has been installed in the wide area surroundings of the former smelter sites to evaluate the status of groundwater quality. An assessment tool has been developed to 1) follow-up of the spatial and temporal groundwater concentrations for trend analysis; 2) to evaluate the need of remedial actions and to 3) report the groundwater quality per groundwater body (zone) according to the status assessment of the WFD.

The assessment tool integrates measured groundwater concentrations provided by the Flemish Waste Agency (OVAM) and groundwater monitoring data of the Flemish Environmental Agency (VMM). Spatial variability of concentrations levels can be assessed on interactive maps where measured values can be compared to adjustable environmental quality standards. For each location, graphs with time series of the measured concentrations are generated in the tool. The current tool allows for evaluating the regional groundwater pollution with arsenic, cadmium, lead and zinc. The evaluation of the groundwater quality per groundwater body is based only on VMM data according to the status assessment of the European Water Framework Directive (WFD). The groundwater quality for different years/periods can be compared per groundwater body.

The tool is not only applicable for heavy metal pollution, it can be adapted for the evaluation

of other regional pollutions as well, provided that sufficient area-covering data are available. The tool will be presented on a poster.

Session 4 poster / Abstract title: Using Real-Time Monitoring to Understand the Variability of TCE Concentrations in Indoor Air in a Site in Belgium

ID: 336

Key words: Vapor intrusion, trichloroethene, real-time monitoring, soil gas, atmospheric pressure

Submitter: Paulo Valle

Organization: Environmental Resources Management

Co-authors: Paulo Valle, ERM, Technical Partner ; Eléna Marino, ERM, Principal Consultant

Session: 4 poster

Abstract

Paulo Valle*, Elena Marino*

Affiliation(s): ERM*

Background/Objectives. In a former manufacturing Site located in Belgium, soil and groundwater investigations performed as part of a Site closure process identified Trichloroethene (TCE) impacts in the shallow soils underneath the main building. The TCE impacts in soil were associated with historical degreasing activities performed at the Site, and the remedial strategy included excavating the shallow soils and installing a vapor extraction system in the areas where residual soil contamination would remain (i.e. impacted areas that could not be excavated due to Site constraints). As part of the delineation campaign, a Vapor Intrusion (VI) assessment was performed to investigate the potential human-health inhalation risk for future workers at the Site. The VI assessment included collecting paired indoor air and sub-slab samples at multiple locations across the Site, an approach commonly used in Belgium and generally well accepted by the regulators. In addition to the VI assessment, during the due diligence process to sell the Site, an additional indoor air and sub-slab sampling round was performed by a potential buyer. The results of the samples collected by the potential buyer differed considerably of the VI assessment results, halting the negotiations and bringing into question the TCE concentrations measured in indoor air during the VI assessment. This study shall summarize the results of the VI sampling campaigns performed at the Site and discuss the efforts performed to understand the different TCE concentrations measured in the indoor air samples collected at the Site.

Approach/Activities. In order to investigate the variability in concentrations of TCE in indoor

air, a SRI 8610 Gas Chromatograph (GC) was used to perform indoor air and soil gas real-time monitoring in target locations across the Site. The equipment was fitted with multiple sampling channels and performed repeated measurements over time in different building rooms located within the impacted area. Discrete samples were collected at potential vapor entry points to investigate the influx of TCE via these points, and the sub-slab differential pressure and the atmospheric conditions were continuously recorded during the real-time monitoring campaign. During the real-time monitoring, indoor air samples were collected with Summa canisters equipped with 8-hour flow regulators to ensure that the real-time results accurately measured the TCE impacts in indoor air.

Results/Lessons learned. The analytical results obtained during the real-time monitoring campaign correlated well with the summa-canister results and confirmed that TCE concentrations in the different building compartments can vary considerably over time. Both the atmospheric pressure and the differential pressure measurements showed a clear correlation between increased concentrations of TCE in indoor air in the building and periods of positive sub-slab differential pressure. This correlation was also observed in vapor entry points located in the warehouse as well as in the office area, where a higher contaminant flux was observed in moments where a positive sub-slab differential pressure was measured. This assessment demonstrates the importance of monitoring and understanding the building conditions during indoor air sampling events, and raises questions on the approach commonly applied in many countries across Europe where indoor air and slab samples are collected without the monitoring of the sub-slab differential pressure. Since Vapor Intrusion guidelines in Belgium as well as many other European countries do not require the monitoring of the building conditions during sampling, the indoor air sampling results obtained in many project Sites across Europe may not be representative of the actual vapor intrusion risks occurring at the investigated properties.

Session 4 poster / Abstract title: Application of a novel bioelectric-based respirometry technique to assess electroactive microbial growth in horizontal subsurface flow treatment wetlands

ID: 342

Key words: treatment wetlands, clogging, bioelectrochemical systems, respirometry, growth yield

Submitter: Marta Fernandez-Gatell

Organization: Universitat Politècnica de Catalunya

Co-authors: Ana F. Galvão, CERIS, Instituto Superior Técnico, Universidade de Lisboa. Xavier Sanchez-Vila, GHS - Dept. of Civil and Environmental Engineering, Universitat Politècnica de Catalunya. Jaume Puigagut, GEMMA - Dept. of Civil and Environmental Engineering, Universitat Politècnica de Catalunya.

Session: 4 poster

Abstract

Treatment wetlands (TW) are natural wastewater treatment systems valued for their low energy needs and the simplicity of their operation and maintenance. However, TW requires a larger treatment area than conventional technologies to achieve adequate treatment performance and suffers from a progressive reduction of the effective treatment volume over time (the clogging). Coupling bioelectrochemical systems (BES) with TW (TW-BES) has been demonstrated to increase treatment efficiency. BES are devices that generate a small current out of the metabolic activity of a group of bacteria called electroactive bacteria (EABs). Furthermore, wetland clogging leads to reduced treatment capacity and higher operational costs. Biofilm growth is one of the main contributors of the clog matter. Therefore, if the biofilm growth is diminished, the clogging caused by this factor will be also reduced. It is known that the growth yield of EABs is very low compared to other microbial populations. However, the reduction of clogging in TW-BES has never been specifically addressed in current studies. Therefore, could we estimate electroactive microbial growth in TW-BES to assess how much can we reduce the biological component of clogging?

To answer this question, the growth yield of EABs was assessed and compared side by side with the growth yield of the general heterotrophic population. Respirometry is a technique widely used in activated sludge for assessing stoichiometric and kinetic parameters and has been also applied successfully to TW. Since there is no standardised technique to estimate electroactive growth, a novel “bioelectric respirometry” was developed mimicking a conventional respirometry test. As a source of biomass, a reactor of 15 L of effective volume filled with 42 gravel sockets, was built up and fed with a mixture of real and synthetic

domestic wastewater. The reactor represented a core of an unplanted sub-surface flow TW. Conventional and bioelectric respirometry tests were performed in parallel in two different respirometers, one adapted to conventional respirometry and the other adapted to a BES. To start a respirometry test, the same amount of gravel from the main reactor was placed in each respirometer and let the organic matter to be consumed until the endogenous respiration was reached. After that point, a known concentration of sodium acetate was added and the response of microorganisms (by means of electric current produced in bioelectric respirometry or the oxygen consumption for conventional respirometry) was monitored.

Results show that bioelectric respirograms have a similar pattern to that of conventional ones. Moreover, the obtained heterotrophic growth yield (YH=0.66 mg CODbiomass/mg COD) from conventional respirometry test is in accordance with the values reported in the literature. Also, the growth yield of electroactive bacteria (YH-EAB=0.4 mg CODbiomass/mg COD) is consistent with previous studies, even though the calculated value is higher than the ones previously documented. From our results, the EABs growth yield is, at least, 40% lower than the growth yield of the rest of heterotrophs.

Main conclusion of our work is that a novel bioelectric-based respirometry can be applied to the kinetic parameters assessment of the electroactive microbial population of TW-BES. We have applied this methodology to estimate EAB's growth and showed that we can actually relate it to the reduction of the biological component of clogging. However, the technique can be further optimised and applied to estimate other kinetic parameters that might serve as a starting point to improve treatment efficiency strategies in TW-BES or support mathematical modelling.

Acknowledgements: this work has been carried out with the financial support of the T.I.M.E Association (TP- 2022-003). MFG acknowledges her EMBO scientific exchange grant (9867) to the General Programme of the European Molecular Biology Conference.

Session 4 poster / Abstract title: Characterization of contaminant spreading from a point source in an aquitard/aquifer system combining 3D numerical modeling and high-resolution vertical concentration profiles

ID: 352

Key words: contaminant mass discharge, vertical concentration profiles, 3D numerical modeling, aquitard/aquifer system

Submitter: Klaus Mosthaf

Organization: Technical University of Denmark

Co-authors: Louise Rosenberg, Technical University of Denmark, PhD student; Gro Lilbæk, NIRAS, hydrogeologist; Anders G. Christensen, NIRAS, expertise director; Henriette Kerrn-Jespersen, Capital Region of Denmark, chief consultant; Nina Tuxen, Capital Region of Denmark, chief consultant; Vinni Rønde, Capital Region of Denmark, consultant; Annika S. Fjordbøge, Technical University of Denmark, senior researcher; Mette M. Broholm, Technical University of Denmark, associate professor; Poul L. Bjerg, Technical University of Denmark, professor

Session: 4 poster

Abstract

Many point sources of contaminants like chlorinated solvents are located in low-permeability aquitards, such as glacial sediments. The contamination stored in an aquitard can act as a long-term source to an underlying aquifer and threaten the groundwater quality. Determining the development of the contamination and quantifying the contaminant mass discharge (CMD) from a point source located in an aquitard can be challenging and usually requires extensive site investigations. This information is, however, essential to assess the risk that the contamination poses to the groundwater. This study aims at demonstrating the strength and capability of a 3D numerical model to integrate high-resolution hydrogeological and contamination data to characterize the CMD from a point source in an aquitard into the underlying aquifer. Furthermore, potential plume evolution scenarios are developed based on different source zone conceptualizations with and without fractures in the aquitard.

In addition to collecting hydrogeological data and measurements from traditional screened wells and soil samples, we determined high-resolution vertical concentration profiles at several locations downgradient of a dissolved chlorinated solvent point source. The profiles were determined using advanced direct-push techniques with water sampling through a probe with a 10 cm screened interval. A 3D flow and solute transport model integrated the hydrogeological data and was calibrated to the concentration profiles to interpret the detailed

measurements.

The source zone was simulated using different source conceptualizations: (1) an initially uniformly contaminated aquitard, (2) contaminant input to an initially clean source zone with a range of sorption coefficients using a 2D submodel, (3) contaminant input to an initially clean source zone with different realistic hydraulic fracture aperture distributions using a 2D submodel. The submodel setups were used to generate contaminant input functions from the source zone to the aquifer. The input functions were integrated into the larger-scale 3D model to simulate the plume evolution in the aquifer.

The measured vertical concentration profiles showed a characteristic sinking of the plume with distance from the source zone. This behavior could be consistently reproduced by the 3D numerical model and was found to be mainly controlled by the interplay between infiltrating water and horizontal groundwater flow. The model calibration to the vertical concentration profiles allowed for the simultaneous determination of the vertical water fluxes and hydraulic conductivity in the low-conductivity aquitard, and, ultimately, the CMD in the aquifer. The combination of a 3D numerical model and high-resolution data yielded an improved understanding of the aquitard/aquifer system and of the spreading of the contaminant from the source zone into the underlying aquifer. The integration of input functions using fractured and non-fractured source-zone realizations demonstrated that the sorption properties and fractures in the aquitard could substantially impact the resulting leaching patterns and development of the contamination.

The findings of this study shed light on the potential long-term fate of the contamination and mass discharge from a point source in an aquitard. The combination of high-resolution vertical concentration profiles and 3D numerical modeling, as used in this study, can be useful in the risk assessment of contaminated sites with similar hydrogeological conditions as well as for other dissolved contaminants like pesticides. A simplified 2D version of the employed model has been used to develop a screening method for contaminated sites in a similar aquitard/aquifer setting. The screening method allows for an estimate of the CMD using high-resolution vertical concentration profiles in the plume as a primary input.

Session 4 poster / Abstract title: Using tTEM for contaminated site investigations – part 1

ID: 368

Key words: Geophysics, Geology, Detailed-3D-resolution, Groundwater-contamination, knowledge-driven-circular-workflow

Submitter: Daniel Okholm

Organization: WSP Denmark

Co-authors: Anders Edsen Msc., WSP Denmark, Head of Geophysics; Dr. Flemming Jørgensen, Central Denmark Region, Chief Consultant; Jesper Bjergsted Pedersen Msc., Department of Geoscience, Aarhus University, Denmark, Senior Research Geophysicist; Johanne Jager Jensen Msc., WSP Denmark, Geophysicist; Daniel Juul Okholm Msc., WSP Denmark, Geophysicist; Jesper Simensen Msc. Civ Eng, Central Denmark Region, Team Leader

Session: 4 poster

Abstract

Purpose of study
Since its development, the tTEM geophysical method has been increasingly used for mapping geology in relation to groundwater resources and lately also for determining possible pathways for leaking contaminants from contaminated sites.
In order to define general guidelines for the application of tTEM in contaminated site investigations, a technology development project across the Danish regions was initiated. The aim of the project is 1) to investigate the specific needs related to contaminated site investigations, 2) to design dedicated fieldwork mapping procedures and concepts, and 3) to describe and define workflows taking important data processing and interpretation steps into account and ensuring collaboration between project leads, geophysical and geological experts.

Note: This abstract is focussed on survey design, mapping procedures as well as instrument strengths and weakness identified during the application of the tTEM method as a non-intrusive data collecting method specially targeted on contaminated site investigations. Project results related to the risk assessment procedures including the characterization of the geological subsurface structures and properties of the sedimentary units/layers are presented in the abstract “Using tTEM for contaminated site investigations – part 1”.

Methodology
The tTEM system is a product of focused research at the Department of Geoscience at

Aarhus University in the years 2015 to 2020. The system is now commercialized and as the first consultant worldwide WSP Denmark acquired a system in the early 2020.
tTEM is essentially a ground based Transient ElectroMagnetic system reduced in size. The total length of the system is 11 meters, and the relatively small size allows the system to be towed by an ATV (All-Terrain Vehicle).
tTEM is a Dual Moment (DM) system, and the magnitude of the transmitted current alternate between a Low Moment (LM) mode and a High Moment (HM) mode. The system automatically switches between HM and LM and thus, data related to the shallow part as well the deeper part of the subsurface are obtained. Data are measured continuously, while driving at a speed up to 20 km/h.
The smaller size in combination with the DM capacity enables the tTEM system to produce high resolution imaging of the subsurface both horizontally and vertically down to 50 to 100 meters depth.

A tTEM survey comprises survey lines with a mutual distance of 10-35 meters and soundings compiled for each 5 to 10 meters. Each sounding is transformed into a 1D multilayer resistivity model of the subsurface, and within an area of one hectare (100x100 m) the subsurface is described through more than a hundred 1D models. This high density enables constructing geological and hydrogeological models with a 3D resolution typically needed for contaminated site investigations.

Summary of results
Results from the evaluation of the tTEM method utilized in the context of contaminated site investigations will be presented. We will show how the quality of the tTEM survey and thus, the ability to resolve subsurface geological structures, strongly depend on relatively simple choices made in the field during data collection. This imply consequences of the choice of driving speeds as well as choice of survey line spacing and direction. Also, examples of critical choices of data processing parameters and the influence on the resulting geophysical models are presented.

Conclusion
In order to utilize the full potential of the tTEM method in contaminated site investigations, it is proved essential, that the application of the method is targeted the aim and conditions at the specific investigated site.
Further, the project showed the importance of applying the method in an early phase of the site investigations and that the results are evaluated by project members with different fields of expertise in a knowledge driven circular workflow.

Session 4 poster / Abstract title: The use of advanced numerical modelling to select the optimum remediation method for an extensive plume of contaminants in the former Zachem Chemical Plant in Bydgoszcz (North Poland)

ID: 410

Key words: brownfields, organic contaminants, optimal remediation, advanced numerical modeling

Submitter: Mariusz Czop

Organization: AGH University of Science and Technology / InTecH2O

Co-authors: Dr. Ewa Kret, AGH University of Science and Technology / InTecH2O, scientist environmental consultant

Session: 4 poster

Abstract

The area of the former "Zachem" chemical plant in Bydgoszcz is generally considered to be the most polluted area in Poland. In the light of the studies carried out in the above-mentioned area, even more than 20 potential contamination hotspots were identified, from which chemical substances, both inorganic and organic, penetrated the groundwater environment and were carried in the groundwater stream for several decades of the plants' operation. Over the years, up to 20-30% of the sites of the facility became contaminated and several plumes of contaminants flowed out of the area, successively moving towards the Vistula River. One of the most dangerous pollution plume which is associated with the "Zielona" industrial waste dump complex is currently about 2.5 - 3 km long and covers an area of about 250 ha. The cloud passes through inhabited and agriculturally used areas where pollutants flow into drainage ditches, small watercourses and water reservoirs located in the Vistula River valley and shallow drilled wells used for agricultural irrigation. The main pollutants carried by groundwaters are chlorides and sulphates and highly toxic organic compounds with carcinogenic and mutagenic effects, i.e. aromatic hydrocarbons, mainly toluene, polycyclic aromatic hydrocarbons, nitro compounds, organochlorine compounds and phenols. Groundwater within the contaminant plume ranges in colour from weak tea to black coffee or cola and total organic carbon values reach levels of several hundred mg/l. Effective remediation of this type of extensive contaminant plume additionally containing extremely high concentrations of a whole conglomerate of organic and inorganic compounds is a very difficult task. The main task is to stop the further spread of the pollutants including stopping the inflow of highly contaminated groundwater to the human inhabited zone. Optimal remediation methods are selected for individual fragments of the pollution cloud that differ not only in terms of pollutant concentrations but also in their species composition.

In the case of an extensive contamination cloud associated with the "Zielona" industrial landfill complex, the complicated geological structure is an additional element making remediation difficult. This is because the plume flows from the upland region built of generally low-permeability formations (boulder clays), in the zone of its bank strongly eroded in the past by the Vistula River. As a result, the flow of the groundwater stream is complicated and takes place using erosion channels perpendicular to the upland edge filled with more permeable sand and gravel formations. The contaminants then migrate to the floodplain of the Vistula where a complex of thick sandy formations generally dominates. Under such conditions, the pollution plume undergoes significant dispersion and the concentrations of all pollutants within it are considerably reduced.
Taking into account all the presented geological assumptions for the contaminant plume in question, an advanced numerical model was made, which made it possible to propose an optimum remediation method taking into account the cost and time factor. The modelling made it possible to optimally locate the barrier of wells intercepting the core of the contaminant plume with high concentrations of toxic substances before they enter the floodplain of the Vistula River. For the upper part of the contaminant plume, based on numerical modelling, optimal remediation methods were proposed including construction of a sarcophagus around the landfill complex, application of pump-and-treat methods with re-injection of treated water into the ground and a system of impermeable screens blocking the spread of contaminants. For the lower part of the contaminant plume, optimal remediation methods related to the pump and treat method and using the bioremediation method were proposed based on the modelling performed.

Session 4 poster / Abstract title: Integrating groundwater flux measurements in groundwater modelling of drought adaptation impacts: case study on sub-irrigation of treated wastewater in Kinrooi (Belgium)

ID: 59

Key words: Treated wastewater reuse, groundwater flux measurements, groundwater modelling

Submitter: Lara Speijer

Organization: Vrije Universiteit Brussel and Vlaamse Instelling voor Technologisch Onderzoek

Co-authors: Mateusz Zawadzki, Department of Hydrology and Hydraulic Engineering, Vrije Universiteit Brussel; Delphine Vandeputte, Department of Analytical, Environmental and Geo- Chemistry, Vrije Universiteit Brussel; Yiqi Su, Department of Analytical, Environmental and Geo- Chemistry, Vrije Universiteit Brussel; Minqyue Luo, Department of Analytical, Environmental and Geo- Chemistry, Vrije Universiteit Brussel; Yue Gao, Department of Analytical, Environmental and Geo- Chemistry, Vrije Universiteit Brussel; Marc Elskens, Department of Analytical, Environmental and Geo- Chemistry, Vrije Universiteit Brussel; Pascal Verhoest, Department of Communication Sciences, Vrije Universiteit Brussel; Joke Bauwens, Department of Communication Sciences, Vrije Universiteit Brussel; Tom Coussement, Bodemkundige Dienst van België; Frank Elsen, Bodemkundige Dienst van België; Birte Raes, Aquafin NV; Steven Eisenreich, Department of Hydrology and Hydraulic Engineering, Vrije Universiteit Brussel; Goedele Verreydt, iFLUX; Jef Dams, Vlaamse Instelling voor Technologisch Onderzoek; Marijke Huysmans, Department of Hydrology and Hydraulic Engineering, Vrije Universiteit Brussel

Session: 4 poster

Abstract

Flanders (Belgium) experienced recurring intense summer droughts last few years, resulting in low groundwater levels throughout the region. Irrigation using treated domestic wastewater could be an interesting strategy to make agriculture more resilient against drought. Therefore, sub-irrigation with treated domestic wastewater is deployed on an agricultural field in Kinrooi (Belgium) in order to assess the environmental impacts of this water reuse practice.

A numerical groundwater flow and transport model was created to investigate the transport behaviour of the effluent in the subsurface. However, high uncertainties in the inputs, parameters and the conceptual model results in uncertainties on the simulated output.

Therefore, novel direct real-time groundwater flux sensors developed by iFLUX will be installed in the field to measure groundwater flow rates and directions, as literature indicates the potential to significantly reduce uncertainties in groundwater models through the incorporation of flux measurements in groundwater flow model calibration. However, the sensor's measurement volume is much smaller than the larger groundwater model grid size. Therefore, the aim of this research is to investigate how these measurements can be incorporated into groundwater models, taking into account their scale and measurement error.

First, the flux sensors will be deployed at the experimental field at small distances from each other in order to assess local heterogeneity of groundwater fluxes. Then, statistical upscaling methods will be applied in order to bridge this gap in spatial scale. Eventually, the goal is to incorporate these flux measurements in the existing groundwater flow and transport model in order to assess the impact on model uncertainty and to potentially provide more accurate predictions of impacts of sub-irrigation with treated wastewater on groundwater quantity and quality.

Session 4 poster / Abstract title: Effects of Fish Mortality from Water and Air Quality Data Simulation

ID: 60

Key words: air pollution; machine learning; mortality; water quality

Submitter: Ying-Chu Chen

Organization: National Taipei University of Technology

Co-authors: Professor Ying-Chu Chen, Department of Civil Engineering, National Taipei University of Technology

Session: 4 poster

Abstract

Earth's water cycle transforms water through air, liquid, and solid states in the environment. This transformation is interrupted by human activities, such as urban construction, industrial and agricultural production, and groundwater exploitation. Society thus faces irreversible water shortage and degradation problems. Worldwide, between 1.4 and 2.1 billion people lack an adequate clean water supply. The degradation of freshwater quality is a myriad of water-related problems that negatively affect human health and the sustainability of aquatic organisms.

Accurate forecasting is essential to understanding the effects of climate change and anthropogenic disturbances on the water environment. Two categories of water-related models, namely physical and data-driven models, have been used in past studies. Physical models are based on heat budget equations and site-specific data that are unavailable for many river systems. Data-driven models are mainly derived using statistical and data-mining methods and are widely used in research. Machine learning methods, such as those based on the support vector machine and artificial neural network, have been explored to overcome the limitations of physical models relating to the use of default parameters and a lack of observations.

The present study innovatively combined air quality and water quality data of both air and liquid phases as signals of water quality degradation to predict accidental fish mortality adopting a deep learning method. Few studies have reported predictive models that combine water quality and global climate change models. The study area named Tamsui River is the third-largest river in Taiwan and has a drainage area of 2726 square kilometers. The Tamsui River Basin is formed by the confluence of the main tributaries of the Takoham River, Xindian River, and Keelung River. Meteorological data were acquired from the three weather stations for the period from 2014 to 2019. The meteorological data included the average air

pressure (hPa), temperature, and relative humidity (%) and the accumulated precipitation (mm) and insolation hours (h). The short-term water-quality data were acquired for the period from June 2020 to June 2021 and included the daily average concentrations of DO, NH3-N, suspended solids (SS), and biochemical oxygen demand (BOD). These data were used to calculate the daily RPI. Monitoring data have been continuously collected since June 2020. After data preprocessing and feature extraction, both deep learning training and exploratory data analysis were conducted to compare the results of predictions.

This study retrospectively investigated the 324 days on which the predicted fish mortality was greater than 10% but there was no actual fish death event in the study area. The K-nearest neighbor algorithm had the highest accuracy when K = 5, i.e., using 5 days of continuous environmental data before the events provided the highest accuracy of prediction. The selection of 5 days of continuous environmental data provided higher accuracy than the construction of a multilayer perceptron to predict the occurrence of fish mortality. The accuracy of the model reached 93.8% with loss error of 21.3%. Ten of the fish mortality events occurred in summer, and the probability of fish mortality in summer was comparatively high (12%).

The RPI of the Tamsui River has been between 2.3 and 3 in recent years. Short-term hypoxia may not be a critical issue for an aquatic organism, whereas long-term hypoxia could result in reduced fishery output and benthic animal mortalities. Additionally, a higher WT resulted in a lower DO concentration in water. When the number of insolation hours was less than 1.5 per day, the DO concentration was insufficient for fish in the Tamsui River. The results of the study provide a foundation for the analysis of land-use and water-resource management changes relating to climate change.

Session 4 poster / Abstract title: Advanced techniques of NN predictions in the current hydrological field

ID: 61

Key words: hydrology, computing, data predictions, data handling

Submitter: Zuzana Benova

Organization: CZU, Prague

Co-authors: Hanel, prof. CZU, Rakovec, doc. UIG Leipzig

Session: 4 poster

Abstract

There are several basic types of models used in hydrology and environmental studies, process-based models, empirical models, and conceptual models. Empirical models are the most simple of the models, while conceptual models are considered to have a degree of complexity between empirical and process-based models (Letcher and Jakeman, 2010). Three of the models will be presented during the speech, illustrated bz the regional data model.

Although, process based models may include some empirical data and the correlation existents in empirical models can be useful to assume a link to a process. Process-based models are mainly applied in ocean and atmosphere models, climate modeling, and subsurface hydrological modeling Letcher and Jakeman, 2010; Wali et al., 2010). Empirical models are commonly applied in agricultural, ecological, and ecotoxicological studies Bradford and Fierer, 2012; Koltermann and Gorelick, 1996;Wali et al., 2010).

This Some models use a hybrid approach and combine process based methods and empirical representation of relationships Korzukhin et al., 1996;Letcher and Jakeman, 2010;Makela et al., 2000;Perez-Cruzado et al., 2011).

This presentational article shall reconsider and discuss the hybrid methology models used with practical example on Czech Rep. micro/region of water basins and streams and data from 2020-2021.

Thesis to reestimate: Process based models typically have a large quantity of spatially distributed parameters. Limitations of process models and parameters included is subyacent question that shall be addressed suibsequentially (Letcher and Jakeman 2004).

Core of the discussion will estimate > 1] best fitted hybrid models and correlators 2] optimal

process of data variables elimination 3]example of the practical case on the given CZ microregion

Session 4a1 orals

Session 4a1 / Abstract title: SAW sensors for BTEX detection in groundwater

ID: 127

Key words: SAW sensors; in-situ monitoring; BTEX ; lithium tantalate

Submitter: NIEF Nathalie

Organization: TOTALENERGIES

Co-authors: Vincent LUZET1, Frédéric CHERIOUX1, Jean-Michel FRIEDT1, Nathalie Nief2, Bertrand Segues2, Gilles Pucheu2, Sebastien Dehez2, John-Richard Ordonez-Varela2 1Univ. Franche-Comté, CNRS, FEMTO-ST, 15B Avenue des Montboucons 25030, Besançon -France 2TotalEnergies OT- PERL, 64140, Lacq – France

Session: 4a1

Abstract

To answer the need for rapid, reliable, in situ and representative measurements for onsite groundwater monitoring, direct detection sensors able to selectively detect pollutants without sample preparation have been designed, manufactured, and tested.
The two broad classes of direct detection transducers are optical - converting the detection layer optical thickness into a physical measurement such as surface plasmon coupling angle - and acoustic. The latter transduction technique which is the object of this study uses a piezoelectric substrate to convert incoming electromagnetic power into acoustic waves whose velocity and losses are dependent on boundary conditions, including thin polymer films tailored for reacting with a given compound. Surface Acoustic Wave (SAW) transducers act as piezoelectric transducers, that convert a change in the acoustic wave propagation path velocity - density or Young modulus variations due to interactions with the pollutant in the surrounding fluid - into a measured quantity such as resonance frequency or propagation delay measured as a phase. The selectivity is brought by a thin film tailored towards a given compound of interest for pollution detection and monitoring, deposited on the acoustic path. Most SAW transducers are manufactured in quartz, a piezoelectric material with a low permittivity. However, by using quartz transducers, monitoring of analytes in water has been plagued by packaging issues since the fluid must be allowed to reach the sensing area where the acoustic wave is propagating while preventing capacitively short-circuiting micrometer-sized electrodes patterned on the low-permittivity piezoelectric substrate due to the water high relative permittivity. However, the associated packaging issues are not

suitable for in situ monitoring of groundwater. In this work, we demonstrate how using lithium tantalate (LTO) as a piezoelectric substrate provides a solution to measuring pollutant concentrations in the sub-surface environment. Two practical demonstrations include hydrogen sulfide detection using the specific reactivity of sulfur towards noble metals, and toluene detection as part of BTEX pollutant monitoring, answering the challenge of the low chemical reactivity of organic solvents. In both cases, interference of other species found in the groundwater, especially pesticides, is emphasized as a potential source of false positive detection and sensing layer degradation. The detection polymers are also formulated with a composition compatible with cleanroom spin coating techniques for reproducible deposition of sub-micrometer thick sensing layers at the square-inches scale. The tailored thin films not only act as a selective detection layer but also channels the acoustic energy in a Love mode propagation.

Finally, an analog measurement is performed from the surface instrument to the sub-surface acoustic transducer either through a tethered radiofrequency-grade cable or a wireless interrogation by Ground penetrating RADAR, and the relevant measurement (time delay in GPR measurement, resonance frequency in a wired configuration) is then digitally transmitted.

To conclude, after a few years of development and laboratory tests to optimize these SAW sensors for BTEX measurement, field experiments were performed on an industrial pilot site equipped with several piezometers, to evaluate the robustness under real conditions to improve the sensitivity and to challenge the selectivity of BTEX measurements in multi-contaminated groundwater. These first tests have shown promising results for further operational deployment. This new sensor corresponds to the ambition and the strategy to set up reliable in situ monitoring solutions which are easily deployable in network, with remote data transmission, and effective cost-benefit.

This work is supported by the French National Agency through the project UNDERGROUND (ANR-17-CE24- 0037).

Session 4a1 / Abstract title: Improved data quality with sensor based real-time monitoring. Quality assurance of a complete (sensor to dashboard) in situ real-time monitoring system for environmental parameters related to excavation production and transport of soil and rock

ID: 179

Key words: Real-time sensor based monitoring, environmental monitoring, nutrients, hydrocarbons,

Submitter: Espen Eek

Organization: Norwegian Geotechnical Institute

Co-authors: Caroline Berge Hansen (NGI), Ivar-Kristian Waarum (NGI), Per Sparrevik (NGI), Lars Været (Bærum municipality/Norconsult), Tore Gulli (Bærum municipality), Morten Saue (NGI), Henrik Meland (NGI), Harald Svendberg (NGI) Kenneth Nordum (NGI), Arne Pettersen (NGI)

Session: 4a1

Abstract

Projects where contaminated or non-contaminated soils and other materials are produced, excavated or transported will usually be subject to environmental monitoring required by environmental authorities. For many parameters such as total suspended solids, nutrients, metals and hydrocarbons in water, sensor-based methods are available for remote monitoring, yet manual sampling followed by laboratory analysis is the main approach for most of these parameters in many projects, resulting in poor temporal resolution and results that are not suitable for real-timer management of the soil handling (re-use or landfill disposal). Sensor-based environmental monitoring therefore has the potential to strongly improve the quality and usefulness of environmental monitoring.

The, often under-communicated but important advantages of sensor-based real-time environmental monitoring are: 1) Superior data density, 2) the elimination of sampling, storage and laboratory handling of samples, 3) recently increased capabilities for automated data analysis. These advantages means that real-time monitoring in many cases can give a better answer to questions such as: "How much nutrients or metals are discharged with a water stream?", than traditional sampling and laboratory analysis approach.

We speculate that sampling and laboratory analysis often is preferred because of the impression that it will produce more reliable answers to how the soil handling impact the environment. This impression can be strengthened by the strong tradition of quality control in laboratory testing and implementation of systems for accreditation of laboratories.

Nevertheless, the quality of senor generated data needs to be systematically assessed and documented as is done with laboratory generated data.

Here we present a systematic quality assurance approach to assess and evaluate the quality of data from sensor-based environmental monitoring. Relying on data quality assessment with a four-level approach:
1) Repeatability of measurements in a constant environment
2) Accuracy determined by measuring standards with known concentrations/values
3) Accuracy determined from independent measurement of the same environment
4) Accuracy in determining known natural changes in the environment

We also present the implementation of this systematic quality assurance approach on data from a sensor based real-time environmental monitoring system, with assessment of a complete data chain from sensors to cloud-based database and to presentation in online dashboards. Parameters included in this real-time monitoring system are: hydrocarbons (oil), ammonia, nitrate, turbidity, conductivity in water and water flow, water temperature, ground vibration, noise, particle concentration in air, air temperature, precipitation, wind speed and wind direction

A complete system for real-time environmental monitoring was successfully demonstrated. Quality assessment of data collected every 5 – 10 min for 7 months showed that real-time environmental monitoring can produce reliable environmental data. This also shows that sensor-based monitoring can answer many of the questions about environmental risk and impact from construction sites and soil excavation and transport more precisely than most monitoring schemes relying on manually collected samples and laboratory analysis.

Session 4a1 / Abstract title: Rapid evaluation of nitrate from soil pore water for real-time decision making in a drip irrigation agricultural system of Southern Spain

ID: 198

Key words: Ion chromatography, Portable, Nutrients, Nitrate, Soil pore water

Submitter: Meritxell Grau Butinyac

Organization: T.E. Laboratories

Co-authors: Valeria Arenas-Montaño, MSc, Research and Development, T.E. Laboratories Ltd. (TelLab), Ireland, Analytical Chemist; Meritxell Grau Butinyac, PhD, Research and Development, T.E. Laboratories Ltd. (TelLab), Ireland, Analytical Chemist; Pedro Mínguez Alcaraz, C.D.T.A El Mirador, Murcia, Spain, Technical Director; Ángel Martínez López, C.D.T.A El Mirador, Murcia, Spain, Agronomist; Eoin Murray, PhD, Research and Development, T.E. Laboratories Ltd. (TelLab), Ireland, Analytical chemist

Session: 4a1

Abstract

Continuous nitrate monitoring in agricultural soil is being increasingly regulated in areas where concerns of eutrophication have been detected. Analysis of nitrate is usually carried out at external labs for which a large sample of soil pore water has to be collected using a lysimeter hammered into the soil and left for hours or days depending on the soil moisture. Degradation of the sample on exposure to environmental conditions during collection is highly likely especially in dry and hot conditions so these results are not representative of the real concentration of nitrate in soil. Moreover, the results take several days to be reported back from the lab and no immediate decision-making is possible for fertiliser dosing. Alternative nitrate meters that allow for a small sample, such as portable ion selective electrodes, have shown promise but require calibration before each analysis, present low accuracy and are frequently impacted by interferences due to other soil compounds.
A portable nitrate/nitrite analyser based on ion chromatography and UV-LED detection was capable of achieving analysis of nitrate from soil pore water collected from lysimeters in just under 10 minutes using a 1 mL sample with 95% accuracy. The detection range is between 1 ppm and 500 ppm NO_3 and NO_2 detection is also available. When the sample is injected, a syringe filter is attached to remove particles and 1 mL of sample pushed through the system. The sample is injected through an IC column, eluted with 120 mM NaCl eluent and the absorbance is detected using a UV-LED and photodiode. The chromatogram generated is automatically integrated and the results are transmitted to the user via an Internet of Things (IoT) enabled platform. No hazardous chemicals are used, no highly technical personnel are needed for its operation and no service is required for at least 600 sample

runs.
This analyser will be deployed in Southern Spain as part of the EU Horizon 2020 PestNu project for frequent monitoring of nitrate in agricultural soil and for enabling improved fertiliser management in addition to compliance with local regulations. As part of the project, other parameters are currently being developed for analysis of nutrients in soil pore water.

Session 4a1 / Abstract title: Coupling hydro-stratigraphic and numerical 3d models with in situ sensors to improve the environmental sustainability of groundwater containment systems and assess full scale remediation strategy

ID: 208

Key words: Groundwater Modelling, Hydrostratigraphic Modelling, In situ sensors, Remediation, Environmental sustainability

Submitter: Fabio Canova

Organization: Eni Rewind

Co-authors: Dr. Fabio Canova, Eni Rewind, environmental consultant; Dr. Giovanni Prassede, Eni Rewind, environmental consultant, Dr Davide Caragnini, Eni Rewind, environmental consultant, Dr. Gabriele Macchi Ceccarani, Eni Rewind, environmental consultant; Dr. Paola Frattini, Eni Rewind, environmental consultant, Dr. Giuliana Buongiovanni, Eni Rewind, environmental consultant, Dr. Guido Bonfedi, Eni Rewind, Head of the Environmental Engineering Market Development Unit, Dr. Michele Pellegrini, Eni Rewind, Head of Environmental Studies Unit

Session: 4a1

Abstract

Eni Rewind, the environmental company of ENI, is managing groundwater remediation activities in more than 40 dismantled and active industrial sites in Italy. An integrated, seamless, and dynamic approach was developed to improve the environmental sustainability of groundwater containment systems and the effectiveness of remediation activities. The methodology envisages:

- Building a database, including all groundwater monitoring data (depth to groundwater, physical and chemical parameters, contaminant concentrations, pumping test results) and a database including all stratigraphic data
- Development of a 3d hydro-stratigraphic model, using borehole data collected since site characterization and borehole data at the regional scale
- Development of a numerical model to simulate groundwater flow and assess optimal pumping rates of the Pump Treat system hydraulic barriers considering seasonal fluctuations
- Installation of depth to groundwater dataloggers with real time data transmission to continuously adapt pumping rates
- Application of a specific monitoring plan to check hydraulic containment efficiency in the field
- Groundwater remediation pilot testing

- Development and calibration (based on pilot test results) of a contaminant fate and reactive transport numerical model to assess full scale remediation strategy.

The method was developed starting from a specific case study: a dismantled industrial site located in Tuscany where a Pump and Treat system is active and remediation activity pilot tests are currently being designed. The site is located on an alluvial fan at the foothill of the Apuan Alps, and the site conceptual model can be summarized as follows: a highly permeable, phreatic, gravelly and sandy aquifer locally divided in two sub-units by a silty aquitard. Seasonal groundwater fluctuations can happen suddenly and with significant amplitude.

A 3d hydro-stratigraphic model was developed using more than 300 borehole data collected at the site and at the regional scale, using the software Leapfrog Works. This model can be dynamically updated as new data are collected, keeping the conceptual model up to date. Using this tool, the complex stratigraphic boundaries of the different units were represented in detail.

The geological surfaces created in the hydro-stratigraphic model were used to build a 3d finite elements groundwater flow model with the software Feflow. The model was calibrated under different seasonal conditions and used to write an algorithm which allows defining individual pumping rates according to groundwater levels.

A specific monitoring plan was applied to check the efficiency of the hydraulic barrier in the field, and water level data loggers with realtime transmission were installed at the site to continuously adapt pumping rates to changing water level.

This approach allowed a 63% reduction of pumping rates (which were previously held constant, regardless of seasonal fluctuations) during drought periods, keeping the effectiveness of the hydraulic containment. unaltered and dramatically reducing overpumping.

Currently, a reactive transport numerical model is being developed, and will be calibrated with the results of Enhanced Bioremediation pilot testing. Subsequently the model will be used to support decision making during the full-scale remediation process and predict the advancement of remediation activities.

The method developed proved to be efficient and dynamic so far, allowing a helpful use of all collected information and an effective support to containment systems management and -in the future- remediation activities design and decision making. Based on collected results it will be applied to other sites where remediation activities are being tested or carried out and where pump and treat systems must be kept running to prevent contaminants from migrating offsite.

Session 4a1 / Abstract title: Sensors, the Internet, and Automated Data Collection and Response Triggering for Vapor Control and Remedial Optimization

ID: 248

Key words: vapor intrusion assessment, automated continuous air monitoring, triger based response

Submitter: Tom Wuyts

Organization: Group Van Vooren

Co-authors: Tom Wuyts MSc., Group Van Vooren Belgium, environmental consultant; Mark Kram PhD, Groundswell Technologies Goleta, CA, USA; Blayne Hartman PhD, Hartman Environmental Geoscience, Solana Beach, CA, USA

Session: 4a1

Abstract

Background/Objectives
Vapor intrusion mitigation and vapor extraction system components are typically evaluated by measuring pressure and vacuum. For some projects, chemical analysis of VOC concentration is performed with randomly-timed passive canisters or sorbent samplers in an attempt to evaluate mitigation effectiveness. These represent an assumed average concentration over the sampling duration, require weeks to process, and do not account for many key controlling factors such as dynamic pressure differential that can occur as a storm approaches, from the stack effect, or during different times of the year when ventilation scenarios change. Also the percentage of time during which there is an upward flow of chemical vapors from soil to indoor, mainly induced by the pressure difference between soil gas and ambient air, is not taken into account when doing randomly-timed passive sampling - resulting in a possible significant underestimation of the vapor intrusion problem. Furthermore, aggressive remediation approaches such as soil heating and subsurface amendment introduction can result in fugitive vapor emissions that require vapor extraction to avoid entry into buildings. Emissions can include VOCs as well as methane. In general, there is a paucity of vapor VOC data collected due to sampling costs and logistics, and as a result risks can go undetected. The objective of this effort is to demonstrate how automated continuous web based monitoring of chemical concentration and controlling factors have been used to confirm fugitive vapor management, to rapidly respond to potential risk conditions, and to successfully optimize vapor extraction remediation project components.

Approach/Activities:
Automated continuous concentration monitoring provides a large amount of data (e.g.,

approximately 150 analyses per day). The data patterns exhibit concentration dynamics over time and space including indoors, outdoors, and at vapor treatment influent/effluent ports. Simultaneous high-frequency monitoring of controlling factors such as wind speed, barometric pressure, ventilation operations, and differential pressure enables practitioners to evaluate mitigation performance and prevent exposures. Data is uploaded in real-time to a Cloud dashboard, which allows practitioners to view conditions from anywhere with an Internet connection. Response criteria is established for multivariate observations, moving averages, and can be customized for each monitoring location (e.g., indoors vs. vapor treatment component). Alerts and responses via engagement of remediation components are automated based on high-frequency site-specific observations and programming logic.

Results/Lessons Learned:
Data from multiple remediation projects demonstrate where continuous monitoring and trigger based response can be successfully employed. Combining sensors, analyzers, Internet, programming logic and automated response represents a viable and effective approach to managing dynamic fugitive emissions and optimizing vapor extraction and treatment during remedial activities.

Session 4a2 orals

Session 4a2 / Abstract title: Quantitative and qualitative comparison of field-based analytical technologies for petroleum hydrocarbons determination in soils

ID: 116

Key words: total petroleum hydrocarbons, soil contamination, field screening, laboratory validation

Submitter: Richard Gill

Organization: Shell Global Solutions B.V.

Co-authors: Markus Hjort, Concawe, Science Executive; Eleni Vaiopoulou, Concawe, Science Executive; Timothy Greaves, Esso, Advanced Technical Advisor; Pablo Campo, Cranfield University, Academic; Chris Walton, Cranfield University, Academic; Tamazon Cowley, Cranfield University, Academic; and Frederic Coulon, Cranfield University, Academic

Session: 4a2

Abstract

Over the past decade, a range of commercial and R field-based analytical technologies have been made available for soil analysis. This has allowed the determination of hydrocarbons (HCs) in soil to be expedited, increase the number of samples that can be processed at lower cost and enhance spatial resolution of soil data at impacted sites. There are to date, however, aspects that have not been fully studied, such as the performance and accuracy of analytical field technologies for different soil types, levels of contamination and fuel type contamination. In this study, the performance of seven field-based analytical technologies were evaluated for a range of gasoline and diesel spiked soils and contaminated soils from field sites. Performance of the field technologies were compared to an established reference gas chromatography coupled to mass spectrometry (GC-MS) method (spiked soils) and accredited commercial laboratory analysis (real soils).

The field-based technologies included 3 portable solvent-based technologies (one portable GC-MS, one portable nondispersive infrared (NDIR) spectrophotometer, one portable ultraviolet fluorescence (UVF) spectrometer), and 4 handheld solvent free technologies (one handheld visible and near-infrared reflectance (vis-NIR) spectrometer, two handheld Fourier-transform infra-red (FTIR) spectrometers, and one handheld photoionization detector (PID))

were evaluated. Three soils (sandy loam, silty clay loam, and clay loam) were spiked with gasoline or diesel fuel on w/w basis to achieve 100, 1000 and 10,000 mg/kg spike levels. All samples were analysed for Total Petroleum Hydrocarbons (TPH), Volatile Organic Compounds (VOCs), Gasoline Range organic (GRO) and Diesel Range organic (DRO) and speciated HC compounds when the chosen technology allowed to do so.

All solvent-based field technologies performed well independently of soil types with RSD values within 15% and bias within 30% for all spiked soils with gasoline and diesel. They can provide GC comparable TPH recoveries and meet the performance requirements for regulatory standards. Further to this, the UFV field technology was able to provide simultaneously determination for total BTEX, GRO C5-C9, DRO C10-C40, TPH C5-C40, and total aromatics C10-C35 within roughly 5 min. This offers time saving for individual soil sample analysis compared to GC-MS methods. In contrast, solvent free, non-invasive technologies showed higher variability and lower accuracy for the low-level diesel spikes (100 mg/kg) and when the levels of soil organic carbon or clay content were high. The IR technologies can however be useful to classify accurately field samples into low, medium, and high concentrations applying a threshold of 1000 mg kg-1. For TPH determination below 500 mg kg-1 an alternative technology should be then considered. Overall, this study is the first overview and comparison of multiple field-based analytical technologies along with bench marking to established laboratory methods and provides guidance to practioners on the selection and use of these technologies for petroleum hydrocarbons determination in soils.

Session 4a2 / Abstract title: Field registration of enviromental data and online automatic processing

ID: 158

Key words: Field registration, Automatic outputs, Digital registration, GIS overview, Data structure

Submitter: Andreas Sahyoun Sørensen

Organization: WSP Denmark

Co-authors: Isak Hjort Dahm Msc, WSP Denmark, environmental consultant

Session: 4a2

Abstract

Purpose of study
A digital platform for registering environmental tasks has been created by WSP. The goal of the platform is to eliminate all use of paper and non-digital tools. The application is built as an web-based application accessible by both mobile devices and PC's. The main page of the app is a GIS based map showing all tasks created, completed and in progress.

Methodology
The main map is coupled to QGIS where points and polygons are added to show pipelines, cables, Wells, excavation fields and much more. Under the map a table is shown where it is possible to sort the different tasks by group, status, type, date etc. Each type of task can be selected, and the user is prompted for the relevant data. With the use of a RTK corrected dGPS it is possible to add points with high precision while it also is possible to use the internal GPS form the mobile device.

The platform is built modular and is thereby possible to create new types of tasks without the use of coding.

When a task is completed, it is possible to download all relevant tasks and upload to a frontend application where data is handled and altered and a type specific output for each type is sent to a user defined mail. Examples of tasks and outputs are:

The drilling of a well: All geological information and layers are defined in the application. This task outputs a drawn drilling well profile, a filled-out database structure upload file for the Danish regions databases and filled out lab requisition forms for multiple laboratories for the soil samples.

Soil vapor samples: All relevant information is filled out by the user and when uploaded it outputs a database structure upload file for the Danish regions databases, filled out lab requisition forms for multiple laboratories for the soil vapor samples and a report showing all sampled points.

Water samples: All relevant information is filled out by the user and when uploaded it outputs a database structure upload file for the Danish regions databases, filled out lab requisition forms for multiple laboratories for the soil vapor samples and a report showing all sampled points.

Summary of findings/results

With the use of online registration all data from projects are much more structured and less prone to get lost. It is easier to get an overview of former projects and what kind of data has been collected. It is now possible for the managers to get an overview of production with the use of a build in statistical tool which records the number of outputs generated sorted by types and users.

Conclusion

As the world is becoming more and more digital it is important to follow the trend. Much time with creating appendices and data-reports can be saved with the use of automatic generated outputs. It is only possible to create a stable consistent automated output with a well-structured easy to use online register of field data.

Significance / contributions of study

The creation of the field registration application has elevated WSP’s collaborations with the Danish regions to easily register data in the national database and deliver a filled lab requisition to the lab digitally.

Session 4a2 / Abstract title: Introducing Environmental Twins: A central insight in a (bio-)diverse environment

ID: 259

Key words: Digital Twin | CDE | Internet of Things | Smart Sensors | Landscape Modelling

Submitter: Joep Kelderman

Organization: TAUW

Co-authors: Jurian van der Vegt MSc, TAUW, project leader Digital Twins

Session: 4a2

Abstract

The main focus of spatial planning has long been 'people' and 'profit'. In this presentation we will talk about the shift in focus where the 'planet' side is assuming an increasingly important position. The physical living environment of our planet is a dynamic system that provides food, drinking water and sources of energy. In addition, it forms a vulnerable system that, without adequate protection, will eventually lose the ability to perform functions for humans, plants and animals.

In The Netherlands, the upcoming new Environment and Planning Act (Dutch: Omgevingswet, 2024) will bring necessary changes in policy, legislation and regulations. The changes are a result of the shift in focus to ‘planet’. This legislation is aimed at protecting the physical living environment and takes a defensive approach to activities. The underlying philosophy is: 'protect and utilize'. Moreover, the Dutch Minister of Infrastructure recently addressed the importance of water and soil in decision making (Kamerstuk Harbers | 25-11-2022).

In the past, in order to monitor and analyze the environment, one has to go out and perform an in-the-field analysis. Thereby only examining one physical system at a time, all because the examiner can only be in one place at the same time. So what happens if we deploy different measuring and monitoring devices in the field. Devices that are connected – through IoT – with our common data environment (CDE). A CDE that allows input from devices that monitor different physical systems (e.g. the soil or wildlife) at different locations.

That is the kind of CDE we use in our Environmental Twins. As a twin consists of two entities – in this case, a physical system and a digital model – we put this CDE between the two parts of the twin. This CDE connection then ensures that there is a data connection between the physical system and the digital model. So that updates in the physical system can also be noted in the digital model.

Also, soil life and hydrological aspects can be monitored in these Environmental Twins. The idea behind this Environmental twins is ‘plug and play’: every situation has its own context and its own different dynamics in the physical system that are important to consider. The setup of the Environmental Twin is that dynamics from different systems can be plugged into the digital twin model. So that all that is important can be monitored from one single platform.

What’s more, insights and updates from the physical system can be automatically analyzed and be transformed to implications that may speak more clearly to policy makers and (landscape) designers. It may communicate certain effects, it may simulate certain scenarios but it may also be used to predict certain outcomes, based on observed input from the physical system. For example, when a smart camera registers the presence of an endangered fauna species, the digital twin will not only show the location and presence of that fauna species in the appropriate spot in the digital model. It will then also show what the (legal) implications are for policy makers and other professionals with developing plans. All so that the ideas and dreams of mankind can be strategically tamed and harnessed by ‘the planet’.

Different digital solutions will be demonstrated during the presentation:
- Smart device noting the presence of something in ‘the physical’.
- A 2D or 3D digital model showing the updates that were observed in the physical.
- Polygons on a 2D map that communicates the implications of observations in the physical.

The aim of the presentation is to demonstrate the centralizing potential of a digital twin (platform), and that it can be used to cross professional borders, in the sense that results and observations can be translated to the language of downstream decision makers. My “Take Home Message” will be: The more we communicate in the digital twin, the more we can ‘be’ and sense in the physical environment.

Session 4a2 / Abstract title: Automated risk and sustainability management for ISTR

ID: 380

Key words: In-situ thermal remediation or treatment (ISTR, ISTT), data management tool, remediation management, risk management, sustainability

Submitter: Uwe Hiester

Organization: reconsite GmbH

Co-authors: Laura Bieber (M.Sc.), reconsite GmbH; Alexander Ruppmann (M.Eng.), reconsite GmbH

Session: 4a2

Abstract

1 Purpose of study

In-situ thermal remediation (ISTR) can be applied in a wide range of contaminated sites to treat source zone areas. Site sizes range from tiny locations (e.g. carport or backyard) to mega-sites with several 1,000 m², with depths usually up to 20 m. The range of applications for these techniques extends from bedrock to clayey soils, silt and sand, and fractured rock. The contaminant spectrum includes all organic compounds up to a boiling temperature of approx. 220°C.

All these different components and their effects on the surrounding environment (e.g. site owner, neighbors, hydrogeology, …) must be taken into account in the remediation management of a site.

Therefore, a lot of data are recorded during ISTR. With our proprietary data management tool (DMT), we run automated data post processing for remediation operation and environment monitoring. This includes data evaluation, calculation of key figures, graphical display and threshold values for risk assessment and remediation management.

2 Methodology

During an ISTR a lot of data are generated. In the DMT, data are stored automatically. During the remediation, diagrams for specific sensors as well as reports can be printed or displayed for a specific time interval.

The DMT is reading e.g. for the following measurement data:

- operation data from the remediation plant (e.g. runtime and temperature of pumps, level sensors)
- temperature in the treatment target zone (TTZ) in different depths or near to relevant underground infrastructure
- vacuum at the recovery pumps as well as in the TTZ
- contaminant concentrations (measured continuously or data from the laboratory) for

soil vapour and groundwater

- discharge measures (of soil vapour and groundwater)
- noise measurement in the surrounding environment

In the beginning of the remediation maximum and minimum threshold values are defined and implemented in DMT. If new data are available and uploaded into the database, they are automatically checked if threshold values are exceeded or fall below. Risks and malfunctions are sent immediately to the persons in charge via e-mail. Next to threshold values, DMT calculates e.g. contaminant mass recovery.

3 Summary of findings/results

DMT simplifies ISTR management processes and enhances the communication to authorities and clients. Through the generated diagrams the remediation process and progress can be easily explained to the involved project team.

Risks through high temperatures near to relevant underground infrastructure, through uncontrolled release of contaminants due to a not working extraction, through noise, … as well as malfunctions of the remediation system are quickly identified. With the so gained knowledge about what's going wrong on site, the engineers save time in the preparation and reparations can be completed soon.

The implementation data is easily possible as long as data are available regularly and digital. Manual generated data, as settlement measures or crack markers, are not implemented in the management tool. However, this only affects a small amount of data, which can be handled well manually. DMT is used to make ISTR more sustainable and energy-saving.

4 Conclusion

During ISTR, a lot of data are generated. A good understanding of the dominating remediation processes in soil and groundwater can only be gained, if these data are checked and interpreted regularly by the responsible project team. The data management tool enables a better process understanding for project members, independent from the TTZ size (for tiny fields to complex mega sites).

5 Significance/ contribution of study

The complex remediation of soil and groundwater with in-situ thermal systems can be explained easily to the project teams. That can make in-situ thermal projects more interesting for clients and might help to increase ISTR acceptance like SEE (steam enhanced extraction) and TCH (thermal conductive heating).

Session 4a2 / Abstract title: An intelligent system for analyzing environmental data to support the management of green areas in urban space on the example of the city of Krakow (Poland)

ID: 406

Key words: environmental data integration, green areas, on-line monitoring, GIS, GreenMap

Submitter: Ewa Kret

Organization: AGH University of Science and Technology / InTecH20

Co-authors: Prof. Mariusz Czop, AGH University of Science and Technology/InTecH2O company, hydrogeologist/environmental consultant

Session: 4a2

Abstract

Green areas in cities occupy from several to several dozen percent of urban space. They have an significant impact on improving the quality of life of residents not only in terms of recreation, but also, above all, improve the quality of the climate in cities. The budget of a medium-sized city in Poland spends up to tens of millions of zlotych annually on the maintenance and management of green areas. The impact of the environment, including in particular anthropogenic processes, i.e. a large share of artificial anthropogenic formations, potentially containing harmful pollutants, and a very strong transformation of natural water conditions have a large impact on the correct and optimal shaping of urban green areas. So far, despite the undoubtedly great importance for the condition of vegetation in urban areas, the issues related to soil and water conditions and the analysis of anthropogenic processes in urban space as a factor shaping green areas and investments related to them are relatively poorly recognized and analyzed only locally, mainly for scientific purposes. In addition, environmental data available in Poland from various publicly available sources are not properly verified or integrated.

During the work implementation, the typical functions of green areas were analyzed and the Universal Model of the City Park (UMCP) was created, for which the following critical environmental parameters were selected: (i) type of geological formations to a depth of 20-30 m, (ii) depth of the water table (iii) permeability of near-surface formations from the surface to the groundwater table, (iv) presence of existing wells and piezometers, (v) physicochemical composition of soils (e.g. salinity and soil contamination), (vi) chemical composition of groundwater and (vii) the suitability of the groundwater for irrigation and, where possible, other uses. Then, a mathematical model was developed, taking into account all the environmental parameters mentioned above, for which the obtained databases were verified in terms of quality and usefulness for the purposes of decision-making in the field of

management of urban green areas. In the next step, algorithms for searching the created databases of environmental parameters were developed in terms of supporting the process of managing green areas in urban space. Search criteria are based on a unique set of properly selected critical parameters and assigned weights.
As a final result, an IT tool GreenMap was obtained, using GIS spatial visualization tools. The user interface contains modules, where each of them reflects a relevant critical parameter. Visualization is possible both in terms of point information obtained directly from databases, as well as spatially, using advanced statistical tools. In addition, the interface allows you to search single data and several parameters at the same time in terms of a given query. An online module was also created to observe changes in selected environmental parameters over time, such as the groundwater table and soil moisture. The tool can be extended with further modules for collecting data relevant for the optimal development of urban space, including: climatic and meteorological conditions, air quality, noise and traffic intensity. It can also be fully integrated with the spatial planning system of the Krakow city. The GreenMap tool allows to maintain, conduct and update the inventory for the purposes of registering the green areas of the city of Krakow. The GreenMap is of particular importance in supporting development planning and ongoing control of the entire urban space, including optimal decision-making and on-line monitoring of the potential negative impact of investments implemented in the area of green areas on their condition (e.g. uncontrolled construction drainage).

Session 4a3 orals

Session 4a3 / Abstract title: Overview of the Concawe LNAPL Toolbox, a New Web-based Decision Support System for Managing LNAPL Sites

ID: 128

Key words: Light Non-Aqueous Phase Liquids, LNAPL, remediation, modeling, web-tool

Submitter: Markus Hjort

Organization: Concawe (Scientific Division of European Fuel Manufacturers Association)

Co-authors: Charles J. Newell, GSI Environmental Inc, Vice President - Environmental Engineer; Dr. Phil de Blanc, GSI Environmental Inc, Environmental Engineer; Dr. Kenia Whitehead, GSI Environmental Inc, Aquatic Scientist; Dr. Brandon Sackmann, GSI Environmental Inc, Aquatic Scientist; Dr. Eleni Vaiopoulou, Concawe (Scientific Division of European Fuel Manufacturers Association), Science Executive

Session: 4a3

Abstract

Purpose of Study
LNAPL stands for 'Light Non-Aqueous Phase Liquids' or hydrocarbons that exist as a separate undissolved phase in the subsurface at some sites with legacy releases of fuels. They are referred to as 'Light' because most petroleum hydrocarbons are less dense than water. Because LNAPLs can sustain dissolved groundwater plumes for long time periods, it is important to understand how much LNAPL may be present at site, if the LNAPL can migrate, if it can be recovered, how the LNAPL composition changes over time, how long it may persist, and finally quickly the LNAPL body is attenuating. Understanding LNAPL behaviour is complex, and therefore Concawe with the support of GSI Environmental aimed compiled a unique collection of useful tools, calculators, data, and resources to help LNAPL scientists and engineers better understand how to manage LNAPL at their sites.

Methodology
In creation of the web-based toolbox application a combination of the programming languages R, Python, JavaScript and HTML were utilised. The toolbox uses a three-tiered approach that provides access to over 20 different LNAPL tools (key infographics, nomographs, calculators, mobility models, videos, checklists, and other formats) with different levels of complexity and time requirements. The three tiers of complexity are:

- Tier 1: Simple and quick graphics, tables, background Information
- Tier 2: Middle level quantitative methods and tools
- Tier 3: Gateway to Complex Models

Firstly, Tier 1 provides a simple summary regarding a specific question that the toolbox is set to address. Secondly, Tier 2 is where the bulk of the novel programming of the toolbox was performed to develop user-friendly calculation tools. Finally, Tier 3 offers a gateway to more complex calculation tools that are available, either by videos or text explaining how these tools can be used.

Summary of Results

In terms of content, the Concawe LNAPL Toolbox was designed to address six questions via six different tools designed under Tier 2 to help answer:

1. How much LNAPL is present?
2. How far will the LNAPL migrate?
3. How long will the LNAPL persist?
4. How will LNAPL risk change over time?
5. Will LNAPL recovery be effective?
6. How can one estimate Nature Source Zone Depletion (NSZD)?

Tool 1 includes an “LNAPL volume model” where users enter the LNAPL apparent thickness in monitoring wells, soil conditions, LNAPL characteristics, and the model estimates specific volume at each location and provides a general estimate of the LNAPL volume in place. Tool 2 includes a new “LNAPL Body Additional Migration Tool” where users enter LNAPL hydraulic gradient, LNAPL Transmissivity, and NSZD rate and the tool estimates if the LNAPL is likely to expand will, and if so, by how much. A simple mass balance box model used in the US Environmental Protection Agency’s LNAPL model REMFeul has been adapted in Tool 3, where users enter an estimated LNAPL mass, area of the LNAPL body footprint, NSZD rate and the model estimates a range of LNAPL lifetimes. Tool 4 includes an “LNAPL dissolution calculator” and Tool 5 includes an “LNAPL transmissivity calculator” to estimate of LNAPL can be recovered by LNAPL pumping. Finally, Tool 6 includes a number of tables, references, resources, videos, calculators regarding how to measure and how to process Natural Source Zone Depletion (NSZD) data.

Conclusions

The Concawe LNAPL Toolbox can be accessed freely via a webpage on an internet browser (https://lnapltoolbox.concawe.eu/lnapl_toolbox), or by downloading the toolbox via GitHub (https://github.com/concawe/LNAPL-Toolbox-) for the use on a personal computer. The Toolbox User Manual is also published as Concawe Report 5/22.

Significance of Study

The Concawe LNAPL Toolbox is a wide-ranging but easy-to-use web-based toolbox to deliver key LNAPL knowledge to the LNAPL remediation community to help LNAPL scientists and engineers better understand how to manage LNAPL at their sites.

Session 4a3 / Abstract title: Field Data Management from a Groundwater remediation plant through Power BI software

ID: 254

Key words: Digitalization and innovation, Power BI dashboards, water in the digital word, data processing optimization, dataflow

Submitter: Roberta Sauro Graziano

Organization: Ramboll

Co-authors: Roberta Sauro Graziano PhD, Ramboll Italy, Consultant; Antonio Molinari PhD, Ramboll Italy, Consultant; Mauro Fortugno Msc, Ramboll Italy, Lead Consultant; Luca Sacillotto Msc, Ramboll Italy, Senior Managing Consultant; Andrea Campioni Msc, Ramboll Italy, Country Market Director - Italy

Session: 4a3

Abstract

Ramboll is carrying on an in-situ remediation of groundwater contaminated by chlorinated solvents, through the application of a sustainable technology as the Enhanced Reductive Dechlorination with injection of an organic substrate (dairy cheese whey). On a regular basis, the project team collects numerous information concerning the plant operation and the quality of the treated waters. In this framework the proper management and interpretation of a large amount of field data, related to the plant operation and to the treated groundwater, is crucial to assess the treatment performance and to adequately deal with the operation of the plant. Therefore, this work focused on the development of a digital dashboard targeted to speed-up the time of data processing and reporting by means of the Microsoft Power BI software. The dashboard was designed to meet different control levels and suit various needs of insight. Hence, it includes both a general panel to rapidly check out the values of key parameters and more detailed sheets for an in-depth analysis. The user can visualize and evaluate a) chemical-physical parameters and trends of contaminants and their speciation; b) key indicators of the treatment performance, such as the contaminant concentration in and out of the treatment unit or the removal percentage of each contaminant over time; c) the compliance of each well with threshold values of target compounds, set by the approved remediation plan, and their evolution over time.
Some graphical objects were structured with conditional formatting with colors or symbols which immediately provide clear view of BAD/GOOD performance (Red/Green) of the visualized parameter. Furthermore, such dashboard was directly connected to the Ramboll SQL database where all historical data are stored, thus simplifying and speeding up the procedure of data importing and reporting.
The implementation of a digital approach to integrate the management of the remediation

plant has led to enhance and simplify in a unique graphical platform all information stemming from periodical monitoring and management activities related to the on-going remediation plant.

In terms of added value, this kind of dashboard provides a customizable and user-friendly graphical interface to rapidly acquire information about the operation conditions of a remediation plant. The high flexibility and customization level allows to obtain a wide range of graphical representations and analysis, through the link with programming languages such as R and Python, thereby meeting any need of the user. Then, the user, e.g., the client, will have the possibility to query an efficient tool, always updated to the last sampling campaign and able to return information about the achievement of the remediation objectives. Such a dashboard significantly reduces the data processing and reporting time, hence the costs of reporting. In addition, the dashboard can be optimized for a quick and portable visualization on mobile devices such as mobile phone, tablet, Ipad etc, thus facilitating the analysis of graphs directly on the field or during a technical meeting with public authorities or stakeholders. The dashboard was developed by an easy-to-use software as Microsoft Power BI, without the need of specific data management software. This allows to make a difference, even more when different types of environmental services are requested to be integrated and managed in the redevelopment stage of a contaminated industrial site.

Lastly, from a perspective of sustainability, the developed dashboard, matches goals no. 6 and 12 of the UN Sustainable Development Goals (SDGs), since an efficient management of field data allows to improve the performance of the treatment, to provide a quicker restoration/cleaning of contaminated groundwater through the injection of a sustainable substrate derived from the wastes of the food industry, thereby enhancing the recycling and the responsible consumption of food.

Session 4a3 / Abstract title: Power BI as an Innovative Analytical and Visualization Tool in a Short-Term Remediation Project

ID: 337

Key words: Power BI, excavation, short-term project, transparency, one place

Submitter: Charline Kaplan

Organization: Environmental Resources Management

Co-authors: Charline Kaplan, ERM, Consultant ; Mattias Verbeeck, ERM, Principal Consultant (Technical) ; Paulo Valle, ERM, Technical Partner

Session: 4a3

Abstract

Charline Kaplan*, Mattias Verbeeck*, Paulo Valle*

Affiliation(s): ERM*

Background/Objectives. At a former industrial plant in Belgium, soil and groundwater impacted with Cumene and other volatile compounds had to be remediated. The remedial strategy consisted of excavating a significant amount of contaminated soil (close to 30,000 m^3), and application of substrates at the bottom of the excavation pit to enhance biodegradation processes and reduce the potential for re-contamination of shallow backfill material. The depth of the excavation (up to 7 meters below ground level (m-bgl)) required lowering the groundwater table using a groundwater extraction and treatment system, and an extensive monitoring program needed to be implemented to allow the close follow-up of the installation. In addition, given that the main compounds of concern were volatiles, a specific air monitoring program was developed to track real-time potential impacts to Site workers and neighbors during the remediation works.

In order to follow-up on the development of the excavation works including environmental and safety monitoring activities, a Power BI dashboard was developed prior to the start of the remedial works. The main objective of the dashboard was to expose and analyse data collected on the field through Key Performance Indicators (KPI), tables, maps, and graphs, and to facilitate the communication with the different project stakeholders involved.

Approach/Activities. The Power BI dashboard was composed of multiple tabs to create personalized and interactive visuals through a shared online interface for all the project elements being tracked. The dashboard was built with four main sections – Excavation,

Groundwater Treatment Installation, Ambient Air Monitoring and Backfilling Activities – and had a set of applications and connectors functioning together to transform divers' data sources into visual, immersive, and interactive information.

Each section had interactive filters, unique visuals and built-in indicators allowing the project team to evaluate continuously the advancement of the project. Data was collected daily through online collect forms synced to the database and shared networked documents, resulting in a daily refreshed dashboard that fitted to the best extent the reality of the field conditions.

Results/Lessons Learned. As the remediation project ended, it became clear that the innovative dashboard was an essential tool in the communication, assessment, and transparency of the project towards relevant stakeholders. Having a digitalized approach facilitated the access to information and provided the status of the excavation and monitoring works continuously to the client, safety coordinator, technical experts, and the project team. To this day, the dashboard has evolved in a necessary support tool to the reporting tasks, as key data is present in the dashboard and related database.

Session 4a3 / Abstract title: Cartorisk – A method and computation tool to map spatial variation of health risks and find a best compromise for regenerating brownfield sites

ID: 339

Key words: brownfields, redevelopment, health risks, mapping, geostatistics

Submitter: Claire Faucheux

Organization: eOde Sàrl

Co-authors: Dr. Baptiste Sauvaget, eOde, geostatistician, Claire Faucheux, Geovariances, geostatistician, Dr. Véronique Croze, Element-Terre, geologist, David Pitaval, Ginger Burgeap, hydrogeologist, Sylvie Traverse, Ginger Burgeap, mining engineer

Session: 4a3

Abstract

A major effort to redevelop brownfield sites has been underway in France for several years, to fight against soil artificialisation and scarcity of building surfaces. It is estimated that between 90 000 and 150 000 hectares are occupied by industrial brownfields in France, which constitutes a considerable reservoir of land that can be used for the construction without destroying natural areas. The regeneration of brownfields is thus of great economic, social and environmental interest for the country.

Redevelopment of former industrial sites requires nevertheless to account for soil pollution, in order to check that it is compatible with the intended use and to take the necessary measures to ensure compliance with regulations. Soil can be evacuated and/or remediated to reduce the risks of exposure of future users, or simply to implement building foundations. But this has a cost: the higher the number and concentration levels of pollutants, the more expensive it will be to recycle, reuse or treat soil.

The question raised is thus: how can we optimise a site development plan by reducing both the health risks and the costs of cleaning up polluted soil? The Cartorisk method and code were developed for this purpose. The concepts and the computation tool were created by 4 partners – eOde, Element-Terre, Geovariances and Ginger Burgeap, thanks to the financial support of the Ademe, from 2016 to mid-2023, in 5 major steps:

1. Design of the method
2. Computer development (R package)
3. Tests on 2 real case studies, with the following preliminary work:
   - Analysis of health risks (exposure routes, main pollutants, etc.)
   - Identification of risk indicator substances
   - Geostatistical modelling of concentrations of risk indicator substances
4. Consultation of stakeholders of brownfields regeneration and soil remediation on the

results produced:

- Through a one-day workshop
- Through a questionnaire on the way the health risk maps should be represented for clarity

5. Adjustment of the method and the code according to the feedback of these professionals.

The Cartorisk approach allows to produce two types of maps and results depending on the progress of the conversion project:

- Opportunity maps to define the possible land use with the minimum of health risks and soil excavation and/or clean-up,
- Risk maps for a specific development plan, and associated excavation and/or soil remediation costs.

The code is used to apply analytical equations of soil-gas transfer and exposition through soil ingestion, ingestion of plants and inhalation of indoor air to the cell units of the 3D geostatistical soil contamination model, and compute probabilities that the hazard quotient and individual excess risk exceed the regulatory thresholds. Health risks can be mapped in 2D at different levels of the future buildings (underground, ground floor, floors). Unit costs are applied on the geostatistical model of soil pollution in the areas to be excavated and/or remediated, to estimate the total costs while meeting desired risk levels.

Input data are composed of a set of conditional simulations of pollutant grades, and a table of the parameter values used in the transfer and exposition equations, and of the unit costs applied according to the soil pollution levels (several reuse and clean-up options).

Results produced by the code are:

- Health risk maps (image and csv files),
- Excavation and/or soil remediation costs, represented as graphics and tables of statistics, exportable as image and csv files.

To conclude, Cartorisk is a flexible approach that may help decision-making to define a regeneration plan for brownfields. It allows to test and compare different redevelopment scenarios and to assess their impact on soil excavation costs, as well as their compliance with health risks regulation. Uncertainty on health risks and cost estimates due to the imperfect knowledge of soil contamination is quantified thanks to geostatistics.

Session 4a3 / Abstract title: Using tTEM for contaminated site investigations – part 2

ID: 367

Key words: Groundwater contamination, geophysical mapping, detailed 3-D interpretation, knowledge-driven circular workflow

Submitter: Flemming Jørgensen

Organization: Central Denmark Region

Co-authors: Dr. Flemming Jørgensen, Central Denmark Region, Chief Consultant; Anders Edsen Msc., WSP Denmark, Head of Geophysics; Jesper Simensen Msc Civ eng, Team Leader; Johanne Jager Jensen, Msc., WSP Denmark, geophysisist

Session: 4a3

Abstract

Purpose of study:
The newly developed geophysical tTEM method are increasingly used in Denmark for the purpose of mapping geology in relation to soil- and groundwater contamination. As the method has shown great potential but can be complicated to implement and use, a technology development project across the Danish Regions has been established. The aim of the project is 1) to investigate the specific needs related to contaminated site investigations, 2) to design dedicated fieldwork mapping procedures and concepts, and 3) to describe and define workflows taking data processing and interpretation steps into account and ensuring collaboration between project leads, geophysical and geological experts.

Note: This abstract is focussed on an investigation and risk assessment approach using a non-intrusive sustainable data collecting method for the characterization of the geological subsurface structures and properties of the sedimentary units/layers. Project results related to survey design and mapping procedures are presented in the abstract “Using tTEM for contaminated site investigations – part 1”.

Methodology:
The tTEM method is presented in detail in part 1.

The tTEM method has been applied at six different sites where principal groundwater resources are threatened from point sources by pesticides, chlorinated solvents and PFAS. The contamination originates from industrial plants, agricultural contractors, and landfills.

Summary of findings/results:

We present examples from the sites showing how tTEM data provide vital information about geology and hydrogeology and how this knowledge is used in the investigation planning and improves the assessment of contaminant transport and dispersal.

The tTEM data characterise the architecture of the subsurface and the properties of the sedimentary units/layers. When working with contaminated sites and groundwater threats, it is essential to know if e.g., the aquifer is protected by a widespread clay layer, and whether shortcutting holes or cracks may appear in this layer. tTEM has proven successful in determining the architecture and properties of such protecting clay layers, but also in providing accurate mapping of other geological units such as small buried valleys, faults and glaciotectonics, whose existence and shapes are crucial for proper risk assessments.

The implementation of tTEM as a mapping tool in an early phase has supported the planning of the investigation programme at the six contaminated sites. Locations for new boreholes were optimised, and the number of new boreholes was reduced. The quality of the investigations was improved, and the validity and quality of the resulting risk assessments and eventual remediation actions were increased. At the same time, the investigation programme became more cost-effective and less time-consuming.

Full utilization of the tTEM method requires expertise within the specific geophysical technique and requires employees experienced in using and interpreting the data. Close interaction between specialists is required, but those specialists are often not employed in the same department or institution/company. Workflow solutions to mitigate this challenge will be presented.

Conclusion:
Introducing tTEM data proved valuable in the investigations of the six contaminated sites. The data were obtained early in the investigation programme with the aim of providing a detailed geological understanding. This understanding acts as a guideline for further investigations on the site in terms of borehole locations and positioning of screen levels.

During the investigation programme, it is essential that the results obtained with all different means of investigation are evaluated and the understanding of possible contaminant pathways adjusted accordingly. This implies feedback loops in the investigation concept, where project members representing geophysical, geological, hydrological, and chemical expertise bring their knowledge into play.

Session 4a3 / Abstract title: Added value of iterative sampling and Geostatistics for the characterization of a small but complex industrial site

ID: 401

Key words: Site characterization / Volatile compounds / Iterative sampling / Exploratory Spatial data analysis and geostatistics

Submitter: Claire Faucheux

Organization: Geovariances

Co-authors: David Chazottes, Ginger Burgeap, Project manager

Session: 4a3 backup

Abstract

Operating from 1975 to 1989, the principal activity of the site was the distillation of products coming from degreasing operations of taweries, including chlorinated compounds. The site is made of 400 m² of buildings on an area of less than 3700 m². The main characteristics are the presence of a river 15 m below a steep embankment and residential occupation in the neighborhood. Lots of products waiting for their treatment and treatment residues were stored in barrels, ending up with more than 5000 piled up on the site when the activity ceased.

Since the beginning of the 90's, the site is put in the French agency for ecological transition (Ademe) hands. An initial diagnosis of soils, water and groundwater has been performed, showing multiple contaminations due to grease, petroleum solvents, organohalogen solvents and BTEX, followed by a detailed evaluation of risks. At this stage numerous uncertainties were remaining and several options for remediation works were considered.

In 2007-2008, new studies were undertaken which rigorously followed the MACAOH protocol, dedicated to volatile compounds (on site methanol extraction and small vertical sampling lag of 50 cm as main specificities). Several source areas were identified, partially questioning remediation works based on an accelerated process of natural degradation of pollutants completed by pumping released degradation products and treating the water table.

A new campaign has been decided and undertaken in 2022 regarding the soils and in 2022-2023 for water. Objectives are a better understanding of the location and levels of the contaminants both in soils and water and groundwater, of the natural pathways, of the risks for residents to the east and south etc. They cover an assessment of the state of media quality and the implementation of a remediation plan.

A geostatistical methodology has been undertaken with the specificity to rely on an iterative campaign. An initial modeling based mainly on 2008 data has been carried out to assess

uncertainties and find the most hazardous areas. The optimal locations of 16 first boreholes were determined so as to:

- Confirm or infirm 2008 data,
- Decrease the absolute uncertainty,
- Better delineate impacted areas.

Sampling is not preferential and considers the possible future locations of boreholes of the second part of the 2022 campaign. Using the first results, a first detailed exploratory spatial data analysis has shown poor correlation with old data.

Iterative sampling then proved its advantage by giving the flexibility necessary to set up an optimized sampling plan for the second part of the campaign.

Finally, geostatistical study helps to undertake the mass balance computations, to build scenarios for cost-benefit analyses and to better describe the transfer behaviors of contaminants on the site and down to the river.

Session 4a4 orals

Session 4a4 / Abstract title: Mathematical modeling of water dynamics in soils - a tool for smart management of irrigation networks.

ID: 204

Key words: Richards equation, smart farming systems, computational mathematics

Submitter: Michal Kuraz

Organization: Czech University of Life Sciences Prague

Co-authors: Michal Kuraz, Mariana Hajkova, Johanna Ruth Bloecher

Session: 4a4

Abstract

Mathematical modeling in soil system sciences typically covers three distinct fields: hydrodynamics, thermodynamics and transport of solutes. A very typical property of all hydrodynamical processes in soils is an extremely low velocity of the liquid motion, flow regime is typically laminar. Due to low kinetic forces the flow field is significantly affected by osmotic and temperature gradient. Further, the flow area is scattered into microscopic pore paths, where phase changes such as evapotranspiration and ice crystallization can significantly affect local porous medium hydraulic properties. Setting up boundary conditions representing meteorological conditions is again nontrivial. In this presentation we will explain governing differential equation formulation describing flow processes together with liquid phase changes due freezing/melting and evapotranspiration. A special attention will be given to real-world application of smart farming system developed and installed on vineyards Finca Ecohumus, San Juan, Argentina, where we created a soil moisture forecasting system for efficient irrigation management based on local monitoring and weather forecasting.

Session 4a4 / Abstract title: Remediation of oil-drilling cuttings with ozonation in bubble flow reactors, and process simulation with a machine-learning approach

ID: 349

Key words: remediation; soil; ozonation; neural network; simulation

Submitter: Christos Tsakiroglou

Organization: Foundation for Research and Technology Hellas - Institute of Chemical Engineering Sciences

Co-authors: Krisana Kallari MSc, Research Assistant PhD candidate; Konstantinos Christodoulis MSc, Research Assistant PhD candidate; Dr. Nadia Bali, Research Associate; Dr. Maria Theodoropoulou, Research Associate

Session: 4a4

Abstract

Oil and gas industry generates a considerable amount of by-products and wastes which must be managed and treated properly. Oil-drilling cuttings (ODCs) are the major wastes generated during the process of oil/gas exploration and extraction. The oil originates from either the oil-based / synthetic drilling muds or reservoir crude oil. Ozonation is an effective and rapid method for the removal of petroleum products from contaminated soils and ODCs. ODC is pre-treated with aid of ultrasonic bath or ultrasound probe by mixing it with synthetic seawater of pre-specified composition at varying volume ratios, and adding the anionic surfactant sodium dodecyl sulphate (SDS) at various concentrations (0%,0.2%,0.5%). The pre-treated suspension is placed in a column reactor within which the ozone-rich gas is bubbled through a porous diffuser. During the ozonation process, a number of parameters (ozone concentration, pressure drop, pH, redox potential, temperature) are monitored on-line, solid and liquid samples are collected to detect the changes of the total organic carbon (TOC) as a function of time, while the concentration of the total petroleum hydrocarbons (TPH) is measured with GC.-FID before and after ozonation.
The design and optimization of bubble flow reactors used in ODC ozonation with knowledge-based models is a difficult task, due to the complex multiphase flow regime associated with a variety of mass-, momentum- and energy-transfer processes, complex reaction pathways and kinetics, multiple phases (gas, liquid, solid), and a high number of substances comprising each phase. On the other hand, the data-driven models, specifically the deep neural networks have shown promising results on capturing complicated interactions within the parameter space, without detailed information about the nature of the problem. However, training deep networks – such as those based on Recurrent Neural Networks (RNNs) – requires large labeled data, high computational resources, and significant hyperparameter

tuning effort. In the context of this work, we integrate transfer learning in order to address these issues when using RNNs to model the multivariate ozonation process with a high prediction accuracy. We consider transferring the knowledge captured in an RNN pretrained on a developed simulated database for the ozonation of ODC to build the model based on the experimental database. The final developed RNN will provide a short-term forecasting of the remediation rate of ODC under varying operating controls.

Session 4a4 / Abstract title: Evol' a methodology for determining the error of contaminated soil volume with deep neural networks and interpolation models

ID: 57

Key words: soil contamination, error estimation, integrated approach, deep learning, Deep Neural Network (DNN), and sample set analysis.

Submitter: Ignacio Guridi

Organization: SARPI Veolia Bordeaux University

Co-authors: Romain Chassagne, BRGM (French Geological Survey), France Alexandre Pryet, EPOC (UMR 5805), CNRS, Univ. Bordeaux Bordeaux INP, France Olivier Atteia, EPOC (UMR 5805), CNRS, Univ. Bordeaux Bordeaux INP, France

Session: 4a4

Abstract

Determining the volume of soil that exceeds a threshold of contamination is of critical importance when planning and implementing remediation strategies. However, the process of assessing the level of contamination is often hindered by uncertainty, as it is mainly based on preliminary sampling studies. Traditionally, this uncertainty is expressed in the form of confidence intervals, which can be quite broad and not particularly useful in determining a remediation strategy.

To address this issue and improve the accuracy of contamination estimates, we propose the use of a methodology called "Evol." This approach aims to reduce uncertainty in volume calculation by combining classical interpolation techniques, such as geostatistics, with the utilization of deep learning algorithms to predict errors.

The Evol methodology is based on a synthetic model generated from a real site, which is used to extract descriptive variables from multiple sample sets and evaluate errors. A Deep Neural Network model is then trained with these features to estimate the volume and uncertainty range for any given sample set.

The results of applying the Evol methodology have been promising, with high accuracy in estimating the volume and its error for most samples taken. Additionally, the approach leads to narrower confidence intervals of possible volumes than other classical techniques.

Because of these benefits, the Evol methodology can be used at an early stage of the remediation process, as well as during the actual remediation, to more accurately estimate

the volume of soil that needs to be addressed. This can greatly aid in the design and implementation of effective remediation strategies.

Session 4a4 / Abstract title: Establishment of the regional all-for-one customization model of black soil granary

ID: 89

Key words: Black soil granary; all-for-one customization; mode; platform; conservation tillage

Submitter: Xiaoming Wan

Organization: Chinese Academy of Sciences

Co-authors: nan

Session: 4a4

Abstract

The black soil is a valuable resource worldwide. Unreasonable development and utilization lead to serious black soil degradation in some areas, affecting food production and economic and social development. In the context of the intensification of the contradiction between food supply and demand around the world, it is urgent to focus on the overall situation of regional sustainable development and to seek systematic, scientific and economic solutions. Guided by the comprehensive idea of geography, based on the regional system of human-land relationship, customized and accurate management, agricultural system theory and agricultural informatization, the regional all-for-one customization mode of black soil granary is established. The aim of this regional all-for-one customization mode is to systematically diagnose the key problems and leading factors of black soil degradation, and to build a solution combining commonness and individuality of black soil protection from a perspective of multi-scale linkage, multi-factor coupling and multi-technology cooperation. The regional all-for-one customization mode of black soil granary integrates the two perspectives of "global" and "customization" into the protection and comprehensive utilization of black soil for the first time, which takes zoning, grading and classification as the main strategy, and big data and artificial intelligence as the main technical means. Relying on the "satellite-air-ground-network" three-dimensional monitoring system, combined with the all-for-one customization platform driven by big data and artificial intelligence, the model constructs three different scale strategies: first, implementing "zoning policies" at the regional scale, to formulate the regional agricultural resources allocation scheme and agricultural zoning, which could provide strategies to better protect and utilize the black soil; second, implementing the "decision-making policy according to the village" at the village scale, to formulate the black soil protection and utilization mode for different categories of villages, which could promote the organic integration of black soil protection and rural revitalization; third, implementing "one field, one policy" at the field scale to provide accurate strategies for soil restoration and yield improvement in a fixed, quantitative and regular manner. Multi-

scale integrated demonstration and scheme verification of the regional all-for-one customization mode of black soil granary were carried out in Qiqihar City, from "region, village and field" three scales, to solve the key issues of black soil protection and utilization, to form an replicable and popularized system solution, thus providing a model for the sustainable development of Chinese and global black soil agriculture. The regional all-for-one customization mode of black soil granary has important theoretical value and practical significance to promote the high-quality development of regional agriculture and rural revitalization, and provide a demonstration model of black land protection and utilization for the black soil area in China and the whole world.

Session 4a4 / Abstract title: Accurate mean soil temperature estimations in the context of thermal desorption

ID: 99

Key words: Average temperature, fluent

Submitter: Ysaline Depasse

Organization: Haemers Technologies

Co-authors: Ysaline Depasse M.Sc., Haemers Technologies, R Engineer / Mathieu Petitjean M.Sc., Haemers Technologies, R Engineer / Aline Jordens M.Sc., Haemers Technologies, R Manager / Hatem Saadaoui Ph.D., Haemers Technologies, Chief Scientific Officer / Jan Haemers M.Sc., Haemers Technologies, Managing Director

Session: 4a4

Abstract

Thermal desorption is a widely used method for the treatment of contaminated soils. It is a process that involves heating the soil to high temperatures, which causes the contaminants to volatilize, allowing them to be captured and treated. The process is particularly effective for treating soils contaminated with volatile organic compounds (VOCs), polychlorinated biphenyls (PCBs), and pesticides. One of the main advantages of thermal desorption is that it can be used to treat a wide range of soil types and contamination levels, making it a versatile and cost-effective method.

However, one of the challenges in this field is the accurate prediction of soil temperature during the treatment process. Knowing the temperature of the soil is crucial for assessing the progress of the remediation process, and for ensuring that the treatment is being performed in an effective manner. Inaccurate predictions of soil temperature can lead to suboptimal treatment conditions, resulting in incomplete remediation when overestimated, or waste of energy when underestimated. Typically, for cost and space requirements, only the cold points (the points furthest from any heating well) are monitored and do not provide a complete representation of the situation.

Haemers Technologies has successfully modelled its own processes using the FLUENT software, a commercial software package of Computational Fluid Dynamics (CFD). These simulations can be used to obtain the main batch temperature, but this method requires running a heavy simulation every day of the treatment, which can be time-consuming and computationally expensive. Additionally, this method can be complex, and may not be accessible to all practitioners in the field.

To address these challenges, a new method has been proposed that leverages the measurement of the coldest point of the batch, which is done routinely for process control. The temperature profile between a heating well (or hot point) and a cold point is known from previous studies and can be studied to infer the mean temperature of the zone. The integration of the temperature profile is not a realistic method as this profile evolves over time. The data from several worksites has been used to devise a simple weighted sum of the mean hot and cold points where the weight coefficients yield the lowest Root Mean Square Error (RMSE) of the estimation as compared to the full simulation. A correcting factor is then added to account for the duration of the evaporation plateau, where the cold point temperatures stagnate at 100°C but the heat front is still advancing. This results in a weighted sum wherein the weights evolve over time.

The proposed method has been tested and validated on several real worksite data and has been shown to provide accurate predictions of soil temperature. It can contribute to the improvement of the efficiency of the treatment process by allowing for more precise control of the treatment conditions. The method is simple, easily implementable, and does not require advanced computational resources. Overall, this research highlights the importance of continued development and refinement of soil temperature modelling in the field of thermal desorption, in order to optimize the treatment of contaminated soils and make it more reliable and affordable.

Session 4sps1 orals

Session 4sps1 / Abstract title: GWSDAT - GroundWater Spatiotemporal Data Analysis Tool: Overview and Tutorial Session

ID: 44

Key words: GWSDAT; Groundwater; Monitoring; Modelling; Decision Making.

Submitter: Wayne Jones

Organization: Shell

Co-authors: Jones, W.R.^, Radvanyi, P.#, Miller, C.#, Low, M.#, Alexander, C.#, Rock, L.* ^ Shell Research Ltd, London, United Kingdom # School of Mathematics Statistics, The University of Glasgow, Glasgow, United Kingdom * Shell Global Solutions Canada Inc., Calgary, Canada

Session: 4sps1

Abstract

The GroundWater Spatiotemporal Data Analysis Tool (GWSDAT) is an open-source tool to assess environmental data from groundwater monitoring campaigns. This enables to make informed decisions on how to assess / design / manage groundwater quality monitoring programs that evaluate groundwater impacts due to constituents of potential concern (e.g., Benzene). The tool has been used for over 10 years across the globe and is actively maintained and upgraded to add / improve its functionalities.
The purpose of this session is threefold:

- Provide an overview of GWSDAT functionalities, such as mapping of groundwater impacts, plume diagnostics, well redundancy feature just to name a few.
- Illustrate GWSDAT's use in practice through showcasing case studies.
- Conduct an interactive tutorial session on using and analyzing environmental groundwater monitoring data via GWSDAT. AquaConSoil attendees would be asked to indicate interest in attending this session a week prior to start of the conference. Those that expressed an interest would get instructions on what to bring to the session if they would like to follow along and replicate the steps shown during the tutorial.

There will be ample time for Q as well.