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PERFORMANCE COMPARISON OF THREE PASSIVE SAMPLERS FOR MONITORING OF POLAR ORGANIC CONTAMINANTS IN TREATED MUNICIPAL WASTEWATER

Fialova, P., K. Svercova, K. Grabicova, R. Grabic, H. Svecova, P. Novakova, and B. Vrana
Science of The Total Environment 908:168153(2024)

A study compared the performance of three samplers: the Polar Organic Chemical Integrative Sampler (POCIS), the Hydrogel-based Passive Sampler (HPS, an upscaled version of o-DGT), and the Speedisk, on a diverse suite of pharmaceuticals, PFAS, and pesticides and their metabolites. The samplers were deployed side-by-side in the treated effluent of a municipal wastewater treatment plant for different exposure times. All samplers accumulated a comparable number of compounds. Integrative uptake was observed for most compounds detected up to 28 days for POCIS, up to 14 days for HPS, and up to 42 days for Speedisk. In the integrative uptake phase, consistent surface-specific uptake was observed with a significant correlation between samplers ($r \geq 0.76$) despite differences in sampler construction, diffusion barrier, and sorbent material used. The low sampling rates compared to the literature and the low estimated overall mass transfer coefficient suggest that the water boundary layer was the main barrier controlling the uptake for all samplers. Although all devices provided comparable performance, Speedisk overcomes POCIS and HPS in several criteria, including time-integrative sampling over a long period and physical durability.

DESIGN AND INSTALLATION OF A PILOT-SCALE PHYTOREMEDIATION SYSTEM FOR PESTICIDES IN GROUNDWATER, WEST COLUMBIA, SOUTH CAROLINA

Landmeyer, J. I. Clemson Hydrogeology Symposium, 28 March, Clemson SC, abstract only, 2024

A pilot-scale remediation system comprised of 200 hybrid poplar trees was designed and implemented to evaluate whether the trees would decrease pesticide concentrations in groundwater at a site near West Columbia, South Carolina. Toxaphene and beta-benzene hexachloride (β -BHC) concentrations were highest near the pesticide source area and decreased in the direction of groundwater flow toward a small creek. Pesticide concentrations in groundwater near the creek were much lower than anticipated. For example, the average decrease of total pesticides in groundwater near the creek was 22 times more than expected based on pesticide decreases near the source area. Similarly, the average decrease of β -BHC and toxaphene in groundwater near the creek were 48 and 8 times more than expected, respectively. The USGS investigated and hypothesized that the higher decreases in pesticide concentrations may be related to the large number of native trees growing near the creek. The uptake of pesticides by native trees was confirmed by the detection of pesticides in passive samplers placed in representative trees near the creek. The pilot-scale remediation system will test the idea that the hybrid poplar trees will take up groundwater and organochlorine pesticides during transpiration. System performance will be evaluated by analyzing groundwater from existing monitoring wells, porewater samples beneath the creek, and passive samplers installed in the pilot-scale trees. The overall goal of the pilot is to provide data to evaluate whether the trees will decrease pesticide concentrations in groundwater at a greater rate than the native trees. If successful, the pilot-scale phytoremediation could be implemented across a larger area. *More information:* <https://www.usgs.gov/centers/sawsc/science/pilot-scale-phytoremediation-pesticide-contaminated-groundwater-near-columbia>

Research

ENHANCING REMEDIATION OF RESIDUAL DNAPL IN MULTILAYER AQUIFERS: POST-INJECTION OF ALCOHOL-SURFACTANT-POLYMER MIXTURES

Alamooti, A., S. Colombano, A. Shoker, A. Ahmadi-Senichault, F. Lion, D. Cazaux, C. Marion, J. Lagron, I. Sawadogo, and D. Davarzani.
Science of The Total Environment 918:170680(2024)

A study evaluated the efficiency of post-injection of alcohol-surfactant-polymer (ASP) mixtures containing 1-propanol/1-hexanol, sodium dodecylbenzenesulfonate (SDBS), and xanthan in enhancing residual DNAPL remediation in layered systems. Experimental devices employed included batch, rheological measurements, centimetric 1D column, and decametric 2D tank experiments. Batch experiments revealed that the inclusion of 1-hexanol swelled the DNAPL volume due to alcohol partitioning. Conversely, with only 1-propanol present in the alcohol-surfactant (AS) mixture, DNAPL dissolved in the aqueous phase. The co-presence of 1-hexanol and 1-propanol in the AS mixture favored 1-propanol's partitioning into the DNAPL phase. Following primary xanthan-SDBS (XS) injections, column experiments demonstrated that ASP mixtures with 1-hexanol (regardless of the presence of 1-propanol) underwent a mobilization mechanism. DNAPL appeared in the effluent in the organic phase after post-injection of 0.3 pore-volumes (PV), noted by a reduction trend in its density. Mixtures with only 1-propanol exhibited a solubilization mechanism, with DNAPL dissolving in the aqueous phase and emerging in the effluent after ~1 PV. 2D tank experiments visualized mobilization and solubilization mechanisms in multilayered systems. Post-injection of the ASP mixture with 1-propanol led to DNAPL solubilization, demonstrated by a dark zone of varied DNAPL concentrations followed by a clearer white zone, indicating significant DNAPL dissolution. Injecting an ASP mixture containing 1-propanol and 1-hexanol mobilized swollen DNAPL ganglia throughout layers, with droplets coalescing and migrating to the recovery point. The darkness of mobilized droplets faded as more DNAPL was recovered. The solubilization ASP mixture enhanced the recovery factor by 0.02, while the mobilization ASP mixture led to a 0.08 increase in the recovery factor.

PER- AND POLYFLUOROALKYL SUBSTANCES IN FOOD PACKAGING: MIGRATION, TOXICITY, AND MANAGEMENT STRATEGIES

Phelps, D.W., L.V. Parkinson, J.M. Boucher, J. Muncke, and B. Geueke.
Environmental Science & Technology 58(13):5670-5684(2024)

A study systematically mapped the evidence of PFAS detected in migrates and extracts of food contact materials and provided an overview of available hazard and biomonitoring data. Based on the FCCmixq database, 68 PFAS were identified in various food contact materials, including paper, plastic, and coated metal, by targeted and untargeted analyses, 87% belonging to the PFCAs and fluorotelomer-based compounds. Chain length trends demonstrated that long-chain PFAS continue to be found despite years of global efforts to reduce the use of these substances. ToxPI was utilized to illustrate that hazard data are available for only 57% of the PFAS detected in food packaging. Many adverse outcomes have been reported for the PFAS for which toxicity testing has been performed. The data and knowledge gaps identified in this study support international proposals to restrict PFAS, including in food contact materials, to protect human and environmental health.

STUDY ON THE GAS PHASE MIGRATION AND DISTRIBUTION CHARACTERISTICS IN HORIZONTAL WELL AIR SPARGING REMEDIATION

Zhang, X., B. Liang, Z. Wu, L. Tang, L. Zeng, and D. Wu.
Environmental Technology & Innovation 34:103583(2024)

A study employed model experiments and numerical simulations to investigate the distribution patterns of lateral airflow in horizontal air sparging tubes within a porous medium. The influence of parameters such as air sparging pressure, groundwater flow, the inclination angle of the air sparging tubes, and the diameter of the medium particles on the distribution patterns of gas-phase transport in horizontal well air sparging (AS) were analyzed. Results showed that groundwater flow and the inclination of air sparging tubes disrupt the uniformity of gas distribution. The zone of influence (ZOI) area of AS was observed as an oblong shape in the horizontal plane and a parabolic contour along the boundaries. In addition, a mutual influence was identified between groundwater flow and AS airflow. The inclination of air sparging tubes results in the formation of preferential flow near the air source end. The ZOI of horizontal AS demonstrates a positive correlation with air sparging pressure and a negative correlation with medium particle diameter.

FORMERLY USED DEFENSE SITES ON UNALASKA ISLAND, ALASKA: MAPPING A LEGACY OF ENVIRONMENTAL POLLUTION

Jordan-Ward, R., F.A. von Hippel, J. Schmidt, and M.P. Verhoughstraete.
Integrated Environmental Assessment and Management 20(5):1420-1431(2024)

The goals of this study were to identify hotspots of contamination remaining at Unalaska formerly used defense (FUD) sites, evaluate the risk posed by arsenic, and examine "no US Department of Defense action indicated" (NDAI) status determinations for FUD sites near communities. Soil chemistry data was compiled from remediation reports at 18 FUD sites on and near Unalaska: 9 had past and/or active remediation projects and onsite sampling data, 8 did not have sampling data and were characterized as NDAI, and 1 site was listed as closed. For the 9 sites with sampling data, 22 contaminants of concern (COCs) were compiled, and concentrations were compared to soil cleanup levels for human health. Contaminant concentrations exceeding these levels were mapped to identify hotspots. Some concentrations of the 22 COC exceeded Alaska cleanup levels despite remediation efforts, including diesel range organics, arsenic, and lead. The highest COC concentrations were at the FUD site adjacent to the City of Unalaska. A quantitative risk assessment for arsenic found that the risk of exposure through drinking water is low. The article highlights concerns with NDAI designations and current remedial practices at remote FUD sites adjacent to communities. Data suggest further remediation and monitoring efforts for certain contaminants and research to examine potential threats to human and animal health associated with these sites.

DATA-DRIVEN INSIGHTS INTO THE CONTAMINATION OF POLYCYCLIC AROMATIC HYDROCARBONS IN MARINE BAYS

Liu, D., Y. Luo, W.-H. Bao, M. Junaid, Z.-F. Guo, and Y.-Y. Xu.
Environmental Science & Technology 58(34):15202-15213(2024)

A data synthesis framework was developed to gain insights into the spatiotemporal patterns, compositional profiles, and potential sources of PAHs in water and sediment of marine bays. PAHs were detected in 69 bays worldwide, with contamination hotspots located in Asian bays. PAH concentrations in pre-2000 were significantly lower than those in the 2000s and post-2010, while the dominant species in water and sediment were 2-3 ring and 4-6 ring PAHs, respectively. The composition patterns of PAHs included 2-3 ring, 3-5 ring, and 4-5 ring dominant categories, but no significant distance decay relationship was found in the composition similarity due to international energy trade. Temporal dynamic patterns of concentrations included Descending, Ascending, and Inverted V-type, whereas over longer time spans, the pattern is more similar to the Inverted V-type owing to the reductions in emission intensity. PAHs were found to be derived from petrogenic and pyrolytic sources, with combustion from coal and petroleum being the dominant sources. These data-driven discoveries provide quantitative insights into the spatiotemporal patterns in the concentration and composition of PAHs, contributing to the mitigation of PAH contamination.

WILDFIRES INFLUENCE MERCURY TRANSPORT, METHYLATION, AND BIOACCUMULATION IN HEADWATER STREAMS OF THE PACIFIC NORTHWEST

Baldwin, A.K., J.J. Willacker, B.L. Johnson, Sa.E. Janssen, and C.A. Eagles-Smith.
Environmental Science & Technology 58(32):14396-14409(2024)

Soil, water, sediment, in-stream leaf litter, periphyton, and aquatic invertebrates were sampled in 36 burned (one-year post-fire) and 21 reference headwater streams across the northwestern U.S. to evaluate the effects of wildfire occurrence and severity on total Hg (THg) and methylmercury (MeHg) transport and bioaccumulation. Suspended particulate total mercury (THg) and methylmercury (MeHg) concentrations were 89% and 178% higher, respectively, in burned watersheds compared to unburned ones. These levels also rose with burn severity, likely due to increased soil erosion. Filter-passing THg concentrations were similar in burned and unburned watersheds. Filter-passing MeHg was 51% greater in burned watersheds. Suspended particles in burned watersheds were enriched in MeHg but not THg, suggesting higher MeHg production in burned watersheds. Among invertebrates, MeHg in grazers, filter-feeders, and collectors was 33, 48, and 251% greater in burned watersheds, respectively, but did not differ in shredders or predators. Thus, increasing wildfire frequency and severity may yield increased MeHg production, mobilization, and bioaccumulation in headwaters and increased transport of particulate THg and MeHg to downstream environments.

General News

GUIDELINES FOR SELECTING THE APPROPRIATE BIOACCUMULATION MODEL(S) FOR NONIONIC ORGANIC CONTAMINANTS WHEN ASSESSING RISK AND REMEDIAL EFFECTIVENESS AT CONTAMINATED SEDIMENT SITES

EPA Ecological Risk Assessment Support Center (ERASC), EPA/600/R-24/086, 58 pp, 2024

EPA's ERASC prepared guidelines providing an overview of bioaccumulation models for nonionic hydrophobic organic contaminants and an approach for selecting the appropriate bioaccumulation model(s). The document assists site managers and environmental scientists in selecting the optimum model(s) for bioaccumulation-related applications to assess risk or remedial effectiveness at contaminated sediment sites. Selecting which bioaccumulation model to use at a specific site involves balancing several critical parameters including:

1. The objectives of the study, as well as which contaminants are being investigated and the purpose of the decision being made based on the modeled estimate, which will influence the level of accuracy and precision needed for the estimate(s) generated by the model.
2. The type of data available or site-specific data that can be collected, and
3. The resources available for applying a given model (i.e., level of effort, funding) to make an estimate.

https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=54963181&ab=CFMM

TOOLS FOR ENHANCING REAGENT DELIVERY TO ADDRESS MATRIX DIFFUSION IN LOW PERMEABILITY GEOLOGIC MATRICES

Durant, N. Naval Facilities Engineering Command (NAVFAC) Open Environmental Restoration Resources Webinar Series, 54 minutes, 2024

This presentation overviews four technologies to enhance reagent delivery in situ: electrokinetics (EK); hydraulic fracturing; soil mixing; and permeable reactive columns emplaced via Bomber Technology. Case studies are presented that illustrate the design and implementation of these technologies at U.S. Department of Defense sites.
<https://www.youtube.com/watch?v=2qJdCbT3iQI>

OVERVIEW OF STATE APPROACHES TO VAPOR INTRUSION: 2023 UPDATE

Eklund, B., C. Regan, R. Rago, and L. Beckley
Groundwater Monitoring & Remediation 44(3):76-93(2024)

This paper summarizes current vapor intrusion (VI) guidance, petroleum hydrocarbon-specific VI guidance, and/or media-specific volatilization criteria in broader regulatory programs. Since 2018, 30 states have revised their guidance, issued new guidance or updated criteria or other VI-related information. For each state and the District of Columbia, the review includes tabulations of the available types of screening values (e.g., soil, groundwater, soil gas, and indoor air), the screening values for selected chemicals that commonly drive VI investigations (e.g., TCE, PCE, benzene, and other selected VOCs), and the basis of risk levels used for cancer and non-cancer risk. Federal values are also included for comparison. It also summarizes available key policy criteria for each state, including trigger distances, default subsurface to indoor air attenuation factors, policies for evaluation of petroleum VI, strategies for preferential pathways, and policies for mitigation of VI. <https://ngwa.onlinelibrary.wiley.com/doi/epdf/10.1111/gwmr.12627>

BIOREMEDIATION OF SOILS CONTAMINATED WITH PFAS: AN UPDATE ON AVAILABLE TECHNIQUES, PILOT STUDIES, CHALLENGES, AND FUTURE DIRECTIONS

Beskoski, V., M. Ljesevic, B. Jimenez, J. Munoz-Arnanz, P. Colomer-Vidal, H. Inui, and T. Nakano. Soil Remediation Science and Technology Chapter, pages 331-366, 2024

This chapter aims to address the problem of PFAS pollution, with a specific focus on their occurrence in soil and the current state of the most effective remediation approaches employed.

LESSONS LEARNED APPLYING COMPOUND SPECIFIC ISOTOPE ANALYSIS IN LARGE, DILUTE, AND CO-MINGLED GROUNDWATER PLUMES

Leslie, K. Battelle 2024 Chlorinated Conference, 2-6 June, Denver, CO, 23 slides, 2024

Compound specific isotope analysis (CSIA), including 2D analysis, was applied at several complex sites with large, dilute groundwater plumes where contaminants were co-mingled and/or the source area(s) were unknown. Lessons learned were compiled regarding the specific challenges in applying CSIA to identify source area(s), evaluate contaminant plume co-mingling, determine groundwater flow direction, and assess natural attenuation. Based on the lessons learned, a stepwise framework was developed:

- Qualitative evaluation using 2D isotopic values and groundwater flow pathways to identify areas most closely resembling the TCE source (i.e., lightest isotopic composition).
- Semi-quantitative evaluation to evaluate the data to fit the Rayleigh model and determine if physical or chemical attenuation is occurring.
- Quantitative evaluation to calculate enrichment factor, determine the degradation process(es) occurring, and calculate the degradation rate along a groundwater flow path.

The quantitative evaluation could not be completed at some complex sites with large, dilute, co-mingled plumes. However, using qualitative and semi-quantitative steps of the framework can still provide valuable site characterization, including source identification, confirmation of groundwater flow pathways, evaluation of co-mingled contaminants, and confirmation that natural attenuation is occurring. These results can significantly change the conceptual site model and optimize the remedial approach.
https://xrciaacademy.s3.amazonaws.com/battelle/2024_Chlorinated/C2_1440_424_Leslie.pdf

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