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CHEMICAL EFFECTS

Assessing the protection gap for mobile and persistent chemicals during advanced water treatment - A study in a drinking water production and wastewater treatment plant

2022-07-10

Persistent and mobile (PM) chemicals spread quickly in the water cycle and can reach drinking water. If these chemicals are also toxic (PMT) they may pose a threat to the aquatic environment and drinking water alike, and thus measures to prevent their spread are necessary. In this study, nontarget screening and cell-based toxicity tests after a polarity-based fractionation into polar and non-polar chemicals are utilized to assess and compare the effectiveness of ozonation and filtration through activated carbon in a wastewater treatment and drinking water production plant. Especially during wastewater treatment, differences in removal efficiency were evident. While median areas of non-polar features were reduced by a factor of 270, median areas for polar chemicals were only reduced by a factor of 4. Polar features showed significantly higher areas than their non-polar counterparts in wastewater treatment plant effluent and finished drinking water, implying a protection gap for these chemicals. Toxicity tests revealed higher initial toxicities (especially oxidative stress and estrogenic activity) for the non-polar fraction, but also showed a more pronounced decrease during treatment. Generally, the toxicity of the effluent was low for both fractions. Combined, these results imply a less effective removal but also a lower toxicity of polar chemicals. The behaviour of features during advanced waste and drinking water treatment was used to classify them as either PM chemicals or mobile transformation products (M-TPs). A suspect screening of the 476 highest intensity PM chemicals and M-TPs in 57 environmental and tap water samples showed high frequencies of detection (median >80%), which indicates the wide distribution of these chemicals in the aquatic environment and thus supports the chosen classification approach and the more generally applicability of obtained insights.

Authors: Grete Gollong, Isabelle J Neuwald, Jochen Kuckelkorn, Ralf Junek, Daniel Zahn

Full Source: Water research 2022 Jul 10;221:118847. doi: 10.1016/j.watres.2022.118847.

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Shape dependence of the release rate of chemicals from plastic microparticles

2022-07-12

The release of chemical additives from plastic microparticles in the aqueous phase represents a potential indirect threat for environment and biota. The estimate of the release timescale is demanded for drawing sensible conclusions on quantitative grounds. While the microparticles are generally taken to be spherical for ease of modelling, in reality the variety of shapes is large. Here, we face the problem of working out an empirical simple expression for estimating the release times for arbitrary shapes, assuming that the plastic material is in the rubbery state, that the dynamics inside the particle is a diffusion process, and that the release is irreversible. Our inspection is based on numerical simulations of the release process for randomly generated instances of regular and irregular geometries. The expression that we obtain allows one to estimate the release time in terms of the corresponding time (easy to compute) for the equal-volume spherical particle taken as reference, and of the ratio between the surface areas of particle and equivalent sphere.

Authors: Riccardo Frazzetto, Diego Frezzato

Full Source: Environmental science and pollution research international 2022 Jul 12. doi: 10.1007/s11356-022-21440-2.

To be or not to be degraded: in defense of persistence assessment of chemicals

2022-07-13

Characterizing the degradation behavior of chemicals in the environment is a key component of chemical hazard and risk assessment. Persistence has been successfully characterized for readily and for slowly degradable chemicals using standardized tests, but for the third group of chemicals with intermediate degradability (“middle group”), the assessment is less straightforward. Whether chemicals of this group behave as persistent or not in a given environment depends on environmental factors such as the presence of sorbents that can limit the bioavailability of chemicals. Uncertainties associated with current persistence assessments of chemicals in the middle group do not imply that persistence assessment is generally inconsistent, too ambiguous for regulatory use, and not useful in chemical hazard and risk assessment. Given the complexity of the environmental factors influencing chemical degradation, and the diversity of commercial chemicals, it has to be accepted though that for chemicals in the middle group even improved testing methods will

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not remove all of the immanent heterogeneity in their persistence data. For cases with widely different but technically valid persistence data, a weight-of-evidence approach is necessary and the "benefit of the doubt" should follow the precautionary principle in order to protect human and ecosystem health. We maintain that technically valid persistence data, although they might be considered dissatisfying from a scientific point of view because of high variability or even inconclusiveness, can well be sufficient for regulatory purposes. As with anything, also in persistence assessment, the scientific logic aims for a mechanistic description of the processes involved, low uncertainty, and a comprehensive understanding derived from a broad empirical basis. If the scientific logic is used as a benchmark in the regulatory context, this may easily lead to "paralysis by analysis". While regulatory decisions should be based on sound science, discrepancies between scientific goals and regulatory needs and, consequently, different levels of requirements (must-have versus nice-to-have) for degradation studies need to be recognized and appreciated. We further advocate for enhancing consistency between regulatory persistence assessments ("one substance-one assessment"), which is currently not the case.

Authors: Andreas Schäffer, Kathrin Fenner, Zhanyun Wang, Martin Scheringer

Full Source: Environmental science. Processes & impacts 2022 Jul 13. doi: 10.1039/d2em00213b.

ENVIRONMENTAL RESEARCH

Forecasting of non-accidental, cardiovascular, and respiratory mortality with environmental exposures adopting machine learning approaches

2022-07-14

Environmental exposure constantly changes with time and various interactions that can affect health outcomes. Machine learning (ML) or deep learning (DL) algorithms have been used to solve complex problems, such as multiple exposures and their interactions. This study developed predictive models for cause-specific mortality using ML and DL algorithms with the daily or hourly measured meteorological and air pollution data. The ML algorithm improved the performance compared to the conventional methods, even though the optimal algorithm depended on the adverse health outcomes. The best algorithms were extreme gradient boosting, ridge, and elastic net, respectively, for non-accidental,

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cardiovascular, and respiratory mortality with daily measurement; they were superior to the generalized additive model reducing a mean absolute error by 4.7%, 4.9%, and 16.8%, respectively. With hourly measurements, the ML model tended to outperform the conventional models, even though hourly data, instead of daily data, did not enhance the performance in some models. The proposed model allows a better understanding and development of robust predictive models for health outcomes using multiple environmental exposures.

Authors: Woojoo Lee, Youn-Hee Lim, Eunhee Ha, Yoenjin Kim, Won Kyung Lee

Full Source: Environmental science and pollution research international 2022 Jul 14. doi: 10.1007/s11356-022-21768-9.

Development of an environmental hazard-based rating assessment for defence-related chemical compounds in ecological soil systems

2022-07-05

Environmental hazard-based methods are commonly used to categorise the severity of chemical contamination to ecological soil systems, although a traffic-light approach (green, amber, red) has never been used to assess these consequences. A traffic light approach is an easy to interpretate data as it has a clear visual display which can provide an early warning approach for stakeholders to identify areas that require further investigation. This approach should be underpinned by extensive research data and systematic methods of development. However, the extent of reliable data available for specific chemicals can be limited and therefore decision making may rely on expert judgement. Therefore, in this study, an environmental hazard-based rating methodology was developed by combining the guidelines from the European Chemical Agency (ECHA) and the USEPA for Predicted Non-effect Concentration (PNEC) and Ecological Soil Screening Levels (Eco-SSL) for defence-related chemicals (2,4,6-trinitrotoluene (TNT), 1,3,5-trinitro-1,3,5-triazinane (RDX), cypermethrin, perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS)). The developed hazard-based rating assessment was design to categorise the chemicals into low, medium and high environmental hazards priority to inform and ease the decision-making process for contaminated areas to ensure that sustainable operations are carried out.

Authors: Federica Persico, Frederic Coulon, Melissa Ladyman, Tracey Temple

Full Source: Environment international 2022 Jul 5;166:107392. doi: 10.1016/j.envint.2022.107392.

Environmental hazard-based methods are commonly used to categorise the severity of chemical contamination to ecological soil systems, although a traffic-light approach (green, amber, red) has never been used to assess these consequences.

PHARMACEUTICAL/TOXICOLOGY

Long-term personal PM 2.5 exposure and lung function alternation: A longitudinal study in Wuhan urban adults

2022-07-12

Background: The effect of long-term PM2.5 exposure on lung function has not been well established. Objectives: To investigate the effects of long-term personal PM2.5 exposure on lung function decline, obstructive, and restrictive ventilatory disorders. Method: Personal PM2.5 concentrations were evaluated using an estimation model. Lung function parameters including forced vital capacity (FVC), forced expiratory volume in 1 s (FEV1) and peak expiratory flow (PEF) were measured in 3053 Wuhan participants from the Wuhan-Zhuhai cohort and were repeated every 3 years. Participants were classified into persistently high exposure group, persistently low exposure group and inconsistent exposure group according to the median of PM2.5 concentration of each visit. Mixed linear models with subject-specific random intercept were used to assess the association of 3-year change of lung function with personal PM2.5 exposure, and generalized linear models were used to assess the association of 6-year change of lung function with personal PM2.5 exposure. Cox regression models were applied to assess the associations of PM2.5 with obstructive and restrictive ventilatory disorders. Results: The medians of personal PM2.5 concentrations at baseline and two follow-ups were 153.18, 209.57 and 83.78 μg/m3, respectively. Compared with participants in the persistently low exposure group, participants in the persistently high exposure group showed a 2.99 % (95 % CI: 0.91, 5.08), a 380.15 mL/s (95 % CI: 32.82, 727.48) and a 5.98 % (95 % CI: 0.84, 11.11) additional decline in FEV1/FVC, PEF and PEFpred after 6 years, respectively. Stratified analyses showed that age, gender, body mass index, smoking status and drinking status had no significant modification effect on the associations. The associations of PM2.5 exposure with obstructive and restrictive ventilatory disorders were not significant, except for a positive association between persistently high PM2.5 exposure and restrictive ventilatory disorder among ever drinkers. Conclusion: Long-term high PM2.5 exposure was associated with FEV1/FVC, PEF and PEFpred declines.

Authors: Ge Mu, Bin Wang, Man Cheng, Xiuquan Nie, Zi Ye, Min Zhou, Yun Zhou, Weihong Chen

Full Source: The Science of the total environment 2022 Jul 12;157327. doi: 10.1016/j.scitotenv.2022.157327.

Background:
The effect of long-term PM2.5 exposure on lung function has not been well established.

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The causal and independent effect of ozone exposure during pregnancy on the risk of preterm birth: Evidence from northern China

2022-07-11

The concentration of ozone (O3) in the environment is gradually increasing, but there are limited reports on the exposure to O3 during pregnancy on the risk of adverse birth outcomes. Our study aimed to examine the causal and independent effect of O3 exposure during pregnancy on the risk of preterm birth (PTB) and to identify the critical window. Based on the baseline population of the birth cohort in Jinan, northern China, we obtained the individual exposure for each subject during pregnancy of ambient 8-h moving average O3 through the inverse distance weighting model. The effect of O3 exposure during pregnancy on PTB was evaluated through the time-dependent Cox proportional-hazard models. And we assessed the causal relationship by controlling unknown confounding factors using the instrumental variable (IV) analysis, estimated the independent effect by principal component analysis, and identified the critical window period of exposure through the distributed lag model. Among 6501 subjects, 285 mothers delivered prematurely. The median (IQR) of O3 concentration during pregnancy was 109.51 (23.54) μg/m3. The high level of O3 exposure (>173.64 μg/m^3) increased the risk of PTB, with HR of 1.92 (95% CI: 1.38-2.66). Furthermore, the HR (95% CI) of the O3 estimated value calculated by the IV (wind speed) on the risk of PTB was 2.63 (1.41-4.88). In addition, the high level of O3 exposure was associated with the risk of PTB in the 13th-18th gestational weeks. Therefore, the high level of O3 exposure during pregnancy may independently increase the risk of PTB, which may be a causal effect. The 13th to 18th week of gestation is a critical window for preventing this risk.

Authors: Shuoxin Bai, Shuang Du, Haiping Liu, Shaoqian Lin, Xiaodong Zhao, Zhaojun Wang, Zhiping Wang

Full Source: Environmental research 2022 Jul 11;214(Pt 1):113879. doi: 10.1016/j.envres.2022.113879.

The concentration of ozone (O3) in the environment is gradually increasing, but there are limited reports on the exposure to O3 during pregnancy on the risk of adverse birth outcomes.

Titanium dioxide and carbon black nanoparticles disrupt neuronal homeostasis via excessive activation of cellular prion protein signaling

2022-07-15

Background: Epidemiological emerging evidence shows that human exposure to some nanosized materials present in the environment would contribute to the onset and/or progression of Alzheimer's disease

(AD). The cellular and molecular mechanisms whereby nanoparticles would exert some adverse effects towards neurons and take part in AD pathology are nevertheless unknown. Results: Here, we provide the prime evidence that titanium dioxide (TiO2) and carbon black (CB) nanoparticles (NPs) bind the cellular form of the prion protein (PrPC), a plasma membrane protein well known for its implication in prion diseases and prion-like diseases, such as AD. The interaction between TiO2- or CB-NPs and PrPC at the surface of neuronal cells grown in culture corrupts PrPC signaling function. This triggers PrPC-dependent activation of NADPH oxidase and subsequent production of reactive oxygen species (ROS) that alters redox equilibrium. Through PrPC interaction, NPs also promote the activation of 3-phosphoinositide-dependent kinase 1 (PDK1), which in turn provokes the internalization of the neuroprotective TACE α-secretase. This diverts TACE cleavage activity away from (i) TNFα receptors (TNFR), whose accumulation at the plasma membrane augments the vulnerability of NP-exposed neuronal cells to TNFα -associated inflammation, and (ii) the amyloid precursor protein APP, leading to overproduction of neurotoxic amyloid Aβ40/42 peptides. The silencing of PrPC or the pharmacological inhibition of PDK1 protects neuronal cells from TiO2- and CB-NPs effects regarding ROS production, TNFα hypersensitivity, and Aβ rise. Finally, we show that dysregulation of the PrPC-PDK1-TACE pathway likely occurs in the brain of mice injected with TiO2-NPs by the intra-cerebro-ventricular route as we monitor a rise of TNFR at the cell surface of several groups of neurons located in distinct brain areas. Conclusion: Our in vitro and in vivo study thus posits for the first time normal cellular prion protein PrPC as being a neuronal receptor of TiO2- and CB-NPs and identifies PrPC-coupled signaling pathways by which those nanoparticles alter redox equilibrium, augment the intrinsic sensitivity of neurons to neuroinflammation, and provoke a rise of Aβ peptides. By identifying signaling cascades dysregulated by TiO2- and CB-NPs in neurons, our data shed light on how human exposure to some NPs might be related to AD.

Authors: Luiz W Ribeiro, Mathéa Pietri, Hector Ardila-Osorio, Anne Baudry, François Boudet-Devaud, Chloé Bizingre, Zaira E Arellano-Anaya, Anne-Marie Haeberlé, Nicolas Gadot, Sonja Boland, Stéphanie Devineau, Yannick Bailly, Odile Kellermann, Anna Bencsik, Benoit Schneider

Full Source: Particle and fibre toxicology 2022 Jul 15;19(1):48. doi: 10.1186/s12989-022-00490-x.

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OCCUPATIONAL

A review of omics-based PFAS exposure studies reveals common biochemical response pathways

2022-07-08

Per and Polyfluoroalkyl Substances (PFAS) are a diverse group of man-made chemicals with a range of industrial applications which are widespread in the environment. PFAS are of high concern to regulators and the public due to their potential toxicity and high persistence. They are structurally diverse but comprise a common chemical feature of at least one (though usually more) perfluorocarbon moiety (-CnF2n-) attached to a functional group such as a carboxylic or sulphonic acid. The strength of the Carbon-Fluorine bond means the compounds do not break down easily and they can thus bioaccumulate. At high exposure levels, PFAS has been implicated in a range of harmful effects on human and environmental health, particularly problems in/with development, cholesterol and endocrine disruption, immune system function, and oncogenesis. However, most environmental toxicology studies use far higher levels of PFAS than are generally found in the environment. Additionally, since the type of exposure, the PFAS used, and the organisms tested all vary between studies, so do the results. Traditional ecotoxicology studies may thus not identify PFAS effects at environmentally relevant exposures. Here we conduct a review of omics-based PFAS exposure studies using laboratory ecotox methodologies and environmentally relevant exposure levels and show that common biochemical response pathways are identified in multiple studies. A major pathway identified common among the literature data was the pentose phosphate shunt pathway. Such molecular markers of sublethal PFAS exposure will greatly benefit accurate and effective risk assessments to ensure that new PFAS regulations can consider the full effects of PFAS exposure on environmental and human health receptors.

Authors: David J Beale, Georgia Sinclair, Rohan Shah, Amy Paten, Anupama Kumar, Sara M Long, Suzanne Vardy, Oliver A H Jones

Full Source: The Science of the total environment 2022 Jul 8;157255. doi: 10.1016/j.scitotenv.2022.157255.

Per and Polyfluoroalkyl Substances (PFAS) are a diverse group of man-made chemicals with a range of industrial applications which are widespread in the environment.

Identification of occupations susceptible to high exposure and risk associated with multiple toxicants in an observational study: National Health and Nutrition Examination Survey 1999-2014

2022-06-25

Occupational exposures to toxicants are estimated to cause over 370 000 premature deaths annually. The risks due to multiple workplace chemical exposures and those occupations most susceptible to the resulting health effects remain poorly characterized. The aim of this study is to identify occupations with elevated toxicant biomarker concentrations and increased health risk associated with toxicant exposures in a diverse working US population. For this observational study of 51 008 participants, we used data from the 1999-2014 National Health and Nutrition Examination Survey. We characterized differences in chemical exposures by occupational group for 131 chemicals by applying a series of generalized linear models with the outcome as biomarker concentrations and the main predictor as the occupational groups, adjusting for age, sex, race/ethnicity, poverty income ratio, study period, and biomarker of tobacco use. For each occupational group, we calculated percentages of participants with chemical biomarker levels exceeding acceptable health-based guidelines. Blue-collar workers from "Construction," "Professional, Scientific, Technical Services," "Real Estate, Rental, Leasing," "Manufacturing," and "Wholesale Trade" have higher biomarker levels of toxicants such as several heavy metals, acrylamide, glycideamide, and several volatile organic compounds (VOCs) compared with their white-collar counterparts. Moreover, blue-collar workers from these industries have toxicant concentrations exceeding acceptable levels: arsenic (16%-58%), lead (1%-3%), cadmium (1%-11%), glycideamide (3%-6%), and VOCs (1%-33%). Blue-collar workers have higher toxicant levels relative to their white-collar counterparts, often exceeding acceptable levels associated with noncancer effects. Our findings identify multiple occupations to prioritize for targeted interventions and health policies to monitor and reduce toxicant exposures.

Authors: Vy Kim Nguyen, Justin Colacino, Chirag J Patel, Maureen Sartor, Olivier Jolliet

Full Source: Exposome 2022 Jun 25;2(1):osac004. doi: 10.1093/exposome/osac004.

Occupational exposures to toxicants are estimated to cause over 370 000 premature deaths annually.