CONFERENCE ABSTRACTS

Standard Session Themes:
Transport, fate and exposure modelling of chemicals in the environment
Environmental analysis and monitoring
Metal toxicity and environmental chemistry
Bioavailability and toxicity of organic and emerging chemicals
Nano-risk research: toxicity of micro pollutants
Toxicity of mixtures and multiple stressors
Terrestrial ecotoxicology
Biomarkers and biosensors
Environmental 'Omics'
Emerging ecotoxicological techniques and test methods
Advances in analytical chemistry
Life cycle assessment
Groundwater and salinity issues
Human health issues associated with environmental contaminants
Pharmaceuticals and personal care products in the environment
Biological monitoring of endocrine disrupting chemicals
Ecological risk assessment
Environmental management

Special Session Themes:
Marine and estuarine water quality
Marine ecotoxicology
The role of natural organic matter in environmental toxicology and chemistry
Per- and poly-fluorinated alkyl substances (PFAS): fate and effects

ORAL PRESENTATIONS

A growing field: Selenium uptake in plant proteins determines suitability for mine site remediation

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Theme - Environmental management

ABSTRACT

Extensive mining and agriculture has seen selenium (Se) emerge as a contaminant of increasing concern in terrestrial and aquatic environments in many regions around the world. Se is an essential micronutrient to humans, animals and some microorganisms but to date limited research has been conducted to determine the importance of Se to higher plants with respect to Se translocation and accumulation on a proteomic level in Australia. We investigated 1) the effects of radiolabelled selenite and selenate (75Se) concentrations on patterns of translocation of selenium salts by whole plant autoradiography, 2) the quantity of the 75Se accumulated in lipids, carbohydrates, and various classes of proteins. The plants, Brassica rapa 'Vitamin Greens' and Helianthus annus 'Dwarf Sunflower', secondary Se accumulators, along with Neptunia amplexicaulis, an identified selenium hyperaccumulator, were grown in tissue culture growth media and harvested after 21 days of exposure to a range of increasing concentrations of selenite and selenate salts, after which sub-lethal exposure concentrations were selected for further studies. Autoradiography displayed 75Se translocation of SeIV in relatively greater proportions in the roots than leaves and higher SeVI in the leaves than in the roots. Se was primarily bound to albumin, prolamin and glutelin proteins. These patterns of translocation coupled with further proteomic studies will assist in seleno-protein studies at a later stage to determine if Se is incorporated into specific proteins in these plants. The patterns of selenium translocation, its accumulation and possible phytovolatilization in plants have considerable implications on their suitability as tools for phytoremediation and biofortification.

A new and simple dry separation of PM10 from mining soils for Ni, Co and Mn bioavailability study by kinetic extractions

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Theme - Environmental analysis and monitoring

ABSTRACT

In New Caledonia, thirty active Ni opencast mines have been reported in 2012 and the overall mining activity leads to dust emission rich in Ni, Co and Mn. Dust is fine particle of matter with a diameter smaller than 100 µm and mobilized by wind. Among those particles, PM10 (Particulate Matter in which 50 % of the particles have a diameter below 10 µm) are of particular concern because they can easily penetrate the human respiratory system causing respiratory dysfunction and diseases. Thus, the bioavailable metal content of PM10 is of great interest for health and ecotoxicological risk assessment. Bioavailable metal content in PM10 emitted by mining soils can be estimated by kinetic chemical extractions with EDTA but a large amount of dust is needed. To overcome this problem, we have developed a new and simple device using dry separation of PM10 from bulk mining soils. It consists of a stainless steel tube along which a nitrogen flow is imposed, resulting in the displacement of particles. Taking into account particle transport, fluid mechanics and soil texture, a 6-m long tube with a 0.04-m diameter was needed for PM10 separation. The device was able to produce the necessary several milligrams of PM10 to perform kinetic extractions with EDTA. Kinetic extractions curves were fitted using a two first-order reaction model defining two metal pools, a quickly and a slowly extractable pools with kinetic constants ranging respectively from 0.0222 to 0.1613 min-1 and from 0.0007 to 0.0047 min-1. Although the quickly extractable Ni, Co and Mn pools represent only 0.5–6.4 % of the total Ni, Co and Mn contents, quickly extractable contents are extremely high ranging from 17.8 to 709 mg.kg-1 and can be troublesome in the environment. This simple and dry technique for PM10 separation from bulk soil eliminates the metal leaching risks inherent in wet filtration and should ensure accurate health and ecotoxicological risk assessment of small particles.

Accurate determination of titanium dioxide nanomaterials (nTiO2) in environmental matrices

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Theme - Environmental analysis and monitoring

ABSTRACT

Currently, the ability to monitor the dynamics of nanomaterials in the environment is limited by robust analytical methods to accurately quantify nanomaterial concentrations in environmental samples. For example, nanoscale titanium dioxide (nTiO2) is generally difficult to analyse in environmental samples as it is highly insoluble in water, most acids, and all organic solvents. Although hydrofluoric acid (HF) and sulfuric acid (H2SO4) can dissolve nTiO2 at high temperatures its use has numerous health and safety concerns. Consequently, there is a need to develop robust and safer analytical methods for the analysis of nTiO2 in a variety of complex environmental matrices.

Initially, a number of diverse environmental samples (i.e. solution, soil, and plant) were spiked with known concentrations of nTiO2. Subsequently, a range of digestion methods was evaluated for the ability to digest and thus accurately determine nTiO2 concentrations in solution. Parameters considered where the acid digestion medium [concentrated nitric acid (HNO3), aqua regia (1:3 HNO3: HCl), mixtures of concentrated sulphuric and nitric acid at ratio of 2:1 H2SO4: HNO3, and potassium hydroxide], digestion temperature [140, 180 and 210 oC] and the heating method [block heater, microwave, and muffle furnace]. The recovery of Ti was evaluated by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) and ICP Optical Emission Spectroscopy (ICP-OES). All samples were also analysed using the traditional HF/H2SO4 digestion technique to validate the success of our procedures.

Conventional digestion techniques such as aqua regia and nitric acid which are commonly used for soil and plant digestions respectively did not perform well for the recovery of nTiO2. However, the use of a mixture of H2SO4: HNO3 (1:2) with either a block heater or microwave assisted digestion provided good recoveries of Ti when compared with the traditional HF-H2SO4 based digestion. Sulphur oxide interferences on the major Ti isotope (m/z = 48) were overcome, using an ammonia reaction gas during ICP-MS analysis for Ti. While results for the conventional muffle furnace (MF) - potassium hydroxide (KOH) fusion technique were comparable with the H2SO4: HNO3 (1:2) microwave assisted digestion technique, the MF technique had slightly better digestion efficiency and was less labour intensive and quicker.

This work demonstrates that common digestion techniques may underestimate a number of nanomaterials present in environmental matrices and highlights the importance of validating proposed analytical techniques for the recovery of emerging contaminants such as nanomaterials prior to conducting more extensive contaminant dynamic experiments.

Acute and chronic toxic effects of microplastic beads and fibres on crustacean Ceriodaphnia dubia: single and mixture exposure scenarios

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Theme - Toxicity of mixtures and multiple stressors

ABSTRACT

Concerns have been raised about microplastics, such as synthetic fibres from clothing and beads from cosmetic products, in freshwater environments, with recent monitoring studies finding significant amounts of microplastics in wastewater effluent. There are still many uncertainties regarding the effect of wastewater-derived microplastics, particularly fibres, on aquatic organisms. In this study, we examined the acute (48-hr) and chronic (8-days) toxicity of microplastic beads and fibres on the freshwater cladoceran species, Ceriodaphnia dubia. We also examined the acute toxicity of binary mixtures of microplastic beads and fibres for the first time, which is important given that microplastics are likely to occur as mixtures in the environment. A toxic unit approach was used to assess the toxicity of the binary mixture. The toxicity results showed a dose-dependent trend, with C. dubia more sensitive to polyester fibres than PE microplastics. The 48-hr EC50 value of fibres was 1.5 mg/L (95% confidence interval (CI): 1.3-1.7) compared to 2.0 mg/L (95% CI: 1.6-2.4) for polyethylene beads. The binary mixture of microplastic beads and fibre demonstrated a strong antagonistic response with toxic unit of 1.92. EC50 values for chronic bioassay were 0.38 mg/L (95% CI: 0.31-0.46) for fibres and 1.19 mg/L (95% CI: 0.66-2.16) for PE microplastics. A positive trend of increased toxicity with decreasing growth (body size of adults) and reproduction rate (number of neonates) was observed for both PE and fibre microplastics during chronic bioassays. Deformities, such as carapace and antenna deformation, were also observed in C. dubia exposed to fibres at a concentration of 1 mg/L. While both PE and fibre microplastics caused toxic effects at environmentally relevant concentrations, fibres have a greater capacity to negatively affect C. dubia than PE microplastics.

Adsorption of PFOA using graphene-based materials

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Theme - Per- and poly-fluorinated alkyl substances (PFAS): fate and effects

ABSTRACT

Due to their bioaccumulation and persistence in the environment, perfluorooctanoic acid (PFOA) and related PFAS have raised concern, with several cases of contamination reported worldwide. As degradation of these chemicals is often energy-intensive, adsorption is an effective technology to manage PFOA contamination. Adsorption of PFOA onto activated carbons and minerals has been demonstrated in the past. Graphene, the latest addition to the nanocarbon family, is an excellent candidate for use as an adsorbent. Its versatile surface chemistry offers pathways to multiple mechanisms for contaminant sorption (ligand-exchange, electrostatic, hydrophobic interactions, etc). We synthesised two graphene derivatives, graphene oxide (GO) and an iron-modified graphene composite (FeG), and evaluated them for sorption using 14C-radiolabelled PFOA-spiked solutions. Data from control experiments (in the absence of adsorbents) were used to correct for sorption observed onto lab-ware, which was found to be significant. The influence of different pH conditions, ionic strength, and concentrations was investigated, and performance compared with a commercial adsorbent, RemBindTM (manufactured and supplied by Ziltek Pty. Ltd.), which has been used successfully to treat PFAS-contaminated soils in Australia and the USA.

Both GO and FeG successfully adsorbed PFOA. Performance of FeG was comparable with the commercial adsorbent, RemBindTM. Surface area did not correlate with sorption performance, highlighting the importance of surface chemistry. Data suggest involvement of non-electrostatic mechanisms, and highlight the role of Fe-based minerals in binding PFOA. Results emphasise the potential role of Fe-functionalised graphene materials for effective remediation of PFOA and related PFAS. Resistance to variations in pH and ionic strength highlights the possibility of using these materials, in situ, to remediate contaminated land under varying environmental conditions.

Keywords

PFOA; graphene; adsorption; remediation; RemBindTM

Acknowledgement

We would like to thank Ziltek Pty. Ltd. for their technical support & provision of RemBindTM.

An application of the diffusive gradients in thin films (DGT) technique to investigate heavy metal speciation and bioavailability in soil porewater of rice field soils in relation to fertilizer application: study of a chronic kidney disease area in Sri Lanka

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Theme - Human health issues associated with environmental contaminants

ABSTRACT

The current chronic kidney disease epidemic, the major health issue in rice paddy farming areas in Sri Lanka (similar kidney disease epidemics observed in Andra Pradesh (India) and Central America) with no identifiable cause (CKD of uncertain aetiology) is suspected to be triggered by environmental exposure to heavy metals. Agricultural soils are well recognized as being contaminated with potentially toxic metals from various forms of fertilizers and agro-chemicals, which could easily enter the human body through the food chain. None of the hypotheses put forward so far could explain coherently the totality of clinical, biochemical, histopathological findings, and the unique geographical distribution of the disease and its appearance in the mid-1990s. However, most of the research projects have so far used the conventional ex situ analytical techniques to analyse heavy metal concentrations in paddy soil and related water resources, found high concentrations of As and Cd in both media. Although these ex situ methods are well-established they have limitations and may not accurately reflect the in situ concentrations due to the artefacts resulting from sample oxidation and changes in temperature.

The aim of this study was to investigate the ability and limitations of the in situ passive sampling techniques (diffusive gradients in thin films (DGT)) to predict the speciation and bioavailability of heavy metals, especially As and Cd in contaminated paddy soil, in comparison to conventional soil-analysis techniques. Here, we used DGT probes with MBL (Chelex and Metsorb) and Mercapto-silica as binding layers, deployed in situ on flooded paddy soil to demonstrate the distributions of trace cations, oxyanions and As(III) in paddy soil immediately adjacent to the rhizospheres of rice plants. Furthermore, advances in DGT technique have enabled in situ speciation measurements to be made in paddy soil, an important step forward in understanding the biogeochemical processes behind contaminant mobilization.

Keywords

Chronic Kidney Diseases (CKD); heavy metals; fertilizers and agrochemicals; diffusive gradients in thin films

An in situ, time-integrated approach to measuring dissolved and particulate contaminants in aquatic environments

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Theme - Environmental analysis and monitoring

ABSTRACT

The accurate monitoring of contaminants in rivers and streams requires the measurement of both particulate and dissolved contaminant concentrations. While a number of techniques exist for measuring time-integrated concentrations of dissolved contaminants (e.g., the diffusive gradients in thin films (DGT) technique), the time-integrated measurement of particulates requires on-site grab sampling equipment, which can be prohibitively expensive for large-scale studies and unrepresentative over extended time scales. This disparity in sampling method representativeness can lead to significant error when attempting to estimate a representative total pollutant load from a river or stream. The pumped active suspended sediment (PASS) sampling technique is a novel time-integrated monitoring technique designed to continuously sample suspended sediment from an aquatic system, in order to measure the concentration of total suspended solids and particulate-associated contaminants, such as nutrients, metals and pesticides. A field study in the Loders Creek catchment, a lowland stream system in southeast Queensland, was conducted to assess the combined capability of the DGT and PASS sampling techniques to measure dissolved metals and nutrients, and particulate-associated metals and nutrients, respectively. This new approach was combined with stream discharge measurements and compared to conventional grab sampling approaches for its ability to provide an accurate measure of contaminant loads, which are critical for investigating nutrient and metal sources on the catchment scale.

An issue that won't degrade: microplastic contamination in coral reef environments

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Theme - Environmental analysis and monitoring

ABSTRACT

Microplastics are a contaminant of emerging interest and international concern because they are ubiquitous throughout the world's oceans and along beaches, including in both highly populated and remote regions. This mounting attention has led to a large body of experimental research that has provided important insights into the potential for plastic ingestion and the ability of microplastics to act as transport vectors for certain pollutants to marine organisms. Despite this increase in ex situ experiments, there is still a lack of information on baseline levels of microplastic contamination in situ, including the quantities of plastics being ingested by important fishery species. This lack of information makes it difficult to design experiments with ecological relevance. In this presentation I will compare baseline microplastic contamination in water and sediments collected at coral reef environments in the Maldives and Myanmar. Additionally, I will present data on the quantity and types of plastic ingested by fish and oysters from reefs in Myanmar, where subsistence fishing is extremely important for remote island villages. The contamination levels reported can be used for future experiments to determine pollution uptake into tissues and/or sub-lethal effects caused by plastic particle ingestion.

Analysis of metal concentration and distribution in surface sediments within the Ramsar listed Gippsland lakes, Victoria, Australia

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Theme - Metal toxicity and environmental chemistry

ABSTRACT

The Gippsland Lakes system, traditional home to the Gunaikurnai people and exploited by Europeans since the 1840s, have been subjected to a range of historical anthropogenic activities. Impacts in the region over the past 150 years have included agriculture, forestry, mining, manipulation of waterways, fishing and urbanisation. The legacy of these impacts is preserved within the chemistry of the sediments of the lakes. Here we determine the heavy metal contaminant history of human impact on the Gippsland lakes system and the influence this has on modern ecosystems.

The initial stage of this project looked to determine the spatial and vertical distribution of metals across the lakes. Grab and core sediment samples collected across the lake system in two events in 2015 and 2016. These were analysed for qualitative XRF, total metal content (focus on Cr, Cd, As, Hg, Pb, Ni, Zn), along with physiochemical analysis (pH, particle size and loss on ignition) on all representative samples.

The initial metal results show that in the surface grab samples the contaminant levels across the lakes system was generally low. Elevated levels, above the sediment quality guideline low trigger values of Hg are located predominantly in the west of the system at the Latrobe River Mouth, Heart Morass, Lake Wellington and Lake Victoria West. Elevated levels of As were identified at depth in the Latrobe River and Lake Victoria East cores.

Initial qualitative XRF analysis of sediment cores show an increase in both overall signal and variability of a number of these metals in the upper depths of the cores. This initial scan enables us to target samples for quantitative analysis, including mobile fraction extraction.

Through this combined method, we can obtain an understanding of the distribution of metals through sediment composition and dynamics and also the possible contaminant sources via human activity within the catchment through time.

Analysis of Multiclass UV Filters in Wastewater by LC-MS/MS

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Theme - Environmental analysis and monitoring

ABSTRACT

Of increasing concern to the aquatic environment are organic UV filters which comprise the active ingredients in sunscreen and are used in a variety of personal care products. One of the main exposure pathways of UV filters to the environment is through wastewater effluent released into creeks, rivers and the ocean. Therefore, a method for the multiclass determination of UV filters in wastewater has been validated using liquid chromatography tandem mass spectrometry (LC-MS/MS). The method, validated in wastewater influent using direct injection produced detection limits ranging from 0.01 – 0.15 µg L-1. The application of this rapid direct injection method detected several UV filters in influent and effluent samples collected from local wastewater treatment plants. After further method development, this validated analysis technique will be used to measure UV filters in wastewater samples concentrated through solid-phase extraction. This work will form the foundation for the first extensive detection of UV filters in wastewater and marine surface water in Australia.

Analytical strategies for sensitive measurement of Glyphosate and polar pesticides in Water

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Theme - Environmental analysis and monitoring

ABSTRACT

Glyphosate is the active ingredient in the popular herbicide roundup and is used throughout the world. Recently, its safe use has come into question. While toxicological studies continue to take place, it would be prudent to monitor these compounds to get reference levels. This has heightened the demand for a sensitive method at the low ppb levels for environmental water analysis. Glyphosate is also known to degrade to several metabolites including aminomethylphosphonic acid (AMPA), glufosinate and acetyl-glufosinate. LC/MS/MS using triple quadrupole technology can provide both the sensitivity and selectivity needed. In this study, an analytical method for glyphosate and AMPA using FMOC derivatization were created to achieve sub ppb levels of quantification in water. Further, the method was automated and made more sensitive using an online solid phase extraction setup. However, methods involving derivatization are known to foul up the instrument due to injection of a large amount of derivatizing agent. Further, many derivatizations require that the sample be analyzed within 24-48 hours or the sample degrades. To simplify the analytical process, a direct injection LC/MS/MS method with no derivatization for 9 compounds including glyphosate, its metabolites and 5 other polar pesticides was created. This method achieved sub ppb detection limits in water while requiring essentially no sample preparation. Finally, an ion chromatography (IC)/MS/MS method was also optimized to compare with the LC/MS/MS method. This presentation will contrast the three methods and highlight key analytical validation procedures including method detection limits, spike recoveries, precision and real sample data. The method will also provide occurrence data collected from areas in the north-east region of USA.

Are those fish safe to eat? Accumulation of Nodularin in commercial and recreationally relevant fish species

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Theme - Human health issues associated with environmental contaminants

ABSTRACT

The safety of seafood products as a food source is of great importance from both a public health and economic viewpoint. Worldwide the occurrence of cyanobacteria algal blooms in coastal and estuarine waters has resulted in accumulation of cyanobacterial toxins in seafood which has led to a growing concern regarding the health risks associated with its consumption.

Nodularin is a cyclic pentapeptide hepatotoxin produced by the cyanobacterium Nodularia spumigena, which forms blooms in coastal systems including the Baltic Sea, and more locally the Gippsland Lakes, in south-east Victoria Australia. Often bloom events have resulted in accumulation of nodularin in seafood, such as mussels, prawns and finfish to levels presenting a risk to human health. In order to protect consumers, governments around the world provide advisories regarding seafood consumption during toxic blooms based on health alert levels. However, currently due to a lack of scientific data on nodularin uptake, and tissue distribution in seafood, health alert levels for nodularin are based on those derived for a similar and more commonly researched cyanobacterial toxin, microcystin. In order to improve our understanding of risks of nodularin to seafood safety, studies investigating accumulation and tissue distribution in commercially and recreationally relevant seafood are needed.

This study assessed the uptake, accumulation and tissue distribution of nodularin in two commercially and recreationally relevant fish species. Black bream (Acanthopagrus butcheri) and sand flathead (Platycephalus bassensis) were exposed via oral gavage to a single dose of food contaminated with N. spumigena cells containing nodularin (50 µg/kg or 200 µg/kg ww). At pre-determined time periods (1, 2, 7, 14 and 20 days) following dosing, fish were killed and various tissues (muscle, liver and gut) sampled to assess for nodularin accumulation.

This presentation will detail results of nodularin accumulation in these recreationally and commercially relevant species and discuss the safety of fish for human consumption during toxic blooms.

Assessing differences in marine turtle organ sensitivity using cell-based toxicity assays

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Theme - Emerging ecotoxicological techniques and test methods

ABSTRACT

The long-lived nature of marine turtles and their lengthy residence in coastal foraging grounds can result in high exposure to contaminants from urban, industrial and agricultural sources. Organic or inorganic contaminants have been quantified in all species of marine turtles worldwide. However, very little is known about how these contaminants impact turtle health, valuable information for identifying populations at risk. To date, the effects of only a few contaminants have been investigated for a small number of toxicological endpoints, driven largely by the logistical and ethical constraints of conducting direct exposure experiments on these large, protected animals. In vitro exposure experiments using cell lines established from turtle tissue provide an ethical, reproducible and cost-effective method to identify threats of environmentally relevant contaminants to marine turtles. In recent years, the majority of marine turtle cells lines have been established from skin samples. However, as ingestion is the main route of exposure for these animals, cell lines established from organ tissues may be more pertinent. This study used a number of primary cell lines established from the skin, ovary, heart, liver and small intestine from three individual green turtles to investigate the variation in sensitivity between organs types. Cytotoxicity of five organics and five inorganic compounds was investigated using a total of 13 cell lines. Using multivariate statistical techniques, differences between the cell lines were investigated based on their overall sensitivity to all compounds tested. The results provide recommendations for further toxicological studies involving turtle cells lines that will allow more robust and meaningful risk assessments to be conducted for marine turtles, assisting conservation and management strategies worldwide. Our results also support the use of marine turtle cell cultures as an ethical and reliable method for investigating toxicological effects of environmental contaminants.

Assessment of PFAS effects on stock welfare and productivity

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Theme - Per- and poly-fluorinated alkyl substances (PFAS): fate and effects

ABSTRACT

Per- and poly-fluorinated alkylated substances (PFAS) are globally important environmental pollutants due to their very long persistence, mobility and bioaccumulation. It is highly likely that if stock animals are located in the vicinity of historical point source PFAS releases which have impacted water, soil or fodder that the animals have assimilated these chemicals. While much attention has been paid to understanding the potential effect of PFASs on human and environmental health, little has been done regarding assessment of the welfare and productivity of stock animals. Patently this has important economic implications.

Studies with experimental animals (monkeys and rodents) clearly show body burden is proportional to accumulated dose, and observed effects are proportional to serum concentration. Thus for PFASs, it is well recognised serum concentration is a better dose metric for assessing risk of harm than is the external exposure (dose). Species dose-effect differences are driven by marked species differences in toxicokinetics of PFASs rather than in tissue responsiveness to a given serum concentration (toxicodynamic differences). However for some endpoints rodents appear to be very sensitive.

Here we present a margin of exposure approach for assessing the welfare and productivity of stock that have been exposed to PFASs. The approach assumes stock animals will be at least as sensitive as experimental animals. It involves comparison of stock serum PFAS concentrations with no observed effect, or low observed effect serum concentrations derived from experimental animals. Relevant sensitive endpoints for stock assessment are changes in body weight and body weight gain, fecundity, offspring performance, and liver effects. Critical serum values are supported by a limited number of field and experimental stock studies that have measured serum concentrations.

The approach is illustrated with Australian examples where sheep and cattle have assimilated PFAS from their environment.

Australian tropical dissolved organic carbon ameliorates copper toxicity in tropical freshwater algae

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Theme - The role of natural organic matter in environmental toxicology and chemistry

ABSTRACT

Dissolved organic carbon (DOC), ubiquitous in natural waters, plays a key role in influencing metal speciation and bioavailability. The ability of DOC to alter metal bioavailability depends on its concentration, source and composition. Each aquatic system is distinct, with a unique combination of organic matter sources, resulting in DOC with complex and heterogeneous chemical compositions. Currently, there is limited research comparing the ameliorative effects of different DOCs on metal toxicity, particularly DOC derived from Australian ecosystems. This information is required if we are to include modifying factors in revised water quality guidelines for metals.

This study involved collecting DOCs from five distinct Australian tropical freshwater systems and comparing the effect of each DOC on growth of the tropical alga Chlorella sp. 12. Inhibition of cell division at a range of copper concentrations (0-60 µg Cu/L) was investigated in the presence of each of the DOCs (0, 2 and 10 mg C/L added) in 72-h exposures.

Differences in EC10 and EC50 values showed the effects of DOC on copper toxicity in Chlorella sp. 12 to be dependent on DOC concentration and composition. In general, copper toxicity decreased with increasing DOC concentration. EC10 and EC50 values increased from 1.5 to 12 µg Cu/L and 2.5 to 17 µg Cu/L, respectively, with increasing DOC concentration (0 to 10 mg C/L added DOC). DOC composition and source also affected the sensitivity of Chlorella sp. 12 to copper, with clear differences in both EC10 and EC50 values. The greatest difference was observed for the EC50 at 10 mg C/L added DOC, that ranged from 10 to 36 µg Cu/L across the five DOCs.

These results demonstrate that different DOCs will not have a uniform effect on metal bioavailability in freshwaters and there is a need for site-specific considerations when determining the sensitivity of freshwaters to metals. Thus the development of protective water quality guidelines for metals requires a greater understanding of DOC composition, how composition influences DOC-metal interaction and to what degree these components vary between regions.

Bioaccumulation dynamics and gene regulation in a freshwater bivalve after aqueous and dietary exposures to silver and gold nanoparticles: a comparative study

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Theme - Bioavailability and toxicity of organic and emerging chemicals

ABSTRACT

The increasing production of engineered materials containing nanoparticles (NPs) is becoming a subject of concern, mainly because of the potential environmental risks they pose after release into the environment. This study focused on the bioaccumulation dynamics and effects of silver and gold NP exposure (AgNPs, AuNPs, 10 nm+) on the filter-feeding bivalve Corbicula fluminea. That is, we parameterized bioaccumulation dynamic constants and assessed gene expressions after waterborne and dietborne exposures, in experiments using a range of concentrations (0-5 µg/L, and algae exposed to 0-25 µg/L for AgNPs and; 0-24 mg/L and algae exposed to 0-48 mg/L for AuNPs). Specifically, we estimated the metal uptake rate constants from water (Kuw), the metal uptake rate constants from food (Kuf), as well as the elimination rate constants (Ke) for both Ag and AuNPs, as well as for their ionic counterparts. The waterborne metal uptake rate constant was higher in bivalves exposed to AgNPs (Kuw = 0.52/L/g/day) than those exposed to AuNPs (Kuw = 0.23 ± 0.05 L/g/day), and both Kuws were lower than those for the ionic counterparts. The uptake rate constant from food (Kuf) was lower in bivalves exposed to AgNPs than in those exposed to AuNPs. Because assimilation efficiency (AE) was greater for the AgNPs (AE > 75%) than the AuNPs (AE = 36%), the lower Kuf for AgNPs than for AuNPs is a result of feeding inhibition. The elimination rate constants (Ke) were similar between NPs (Ke = 0.11 and 0.13 ± 0.01/day, respectively). Gene expression was also investigated to study NP exposure effects on 20 genes involved in oxidative stress, immune response, mitochondrial mechanisms and DNA repair. Initial results of waterborne and dietborne exposures to AgNPs showed significant inhibitions of genes involved in the immune responses (c3, gal, atg13, cltl1), oxidative stress (segpx), and mitochondrial mechanisms (cox1) as well as an upregulation of genes controlling endocytosis mechanisms (cav). These results point out interesting differences in the toxic mechanisms implemented by two metallic NPs that might trigger important environmental risks.

Calcareous electrochemical precipitation, a new method to trap dissolved metallic pollutants in seawater

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Theme - Marine Ecotoxicology and Chemistry

ABSTRACT

The contamination of coastal waters by trace metals is an important worldwide concern. Although metals are natural part of the environment, their release to coastal waters may significantly affect the productivity and diversity of lagoon ecosystems. This is particularly true in New Caledonia, where soils are highly enriched in nickel and subjected to intense mining extraction and strong erosion due to tropical rainfall. In this context, a novel use of the calcareous deposit formed under the cathodic protection of a metallic structure is proposed to trap metallic contaminants in seawater.

The calcareous deposit is formed in seawater by imposing a current density to a galvanized steel wire. The working electrode's potential reaches potential in the water reduction range. This reaction induces pH increase at the seawater/metal interface and thus calcium and magnesium precipitation. A voluminous calcareous deposit composed of $CaCO_3$ and $Mg(OH)_2$ grows then with polarization time. Then, experiments are performed in artificial seawater with different amounts of nickel salt. A broad range of total Ni contents, larger than natural ones (few µg/L), is tested by doping artificial seawater with $NiCl_2(s)$.

Analyses reveals that Ni is trapped in this calcareous deposit mainly as ß-$Ni(OH)_2$. The surface of the deposit consists of a pure $CaCO_3$ (aragonite) layer, indicating that Ni is internalized in the deposit. Ni content increases with the initial concentration of $NiCl_2$ in the electrolyte. Up to 24% in weight of Ni initially present in the electrolyte is trapped in the deposit after seven days of polarization.

The calcareous deposit appears like a simple implementation with just a metallic structure immerged in seawater and connected to an electrical circuit which can be charged by renewable energy. This electrochemical method is thus a promising and cheap clean-up device for remediation of contaminated seawater.

This work is a part of the project "EcoCorail" funded by the French Research National Agency (ANR).

Characterisation of artisanal mine waste on Buru Island, Indonesia and toxicity to the brittle star Amphipholis squamata

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Theme - Marine Ecotoxicology and Chemistry

ABSTRACT

Artisanal small-scale gold mining (ASGM) using mercury (Hg) amalgamation commenced on Buru Island, Indonesia, in 2012, but was halted in 2015 due to concerns of widespread Hg contamination. Much of the Hg used in the mining process is lost to trommel waste which is disposed of in settlement ponds that drain into adjacent waterways and into Kayeli Bay. Many 1000s of unmanaged trommel sites and associated tailing ponds exist on Buru Island. This study shows that waste from the Marloso trommel at the Gogrea site contained 203.5 mg/Kg total Hg (THg), with a negligible proportion present as bioavailable methyl Hg (MeHg) and a low total organic carbon content. There are currently very few tools available for ecotoxicological risk assessment of mine tailings for tropical marine ecosystems, and we support the development of Tailings Toxicity Tests (TTTs) and describe laboratory toxicity test methods using the cosmopolitan benthic echinoderm Amphipholis squamata. Undiluted trommel waste caused 100 % mortality of A. squamata within 48 h, and a 96-h LC50 of 6.7 % v/v trommel waste (4.0 mg/Kg THg) was estimated. Sub-lethal effects on the water vascular system of the brittle star were assessed by quantification of the Ability to Right Itself (ARI), and a 48-h EC50 of 7.3 % v/v trommel waste (14.4 mg/Kg THg) was estimated. The results show that trommel waste produced on Buru Island is highly contaminated with THg and is acutely toxic, raising serious concern for receiving ecosystems where Hg methylation to more toxic and bioavailable forms is likely.

Characterising the molecular interactions between hydrophilic contaminants and a polymeric sorbent with the aid of computational chemistry

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Theme - Environmental analysis and monitoring

ABSTRACT

Contaminants often enter the environment in a sporadic manner leading to a hit and miss approach when traditional grab sampling is employed in environmental monitoring programmes. Passive samplers can be employed to overcome these issues as they are often immersed in the aquatic environment from days to weeks at a time. With advancements made in situ sampling techniques, there is a growing need to ensure that these methods have the capacity to produce reproducible and representative results. Whilst the mechanisms by which contaminants adsorb into hydrophobic passive samplers are well characterised, the same cannot be said of the newer polymeric sorbent based hydrophilic samplers.

Traditionally, techniques such as batch adsorption studies have been used to determine adsorption characteristics of selected compounds onto solid phase extraction materials. Whilst these studies are able to provide general rules of thumb for potential interactions taking place between sorbates and sorbent, it is possible that the data generated from these studies could be misinterpreted leading to false assumptions being made. However, with the development of computational methods, we now have the ability to gain greater insight into how sorbates and sorbents interact at the molecular level. This presentation details computational studies that were conducted using hybrid density functional theory (DFT) calculations between common hydrophilic contaminants and a commercially available sorbent, highlighting how computational chemistry can potentially reduce time and financial costs, generate new data on the fundamental interactions taking place and potentially contribute to the design of more efficient separation media.

Chemical monitoring during flood in an ultramafic watershed (Koniambo Massif New Caledonia)

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Theme - Environmental analysis and monitoring

ABSTRACT

In tropical climate, the regolith of ultramafic rocks (peridotites, serpentinites) can show high concentrations of metallic elements such as nickel, cobalt, and chromium. In the Caledonian context, the nickeliferous ore exploitation by quarries or open- mines causes the transport of particles enriched in metallic elements from upstream to surface waters and the lagoon. These sediments mobilization could impact the chemical composition of fresh water on watershed influenced by the mine exploitation. The aim of this study is to characterize the kinetic reactions between total suspended solids (TSS) and water during a flood, through an example of watershed impacted by mines (Koniambo's massif, New-Caledonia). The hydrogeochemical monitoring consists in 15 samples collected manually before, during and after a rainfall event. These samples were analyzed by Inductively Coupled Plasma Mass Spectrometry (ICP-MS). On each sample, 48 elements (major, minor, and traces) were quantified on total and dissolved fractions of each sample. Analysis were completed by chronics of total suspended solids concentrations, temperature, water column, and conductivity. Results allowed to distinguish three classes of chemical elements, by comparison between element and TSS concentrations during the flood: (1) elements strongly correlated with TSS contents, such as Fe, Ni, Co. Their dissolved contents could found their origins in mineral dissolutions; (2) elements with high concentrations beyond maxima TSS contents such as Cr, Cu, Zn that is suppose interactions at the interface solid-liquid more complexes than simple dissolutions; (3) major elements such as Mg, Ca, Si which involve a contribution from groundwaters contamination or a raising of the water table.

Chronic toxicity of ammonia to the tropical freshwater mussel Velesunio spp

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Theme - Emerging ecotoxicological techniques and test methods

ABSTRACT

Ammonia is used during uranium processing at the Ranger mine and is a contaminant of concern due to potential seepage from buried tailings and brines after mine rehabilitation. Freshwater mussels, Velesunio spp., are an important food source for Aboriginal communities living downstream of the mine. International studies have reported that freshwater mussels are sensitive to ammonia, but only limited chronic data are available, while no chronic data exist for tropical species. The site-specific Guideline Values (GVs) for the Ranger mine need to adequately protect this taxonomic group. A chronic 14-d toxicity test was developed for Velesunio spp., and was used to assess the toxicity of ammonia to the juvenile life stage. The parasitic mussel larvae (glochidia) were exposed to a host fish, Mogurnda mogurnda, to produce juvenile mussels. The test protocol involved the addition of fine sediment and a green alga (Chlorella sp.) as a food source. The measurement of shell length at day 0, 8 and 14 was used to determine growth rate as the endpoint. Ammonia exposures were conducted at pH 6.0 and 27.5?C to represent local environmental conditions. Initial chronic toxicity estimates based on growth rate for mussels from two different sites included EC50 values of 6.8 -12.3 mg Total Ammonia Nitrogen (TAN)/L, and EC10 values of 2.7- 3.9 mg TAN/L. These were similar to acute toxicity estimates (LC50 of 9.2, LC10 of 3.4 mg TAN/L) for Velesunio spp. glochidia, which were more sensitive than reported temperate species. Hence, the species-specific Acute-to-Chronic Ratio (ACR) of 2.8 for Velesunio spp. is markedly lower than 15.5, which is reported for the international dataset. These results indicate that juvenile Velesunio spp. may be less sensitive to ammonia than the glochidial stage, and less sensitive than temperate species. Further chronic toxicity estimates will be used to inform site-specific ACRs and GVs and will be useful in revisions of the national default Water Quality Guidelines.

Combining in vitro techniques and non-targeted omics to discover new biomarkers and enhance non-destructive monitoring of adverse effects of contaminants on wildlife

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Theme - Emerging ecotoxicological techniques and test methods

ABSTRACT

Non-destructive biomarkers of exposure and effect are useful tools for overcoming the ethical and practical limitations of conventional toxicity testing on threatened species. However, there are still many challenges that hinder identification of biomarkers of exposure and effect in such species. In this context, methods that do not require the sacrifice of animals are critical, as are rapid and high throughput methods, particularly when considering the continuously changing chemical universe. In contrast to traditional animal toxicity testing, the use of cell lines is high throughput and non-destructive, making it suitable for research on threatened species. Despite the potential for in vitro contaminant toxicity testing for wildlife, the use of cell or tissue cultures for biomarker discovery is marginal or, when used, limited to previously established endpoints. This hinders the discovery of new and potentially more informative biomarkers. In addition, using biomarkers extrapolated from model organisms can be misleading as effects can vary between species. Novel biomarkers can be discovered by non-targeted techniques such non-targeted proteomics that measure the overall proteome response to contaminant exposure.

This study aimed to validate the use of non-targeted proteomics in combination with cell culture for the discovery of new biomarkers in threatened wildlife. The green sea turtle (Chelonia mydas) was used as a model due to its status, accessibility and long life span making it ideal for examining the effects of persistent and accumulative contaminants. Cells cultured from green sea turtles were exposed to contaminants and the global intracellular and membrane-bound proteome was analysed. Differential expression of proteins under exposure conditions indicated pathways potentially affected within this species. Using quantitative methods, we determined the most intensely up or down regulated proteins giving an indication of the most strongly affected pathways after exposure at the cellular level, and identified a few promising biomarkers in this species.

Comparing different passive sampling configurations in monitoring micropollutants in wastewater and the role of biofilms

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Theme - Environmental analysis and monitoring

ABSTRACT

There is an increased interest to monitor micropollutants in municipal wastewater as a means of making inferences about populations. More recently, passive sampling has garnered increasing attention as an alternative to monitor these micropollutants compared to traditional methods. However, conditions in wastewater differ to traditional aqueous matrices such as riverine and marine water and this may result in a lessened role of the water boundary layer and a heightened role of the biofilm as a diffusional layer in controlling micropollutant uptake. The implications of this on the uncertainties in passive sampling and obtaining a representative sample is a research avenue that requires further investigation.

The aim of this study was to evaluate the suitability of passive sampling in monitoring micropollutants in wastewater and whether biofilms may be a source contributing to uncertainty. We compared three different passive sampler configurations exposed to municipal wastewater over a 28-day period. This included a naked Chemcatcher (SDB-RPS sorbent), a PES membrane-covered Chemcatcher and a high-density polyethylene tube with an HLB sorbent. A variety of compound classes were calibrated including pharmaceuticals, pesticides and illicit substances. Differences in the coverage, structure and thickness of biofilms were investigated using optical coherence tomography. The effect of a fouled layer on micropollutant uptake for the two membrane configurations were assessed against unfouled samplers.

Conservative inhalation metal(loid) bioaccessibility (CIMB) method using PM10 and simulated lung fluid (SLF)

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Theme - Human health issues associated with environmental contaminants

ABSTRACT

There is an increasing awareness that inhalation of metal(loid)s in particulate matter with <10 µm diameter (PM10) is a significant exposure pathway in humans. Once inhaled, metal(loid)s in PM10 may dissolve in contact with the lung lining fluid (bioaccessible fraction) and may cross the air-blood barrier and enter the systemic circulation (bioavailable fraction). Therefore, bioaccessibility assessment using simulated lung fluid (SLF) is more germane to exposure assessment than total metal(loid) content of PM10. However, significant differences exist in the experimental parameters currently used, e.g., solid to liquid (S/L) ratio, agitation, extraction time and fluid composition. Furthermore, once the PM10 is cleared from the lungs and is swallowed, metal(loid)s may continue to dissolve in the gastro-intestinal fluids, which has received little attention.

The aim of this study was to optimise an inhalation bioaccessibility protocol by investigating factors affecting metal(loid) dissolution in-vitro at 37°C. To achieve this aim, PM10 from mining/smelting impacted Australian soil from York Peninsula, Port Pirie and Golden Triangle, Victoria was used to investigate the effect of S/L ratio (1:100-1:5000), extraction time (up to 120 hours), agitation (occasional, orbital, magnetic stirring and end over end) and five major SLF compositions. Additionally, PM10 was subjected to simulated gastro-intestinal fluids, following dissolution in SLF. Bioaccessibility of arsenic (As), cadmium (Cd), manganese (Mn) and lead (Pb) were used to develop a conservative inhalation metal(loid) bioaccessibility (CIMB) method.

Results from this study revealed that fluid composition and solid to solution ratio most significantly affected metal(loid) dissolution. Across all three environmental matrices, statistically significant ($p<0.05$) increase in metal(loid) bioaccessibility was observed when PM10 was leached in simulated gastro-intestinal fluid following SLF. The highest cumulative bioaccessibility of As, Cd and Mn was obtained using lung + gastric + intestinal phase, while that of Pb was obtained using lung + gastric phase.

Coral reef ecotoxicology in a changing climate

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Theme - Toxicity of mixtures and multiple stressors

ABSTRACT

Coral reefs are in decline due to multiple global (increasing temperature and pCO2 concentrations) and local stressors (pollution, crown of thorns seastars, weather events) that act simultaneously or sequentially. To help mitigate the impacts of a changing climate on the long term viability of coral reef ecosystems, management agencies need to understand how additional stressors affect the sensitivity of key species, such as corals and seagrass. Moreover, water quality guidelines for contaminants are normally developed from toxicity tests conducted under benign conditions, and the sensitivity of these habitat-forming species may change under future climate scenarios. Here we present a range of examples for quantifying and interpreting the impacts of simultaneous and sequential stressors, including climate, petroleum hydrocarbons, pesticides, nutrients and turbidity on the health of corals and seagrass. While there are exceptions where one stressor may ameliorate the impacts of another, the results from our studies generally indicate that the combined impacts of multiple pressures exacerbate negative outcomes for corals and seagrass.

Cumulative Ecological Risk Assessment for the Rehabilitation of the Ranger Uranium Mine

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Theme - Environmental analysis and monitoring

ABSTRACT

The Ranger Uranium Mine is surrounded by the World Heritage/Ramsar-listed Kakadu National Park. The mining of ore ceased in 2012, with milling of ore due to cease by 2021. Progressive rehabilitation of the site is already underway and scheduled to be completed by 2026. A screening-level Ecological Risk Assessment (ERA) has been conducted to identify the key risks to successful rehabilitation of the site, and the knowledge gaps to be addressed for both the decommissioning and post-decommissioning phases. For the post-decommissioning phase, eight risks were classified as critical, 41 as high risk, 30 as medium risk and 17 as low risk. However, these risks were assessed in isolation from each other, whereas stressors typically co-occur in the environment, with the potential to intereact. Consequently, the next logical phase of the risk assessment was to characterise the cumulative risks of multiple stressors including their interactions, with a focus on the critical and high risks, whilst also addressing the lower ranked risks.

To quantify and predict individual and cumulative ecological risks associated with each major component of the rehabilitation process, the conceptual modelling and risk screening phases of the ERA were subjected to advanced qualitative graphical modelling techniques to assess uncertainty in the structure, as well as interactions between key variables of system models. Initially, the key interactions between revegetation, landform and contaminants on the mine-site were assessed. An extensive catalogue of data was used for quantitative modelling of the identified interacting risks using Bayesian Belief Networks. The cumulative quantitative modelling provides a sound knowledge of ecological processes and interactions, and exposure and effects data relevant to ecological assessment and measurement endpoints ascertained in the early phases of the ERA process. This modelling will determine whether the moderate and low risks become high risks due to interactions with other stressors.

Cumulative impacts: thermally bleached corals have reduced capacity to clear deposited sediment

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Theme - Toxicity of mixtures and multiple stressors

ABSTRACT

The interaction between local anthropogenic pressures, and larger scale regional/global pressures, is often used to explain the current poor condition of many corals reefs. This form of cumulative pressure is clearly manifested by situations where dredging projects happen to coincide with marine heatwaves that cause coral bleaching. A key stressor associated with dredging is elevated sedimentation. In this study, 3 coral species (Acropora millepora, Porites spp. and Turbinaria reniformis), representing three common morphologies (branching, massive and foliose respectively), were experimentally induced to bleach by exposure to a temperature of 31°C for 21 d. The corals were then subjected to a range of sedimentation rates (0, 11, 22 and 40 mg cm-2 d-1), and their sediment-rejection ability quantified after 1 and 7 successive sediment deposition events. Repeated deposition resulted in a ~3-fold increase in the amount of sediment remaining on the corals. Bleached corals were less capable of removing sediments from their surfaces, accumulating 3- to 4-fold more sediment than normally-pigmented corals. The reduction in coral's ability to clear sediments by 10% and 50% (EC10 and EC50 respectively) were calculated after 1 and 7 deposition events. Bleached A. millepora exhibited the lowest threshold for sediment rejection EC10 = 5 ± 4 mg cm-2 d-1 after 7 successive depositions. These results suggest that adaptive management practices could be developed to reduce the impacts of future dredging projects that follow or coincide with elevated sea surface temperatures and coral bleaching events.

Depuration of perfluoroalkyl substances from the edible tissues of wild-caught invertebrate and fish species

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Theme - Per- and poly-fluorinated alkyl substances (PFAS): fate and effects

ABSTRACT

Occurrence of poly- and perfluoroalkyl substances (PFASs) in aquatic organisms has been widely documented. Depuration can remove PFASs from tissues of some species when removed from the contaminant source, but little is known about depuration rates for individual species. Such information is important for understanding how temporally variable PFAS concentrations in water might affect concentrations in biota, or conversely, how concentrations may vary in migratory species as they move away from a contaminated water body.

We present the results of a depuration trial for School Prawn (M. macleayi), Mud Crab (S. serrata), and Dusky Flathead (P. fuscus), three commercially important species in Australia. Perfluorooctane sulfonate (PFOS), and perfluorohexane sulfonate (PFHxS) were present in samples of tissue from all three species collected following exposure under natural conditions in contaminated estuaries. Perfluorooctanoic acid (PFOA) was detected at levels close to the Limit of Reporting (LOR) in the crustacean species and was below LOR in all Flathead samples.

Depuration was tested in uncontaminated water for a minimum of 33 days. PFOA was not detected after 4.5h and 72h in School Prawn and Mud Crab respectively. PFHxS was rapidly depurated by School Prawn, and had a depuration half-life of 5.7h. PFOS was depurated by School Prawn slower than PFHxS, with a depuration half-life of 158.5h. PFHxS and PFOS concentrations were highly variable in Mud Crab both at the start, and during the depuration experiment, and a depuration model could not be fitted to the data. Similarly for Flathead, PFOS concentrations were highly variable and a depuration model could not be fitted. For School Prawn, depuration of PFOS and PFHxS to the relevant screening value for protection of human health (5.2 µg/kg) occurred in <10h. Rapid depuration of PFASs in School Prawn indicates that human health risks associated with consumption may decrease as this species migrates away from the contamination source. Additional experiments are being conducted with Mud Crab using a paired sampling design to account for variability.

Design and Use of Environmental Report Cards

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Theme - Environmental analysis and monitoring

ABSTRACT

Environmental report cards are communication tools that enable synthesis of complex information from multiple sources to provide an overall score for ecosystem health. Since the 1990s, report cards have become an increasingly popular way to present on-going environmental monitoring data as an easily understood snapshot of progress (or lack of) towards specific ecosystem protection goals. They can be used to identify particular issues and regions of concern, to enable adaptive management. Each report card has its own features and approaches related to the type of ecosystem, the goal and values identified by stakeholders, the geographic scale, and the availability of monitoring data and benchmarks. While most report cards focus on the biophysical components of the system, there is a growing interest in including the social, cultural and economic implications of ecosystem management, to provide a greater social-ecological system understanding e.g. The Gladstone Healthy Harbour Partnership Report Card.

Ecotoxicological testing is an important tool that so far has not been utilised as an environmental indicator within report cards. Such tests hold promise for future report card development for the mining industry in particular, as they integrate the effects of multiple stressors and directly link physico-chemical changes to potential impacts on biota.

Using several case studies from Queensland, India and Papua New Guinea, a new report card framework will be discussed to illustrate recent advances in ecosystem health assessment and communication.

Key words

report cards, ecosystem health, indicators, monitoring

Determining the toxicity of nickel in whole-sediment to tropical marine biota: test development and sensitivity

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Theme - Emerging ecotoxicological techniques and test methods

ABSTRACT

The South East Asia and Melanesia (SEAM) region has extensive lateritic nickel ore deposits which has led to this tropical region becoming the dominant contributor to global nickel production. Predicting adverse impacts of nickel production on tropical marine benthic communities relies on identifying threshold effect concentrations as part of a robust environmental risk assessment. Threshold data for metal contaminants can be derived from either controlled, laboratory-based studies (exposure studies) or from field data. No such data have been published for the effect of nickel in sediment on tropical marine benthic species relevant to the SEAM region. The current project aims to provide both laboratory-based toxicity data and field community-based data on the impacts of nickel production relevant to SEAM/tropical marine species. Chronic sediment bioassays are being developed for two SEAM relevant species of benthic marine organisms: the tropical strain of the diatom Ceratoneis closterium and the burrowing whelk, Nassarius dorsatus. The bioassay for C. closterium involves optimisation of the recently developed chlorophyll extraction bioassay for the temperate strain of this species. The bioassay for N. dorsatus is investigating the sensitivity of behavioural endpoints to nickel over 21 days. In addition, a field study of Vavouto Bay, New Caledonia, has been undertaken to examine changes in benthic community composition along a nickel contamination gradient resulting from nickel mining in the surrounding catchment. This involves the application of molecular-based techniques and multivariate statistical approaches to separate multiple environmental stressor impacts from nickel contamination impacts on biota. Collectively these data will provide much needed nickel toxicity data from sediment exposure for tropical marine organisms to support sustainable development of nickel mining in the SEAM region.

Developing Predicted No Effect Concentrations for Nickel in South East Asia and Melanesia

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Theme - Metal toxicity and environmental chemistry

ABSTRACT

Freshwater chronic ecotoxicity data for nickel are available for species from temperate, tropical and South East Asia and Melanesia (SEAM) regions. In order to derive a predicted no effect concentration (PNEC) relevant to all these respective regions it is important to be able to establish whether there is any demonstrable difference in the relative sensitivities of the species tested in each regional dataset.

The temperate ecotoxicity dataset for freshwaters is extensive, whereas the tropical and SEAM datasets are very limited. Comparisons of toxicity values for taxonomic groups represented in all three datasets show no consistent differences in sensitivity to nickel exposure for any specific region.

Comparisons between the sensitivity of tropical species with related temperate species from the same genus suggest that the sensitivity of these closely related species is very similar. It has not been possible to normalise all the data to specific water chemistry conditions due to the absence of appropriate chemistry data in the tests. Some species, already included in the temperate ecotoxicity database, have also been identified as being of relevance to the tropical (11 species) and SEAM (eight species) regions. Both of these lines of evidence suggest that it is not necessary to make a distinction between temperate and tropical freshwater species in terms of their sensitivity to nickel toxicity.

In this presentation we will present an approach to derive regionally relevant PNECs for nickel in freshwaters that attempts to use all the reliable ecotoxicity data.

Development of a National Strategy to manage Emerging Organic Contaminants in New Zealand

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Theme - Environmental management

ABSTRACT

NZ regulators and Maori are increasingly voicing concern about the risks of Emerging Organic Contaminants (EOCs) entering our environment and the knowledge gaps that prevent assessment of their impacts. EOCs are seldom regulated as their effects can be subtle and expressed over a long period. This is further compounded by a lack of organisational coordination and cohesive allocation of resources to address EOC issues within New Zealand. We anticipate that a National Strategy will mitigate these issues and ultimately minimise the risk EOCs pose to our unique ecosystems and native species and protect our water resources which are paramount to our primary industry based economy. In the process of developing this National Strategy enduring partnerships have been created between NZ scientists, regulators and policy makers and world-class international EOC research groups. Workshops facilitated discussions to identify the steps and requirements for inclusion into a National Strategy to manage EOCs in New Zealand. An independent National Advisory Panel on EOCs has been formed to provide a platform to engage Maori and the wider community to promote changes in national policy that will influence pollutant monitoring plans at the regional level and connect with international groups. This panel comprises of environmental experts with experience in designing and implementing strategy and policy from Regional Councils, MfE, MPI, EPA, DoC, industry and the EPA's Maori Advisory Committee. Aspects of the development of an Australasian directive to manage EOCs will also be covered.

Development of Raman spectroscopy based methods for the detection of environmental pollutants

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Theme - Environmental analysis and monitoring

ABSTRACT

Environmental pollution is usually monitored via mass spectrometry based approaches. Such techniques are sensitive and but have several disadvantages. The instruments themselves are expensive, require specialized training to use and cannot be taken into the field, while samples require extensive pre-treatment and processing prior to analysis. The development of analytical methods that matched the sensitively of mass spectrometry but could be deployed in the field and require minimal sample processing would be advantages for environmental monitoring. One possible method that may meet these criteria is Surface Enhances Raman Spectroscopy (SERS), a surface-sensitive technique that enhances Raman scattering by molecules adsorbed on rough metal surfaces or by nanostructures such gold or silver nanoparticles. SERS gives selective spectral enhancement such that increases in sensitivity of 1010 to 1011 have been reported. While this, theoretically, means SERS is capable of single molecule detection such a signal enhancement is hard to achieve in practise the signal enhancements achieved with minimal sample processing still show great promise in a variety of areas.

In this study, we demonstrate the development of SERS methodology for the detection of pharmaceuticals in aquatic systems. Gold citrate was used as the SERS substrate, with detection in the part per million range for a range of pharmaceuticals being achieved with minimal optimization. Subsequent improvements to the method that will be discussed include changing the sample preparation method (e.g. the use of multiple film layering and incubation), modifying the structure of the SERS substrates to be of a uniform shape (such as cuboid, hexagram, and dodecahedral), and using alternative SERS substrates. The results were then used determine which combination of factors would result in the highest degree of SERS sensitivity for a particular compound of interest. Our results show that SERS shows great promise for the detection of pollutants at environmentally relevant concentrations and as such has great potential in environmental science.

Dietary bioaccumulation of per-and polyfluorinated alkyl substances (PFAS) in a small estuarine fish, the blue spot goby (Pseudogobius sp.)

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Theme - Per- and poly-fluorinated alkyl substances (PFAS): fate and effects

ABSTRACT

Per- and poly-fluoroalkyl substances (PFAS) are an emerging group of man-made pollutants that are ubiquitously distributed throughout the environment. International studies indicate that PFAS may bioaccumulate and cause adverse health effects in animals, yet to date there is very limited information on impacts to Australian fauna. The route of exposure (i.e. via food or water) is important in determining accumulation rates so in this study we have focused on the dietary route only.

Bioaccumulation (21 days) and depuration (42 days) were assessed in blue spot gobies (Pseudogobius sp.) that were fed a diet contaminated with a mixture of relevant PFAS compounds (PFOS: C8HF17SO3, PFOA: C8HF15O2 and the PFOA replacement GenX (HPFO-DA):C6HF11O3) at an environmentally relevant concentration. Whole fish homogenates were analysed to determine bioaccumulation rates and the results of these analyses will be discussed.

Dissolved organic carbon composition differs between different Australian freshwaters and climatic regions

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Theme - The role of natural organic matter in environmental toxicology and chemistry

ABSTRACT

Dissolved organic carbon (DOC) plays an important role in environmental toxicology and chemistry of aquatic ecosystems, and this driven by both the type and concentration of the DOC present. In particular, recent studies have shown that differences in DOC composition within freshwaters can lead to differences in the toxicity and bioavailability of metal contaminants. The composition of the DOC depends on the source of the organic carbon to the aquatic environments, and as such is often defined as: allochthonous (terrestrially-derived), autochthonous (microbially-derived).

This study collected and characterised DOC from various climatic regions and freshwater types (circumneutral; naturally acidic; lentic and lotic) around Australia to investigate differences in DOC composition among freshwaters. DOC was characterised using optical methods: absorbance and fluorescence spectroscopy.

Excitation emission scans followed by parallel factor analysis (PARAFAC) showed that Australian DOC was characterised by three main components: protein-like, fulvic-like and humic-like compounds. DOC quality varied between circumneutral and naturally acidic waters, and circumneutral waters were further categorised by climatic zones (temperate versus tropical). There was no observed difference in DOC quality between lentic and lotic systems during this season. Naturally acidic sites were dominated by aromatic (as indicated by the specific absorbance co-efficients at 340 nm: SAC340 (32 - 53 cm2 mg-1) and at 254nm: SUVA254 (3.9 - 5.8 mg C-1 m-1)) allochthonous humic-like DOC of high molecular weight (as indicated by abs254/365 (3.6 - 4.2)). In contrast, the circumneutral waters were dominated by more autochthonous fulvic-like DOC of lower aromaticity and molecular weight (SAC340: 4 - 20 cm2 mg-1 and SUVA254: 0.8 – 2.9 mg C-1 m-1; abs254/365: 4.9 – 7.8). Tropical circumneutral sites were characterised by DOC higher in protein-like components, with lower aromaticity and molecular weight than DOC from circumneutral temperate sites. These results have important implications for the bioavailability of metals within Australian freshwaters.

Do microplastics pose a risk to soil ecology? Microplastics, sorbed pollutants and earthworms

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Theme - Bioavailability and toxicity of organic and emerging chemicals

ABSTRACT

Exfoliating polyethylene microbeads derived from personal care products are introduced to waste water treatment plants (WWTP) following use. As they pass through the WWTP process, and once in the environment, persistent organic pollutants (POPs) adsorb to the microbeads surface and concentrate by factors of 1,000,000 or more from the surrounding environment. Recently it has been determined that the majority of microbeads will partition into the sludge layer through the WWTP process and this poses an issue for biosolids reuse programs. However, very little is known about the ecological impact in the terrestrial environment.

The aim of this study was to assess the potential of microbeads to leach sorbed pollutants to exposed earthworms in the terrestrial environment. Two laboratory experiments were completed that exposed the epigeic earthworm species Eisenia fetida and Eisenia andrei to microbeads extracted from a commercially available personal care product sorbed with polybrominated diphenyl ethers (PBDEs). 500 g of OECD recommended artificial soil with 14 earthworms and 0.25 g of spiked microbeads for experiment one. In the second experiment, two spiked microbead concentrations of 0.25 g and 0.5 g were used.

Earthworm uptake for the lower brominated PBDE congeners including BDE 28, BDE 47, BDE 100, BDE 99, BDE 154 and BDE 153, was found to be statistically significant ($p < 0.05$) when compared to the experimental controls in both exposure experiments. To the authors knowledge this is the first observed uptake of PBDEs adsorbed to plastics in earthworms. The lower brominated congener uptake resembled trends that had been observed in previous earthworm studies examining PBDE contamination of European and North American biosolid amended agricultural fields. These findings highlight the need for a greater understanding of the ecological impact of microbeads in biosolids.

Dynamics of metallothionein induction in the freshwater shrimp Paratya australiensis exposed to continuous or pulsed metal mixtures

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Theme - Metal toxicity and environmental chemistry

ABSTRACT

The use of metallothioneins as biomarkers of metal exposure is described in numerous crustaceans, but there are limited studies available on the dynamics of metallothionein induction in Australian native species. Recently we sequenced the protein-coding transcriptome of the freshwater shrimp Paratya australiensis and identified two putative metallothionein sequences, designated MTa and MTb. The aim of the present study was to determine the inducibility of MTa and MTb in response to a mixture of dissolved metals. We exposed P. australiensis to a mixture of zinc, copper, cadmium and lead under two exposure regimes – continuous exposure for ten days with each metal at the ANZECC/ARMCANZ water quality guideline values for 95% freshwater ecosystem protection (WQGV), or a pulsed exposure comprising two 24-hour pulses at five times the WQGV over a total of ten days – representing equivalent time-averaged exposure concentrations. Metal concentrations determined using ICP-MS were found to be similar to nominal concentrations. Transcript levels for the two genes were determined in whole body at various time points during the exposure. Pulsed exposure for 24 h at 5 × WQGV did not result in significantly elevated transcript levels for either MTa or MTb immediately, but transcripts were upregulated by a factor of 2.4- or 3.6-fold, respectively, after a 72 h recovery period. A second 24 h pulse at the same concentration did not induce transcript levels of either gene and neither transcript was altered at the conclusion of the pulsed exposure regime. Body burden analysis was in progress at the time of submission and may help to explain the observed changes in transcript abundance in response to pulsed exposures. After 10 d continuous exposure at the WQGV, MTa transcript levels were significantly upregulated by a factor of 2.1, while MTb transcript levels were downregulated by a factor of one-third relative to controls. This study demonstrates that P. australiensis metallothioneins are inducible by exposure to dissolved metals but that the dynamics of induction vary with the exposure regime.

Eco-friendly keratin extraction from waste chicken feathers

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Theme - Bioavailability and toxicity of organic and emerging chemicals

ABSTRACT

Keratin protein is a versatile, natural biopolymer that is biodegradable, biocompatible and non-toxic. It can be used in numerous applications such as membrane technology, biomedical engineering, cosmetic products, functional textiles and composite materials. Currently, millions of tons of feathers, which are an excellent source of keratin, are generated annually as waste by the poultry industry worldwide. The amount of this waste is increasing concomitantly with increases in chicken and turkey production. Feather waste poses an environmentally difficult disposal problem and is currently either incinerated or sent to landfill. Therefore, from an economic and environmental viewpoint it is both desirable and important to develop effective processes to transform feathers from a costly waste product to a potentially profitable resource.

Keratin is a tough material due to a range of covalent and non-covalent interactions that must be broken down prior to its reuse. This is currently achieved using large quantities of reductive or oxidative agents such as thiols and peroxides. These cannot be recycled and are often toxic. Hydrolysis is an attractive, simple and eco-friendly alternative processing method to dissolve feather keratin with relatively mild treatment conditions and which preserves the functional properties of the keratin.

In this study a new, environmentally sustainable, methodology to dissolve feathers using L cysteine as the reducing agent has been developed. The structures and properties of keratin based materials created using this process were characterised using gel electrophoresis, liquid chromatography-mass spectrometry, vibrational spectroscopic analysis, solid-state nuclear magnetic resonance, and thermogravimetry analysis.

The results show that the new method is innovative, effective, safe and easy to implement and, could form the basis of a new approach to reduce feather waste in an environmentally sustainable manner. Such methods enable Keratin biopolymers to form renewable, sustainable and eco-efficient products that can compete and capture the current ecologically destructive processes.

Ecolabelled Floorcovering and Supply Chain Trends

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Theme - Life cycle assessment

ABSTRACT

The paper compares Life Cycle Analysis (LCA) of Australian, Asian, European and American made floorcovering for 20 years use. Cradle to grave studies were for third party certified ecolabels and ISO 14025 compliant Environmental Product Declarations. They conform to their product category rules and the same Life Cycle Inventory and Impact Assessment method.

Ecolabelling requires modelling of best available, business as usual and worst case technology. Also increasing reliance on renewable and post consumer content requires particular attention to track and certify sources.

The authors present findings for interior carpet, linoleum, vinyl, ceramic tile, laminated veneer and timber LCA since 2010. Results were compared from supply chains where cradle to cradle, biogenic, synthetic, post consumer and post industrial content and reusable and recyclable shares ranged from zero to maximum influence.

Considering environmental health, minor components are increasingly significant. Collectively such pigments, dyes, fibres, foams, binders, backing, soaps and additives can have significant outcomes in ecolabelling which differentiates product sustainability attributes to >4 levels. Results are also sensitive to additives for viscosity, sheen as well as mould, slip, water, stain, dirt and flame resistance.

Detailed scenario development is also required for floorcovering installation, cleaning, maintenance, disposal and reuse operations over building life. For installation manufacturers increasingly specify low VOC glues to safeguard occupant health. Low tack adhesives enable disassembly and re-use to facilitate industry take-back schemes. To reduce cleaning overheads, design for ease of maintenance means surface treatment and coatings are increasingly important.

Design for reuse has also increased modular options and the range of probable end of life of fates. Further increasing the variety of fates is demand for post consumer recycled feedstock for a range of renewal and remanufacturing operations cradle to cradle.

Ecologically Relevant Pesticide Targets for the Reef Water Quality Protection Plan 2017

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Theme - Environmental management

ABSTRACT

The revised pesticide targets for Reef Water Quality Protection Plan (Reef Plan) 2017 have been developed to ensure a direct and relevant relationship with the long term goal of Reef Plan 2013: "ensure that by 2020 the quality of water entering the reef from broadscale land use has no detrimental impact on the health and resilience of the Great Barrier Reef" (DPC 2013). Second to this, the targets were developed to align with the Queensland Environmental Protection (Water) Policy 2009 and the National Water Quality Management Strategy. The process for setting the pesticide targets involved: (1) Defining the spatial boundaries of the water bodies that contribute to the health and resilience of the Great Barrier Reef; (2) Determining the environmental values of water bodies to protect and conserve the Great Barrier Reef Marine Park and World Heritage Area; and, (3) Determining the corresponding aquatic species protection level consistent with the environmental values of the water bodies. The resulting pesticide target was accordingly set: "To protect at least 99 per cent of aquatic species at the end of catchments". This target was relevant to all pesticides detected across the 35 Queensland reef basins, and annual reporting was necessary to demonstrate the progress of water quality improvement (through improved agriculture best management practice) towards the target. Consequently, the methods to measure the progress towards achieving the targets required: (1) a method for calculating the annual ecological risk of pesticide mixtures; and, (2) daily monitored or modelled pesticide concentrations measured at the end of catchments from 35 basins. Here we present the historical development and setting of the Reef Plan 2017 ecologically relevant pesticide targets and the methods developed to measure the progress of water quality improvement to achieve the targets.

Key Words

Pesticides, targets, Great Barrier Reef, Reef Water Quality Protection Plan, ecological risk.

Effects of Herbicide Degradation Products on Growth and Photosynthetic Efficiency in a Benthic Jellyfish

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Theme - Marine Ecotoxicology and Chemistry

ABSTRACT

Photosystem II (PSII) herbicides are persistent in marine water with half-lives in excess of 100 days in simulated experiments. These herbicides also persist in tropical coastal systems year-round, raising the possibility that coastal habitats may also be chronically exposed to herbicide degradation products. Despite this likelihood, there is little understanding of the toxicity of PSII herbicide degradation products, which may be more toxic than their parent compounds and/or contribute to the overall toxicity of the coastal water.

To assess the toxicity of the PSII herbicides diuron and hexazinone including their degradation products, the symbiotic benthic jellyfish Cassiopea maremetens was exposed to either fresh or degraded herbicides for six days. The exposure effects on photosynthetic efficiency (effective quantum yield) of symbionts, symbiont density, and jellyfish growth were assessed.

There were contrasting effects on both the symbiont and host following exposure to the fresh and degraded herbicides. Photosynthetic efficiency of the symbionts was significantly decreased by exposure to all herbicide products; however, there were contrasting effects on yield between fresh and degraded diuron compared to fresh and degraded hexazinone exposure. Aged diuron (EC50=0.49 µg/L) affected photosynthetic efficiency more than fresh diuron (EC50=1.35 µg/L). The difference in toxicity between aged and fresh hexazinone was not as pronounced with the EC50 for fresh hexazinone 18.7 µg/L and aged hexazinone 24.3 µg/L. The effects of herbicide exposure on the host jellyfish growth were more equivocal but could potentially be explained by their capacity to switch the balance between phototrophic and heterotrophic energy sources in the presence of herbicides.

The outcomes of this study suggest there is the potential for degradation products from some PSII herbicides to be more toxic to marine biota than the parent compound. Accordingly, it may be necessary to consider the contribution of degradation products along with the parent herbicide compounds when setting protection criteria for high value marine systems.

Effects of nickel and copper on tropical marine and freshwater microalgae: investigating different isolates and multispecies bioassays

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Theme - Marine Ecotoxicology and Chemistry

ABSTRACT

Increasing demands for metal resources and the expansion of mining in tropical regions increases the need for environmentally relevant water quality guideline values (WQGVs) as risk assessment tools. The development of WQGVs for tropical regions is hindered due to limited ecotoxicity data with relevant species and uncertainty around applying temperate data to tropical aquatic ecosystems due to their vast differences in climate, geochemistry and the evolutionary distinct biota. In this study, we compared the sensitivity of tropical marine and freshwater microalgae to Cu and Ni.

The species tested included two marine species, Isochrysis galbana and a tropical and temperate isolate of Ceratoneis closterium (Coral Sea and Port Hacking, Sydney, respectively). Freshwater species included Chlorella sp. and Monoraphidium arcuatum tested as single species, together with a novel multispecies test utilising Pediastrum duplex meyen, Nannochloropsis-like sp. and M. arcuatum. Chronic growth rate inhibition bioassays were carried out in natural seawater or synthetic soft water with nutrients (NO3- and PO43-) and Ni or Cu. Algae were washed, inoculated (103 cells/mL) into test flasks and incubated at 27°C (tropical) or 21°C (temperate). Algal growth rates were determined over 72 h. Total and dissolved metal concentrations were also measured.

Both marine and freshwater algae were less sensitive to Ni than Cu. The tropical freshwater microalga Chlorella sp. was the most sensitive to Ni, with growth rate inhibited by 10% (IC10) at 24 µg/L. Tropical marine microalgae were less sensitive to Ni (IC10s of 330 (I. galbana) and 2540?2990 µg/L (C. closterium)) with the temperate isolate of C. closterium eight times more sensitive (IC10: 310 µg/L) than the tropical isolate. In contrast, Cu toxicity to marine tropical and temperate microalgae was similar (IC10: 0.9?2.2 µg/L). In freshwater multispecies bioassays, Nannochloropsis-like sp. was the most sensitive species to Ni (IC10: 21 µg/L) and the least sensitive to Cu (IC10: 13 µg/L). This study demonstrates the importance of using ecologically relevant species for WQGV development.

Environmental exposure to asbestiform minerals: A multidisciplinary approach to the hazard evaluation

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Theme - Human health issues associated with environmental contaminants

ABSTRACT

Occupational exposure to asbestos has been related to the development of lung and pleural diseases including asbestosis, lung cancer and malignant mesothelioma. Cases of mesothelioma have also been described in individuals exposed to naturally occurring asbestos or asbestos-like minerals in Turkey, Greece, Cyprus, Corsica, Sicily (Italy) and New Caledonia. Therefore, in recent years, the awareness of possible health hazards related to environmental exposure to asbestos and asbestiform minerals has been increasing.

New Caledonia is covered by more than a third of its surface with ultramafic rocks, mainly peridotites and serpentinites. The presence of asbestiform minerals in the New Caledonian quarries has been clearly established and included amphiboles but also hydrated serpentines (antigorite, chrysotile). The fibers can be released in the environment following weathering of asbestos-bearing rocks and/or human activities on asbestos-rich soil. This make environmental asbestos a major public health problem for New Caledonia. A particular interest has been given to antigorite, a fibrous mineral largely present in the Caledonian territory.

To assess the health risk posed by antigorite, a multidisciplinary project supported by the Centre National de Recherche Technologique (CNRT-Nickel et environnement) has been carried out with the aim of characterizing the physico-chemical properties of the fibers and evaluating their toxicity profile. We have examined, by means of cell-free tests, two surface properties of the fibers regarded by the scientific community as relevant to mediate pathogenicity: potential to release free radicals and selective release of iron ions in the presence of endogenous chelators. Fiber dissolution in simulated body fluids was also measured. We have then examined in human epithelial cells and in murine macrophages the following effects: i) cytotoxicity; ii) induction of oxidative stress; iii) induction of NO synthesis; iv) genotoxicity. The results have been compared with those obtained with an Italian sample of antigorite and with chrysotile, a serpentine asbestos with well-known toxicity.

Establishment of marine wildlife cell cultures for toxicity testing

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Theme - Emerging ecotoxicological techniques and test methods

ABSTRACT

Globally, chemical contaminants are accumulating in marine wildlife such as whales, dolphins and turtles. However, we know very little about the effects of contaminants in these animals, mainly due to the ethical and logistical restrictions of conducting whole animal toxicity testing on these large animals of high conservation significance. Cell-based (in vitro) bioassays can provide an ethical and cost effective alternative for assessing the effects of chemicals in marine wildlife. However, to date, their application to understanding the health of marine wildlife has been limited, largely driven by the lack of available cell lines for these species. The establishment of marine wildlife cell cultures is therefore an important step in developing the tools for toxicological research in these animals. Here we present methods for establishing cell cultures from marine wildlife using the explant method, as well as more sophisticated methods adapted from the field of medicine for establishing more metabolically active cells such as liver hepatocytes. We also present details on how to characterise the species of origin and cell type (epithelial, fibroblast, etc), how to monitor for bacterial contamination, and cryopreservation techniques. Using these methods, we have established cell cultures from a range of marine wildlife species (whales, dolphins and turtles) and tissue types (skin, liver kidney, brain, etc). These cell cultures provide the basis for in vitro bioassays that can measure the effects of contaminants, using endpoints such as cytotoxicity, oxidative stress, endocrine modulation and DNA damage. The establishment and validation of marine wildlife cell cultures will facilitate species-specific understanding of the impacts of contaminants in these animals, as well as provide important tools for other areas of research including pharmacology, microbiology and virology. This will enhance management and conservation of marine wildlife in Australia, and provide a platform for the international scientific community to research these often-threatened animals.

Examination of Transformation/Dissolution Characteristics of Nickel Lateritic Ores for Aquatic Hazard Classification and Risk Assessment

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Theme - Metal toxicity and environmental chemistry

ABSTRACT

Nickel laterite (oxide) ore deposits are increasingly important sources of nickel for the global marketplace. Until recently, the world's nickel supply was mined predominantly from sulfidic ore bodies, but increasing global nickel demand has necessitated expansion to processing of nickel laterite ores. The process of extraction and transport of metal ores may increase metal exposures to the often sensitive and diverse ecosystems where laterite ores are mined. The impacts of processing laterite ore bodies should be assessed for potential risks and hazard to these environments. State-of-the-science approaches for metals hazard and risk assessment have been developed for use in many jurisdictions; however, direct application of these data and risk assessment approaches to tropical regions, where laterite ores dominate, may not be appropriate without further evaluation due to differences in geochemistry, animal physiology and life history, and the taxonomic composition of endemic ecosystems. Hence, data on the fate, transport, hazard, and ecotoxicity of metals in tropical environments are currently under development.

Screening (24 hour) and full acute (7 day) and chronic (28 day) Transformation/Dissolution (T/D P) studies (OECD 29) were undertaken to determine the reaction kinetics of nine nickel laterite ores to assist in (1) characterizing the regional exposure from nickel operations to improve understanding of the behavior of lateritic ores in the aquatic environment; and (2) to provide data that can be used to determine appropriate classification, handling, and transport of laterite ores.

In general, nickel lateritic ores were less reactive than nickel sulfidic ores, with nickel release over 24-h ranging from 0 to approximately 2% of total nickel in the sample. The results of this study also suggest a difference between the release of metals from limonite (shallower) and saprolite (deeper) ores. These data can be used to further our knowledge of nickel laterite ore fate and behavior and suggest that an aquatic hazard classification under the UN GHS is not warranted for nickel laterite ores.

Extreme water quality events: Changes in organic matter profiles and impacts on other water quality parameters

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Theme - The role of natural organic matter in environmental toxicology and chemistry

ABSTRACT

The southern Murray-Darling Basin experienced two extreme water quality events in 2016- a bloom of the cyanobacteria Chrysosporum ovalisporum in late summer and throughout autumn and then extensive flooding in spring and early summer that resulted in widespread hypoxic blackwater (high dissolved organic carbon, low dissolved oxygen). The Edward Wakool river system is a major anabranch network of the Murray River, and has been a site for environmental water short-term and long term intervention monitoring projects since 2010. This river system is located in the mid-Murray and the catchment includes agricultural and urban land uses as well as floodplain forests and wetlands and so has potential for highly variable carbon inputs. This system was studied extensively during the cyanobacterial bloom and hypoxic blackwater events and the results compared to the baseline conditions within the system. Dissolved organic carbon (DOC) concentrations were altered substantially during both events increasing from an average of 4 mg/L baseline over previous years up to 11 mg/L during the algal bloom and over 20 mg/L during the hypoxic blackwater event. The composition was monitored using UV-visible spectroscopy and Excitation-Emission Fluorescence Matrices (EEMs). Comparison of the changes to DOC and the spectral properties revealed considerable shifts in the organic matter profile of the river system during these events. Dissolved oxygen, nutrient and basic water quality parameters were also impacted and reveal a complex interaction between floodplain connectivity, sources and quantities of DOC, timing of inputs and the changes to other water quality parameters. The release of environmental water having lower DOC and higher DO from irrigation canals to the river during the hypoxic blackwater event resulted in local improvement in conditions, mitigating the severity of this adverse water quality event.

Fingerprinting the effects of individual micropollutants in a bioanalytical test battery developed for water quality monitoring

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Theme - Bioavailability and toxicity of organic and emerging chemicals

ABSTRACT

There is increasing interest in applying bioassays for water quality monitoring. However, information about the effects of individual micropollutants in bioassays, such as pharmaceuticals, pesticides and industrial compounds, as well as their contribution to the overall mixture effect in a sample, is often limited. In the current study, a bioanalytical test battery with both cell-based and whole organism assays was applied to fingerprint the effects of 34 micropollutants, which were selected based on their environmental presence, hazard quotients and mode of action. The bioassays were selected to cover different steps of the cellular toxicity pathway, such as induction of xenobiotic metabolism and receptor-mediated effects, as well as both specific and apical effects in whole organisms. All studied chemicals were active in at least one assay, with the industrial compound bisphenol A active in 70% of the applied assays. While many more chemicals were active in assays indicative of apical effects, the chemicals that had a response in the specific assays typically triggered an effect at much lower concentrations. The generated effect data were applied to existing mixture toxicity modelling of water samples to determine if and how the studied chemicals contributed to the biological effect. A slight increase in the fraction of the effect could be explained by detected chemicals. However, the fraction explained was still less than 1% for some assays, which suggests that many more chemicals contribute to the effect than those that are typically monitored by chemical analysis. This emphasises the need for a complementary approach of chemical analysis and bioanalysis for water quality monitoring.

From sediment chemical status to risk evaluation in the context of the Water Framework Directive using different Lines of Evidences: biology, chemistry and ecotoxicology

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Theme - Marine Ecotoxicology and Chemistry

ABSTRACT

In the framework of the Basque Water Quality Monitoring Network (WQMN), physico-chemical (contaminants in water, sediment, and biota) and biological elements (phytoplankton, macroalgae, benthos, and fishes) are analised in coastal and estuarine water bodies. These data, obtained since 2002, are used in the ecological and chemical status assessment, according to the European Water Framework Directive (WFD; 2000/60/EC).

The objective of this contribution is to assess the risk associated to contaminants present in those sediments from WQMN with benthic community being classified as Good or High status, but with high levels of contaminants. This assessment will be carried out by integrating different Lines of Evidence (LoE) (biology, chemistry and ecotoxicology) according to the Weight of Evidence (WoE) approach, in the context of the WFD.

A total of 53 sediment samples were obtained from the 12 estuaries of the Basque Country, between 2004 and 2013. Several priority substances (metals and organic compounds) were analysed in surface sediments. The toxicity of sediment samples was established using three toxicity tests: (1) Microtox® or bioluminescence inhibition bioassay; (2) 48-h embryo–larval toxicity test of the sea urchin Paracentrotus lividus; and (3) 10-day survival test, with amphipods of the genus Corophium sp. The multivariate AMBI (M-AMBI) which comprises a range of values from 0 to1 (from bad to high) was used for evaluating the benthic community status (BS)

The results show that most of the sediment samples (98% of the total) did not achieve good chemical status and near 53% of those samples showed toxicity evidence. However, more than 70% of the samples not achieving good chemical status were classified as “high” or “good” BS.

This apparent contradiction between chemical and benthic community status highlights that, for regulatory purposes, decisions should be made based not only on the results of the contamination but also taking into account potential toxicity which provide more comprehensive conclusions.

Further Refinements to the Methods for Deriving Australian and New Zealand Water Quality Guideline Values for Toxicants

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Theme - Environmental management

ABSTRACT

As part of the revision of the Australian and New Zealand water quality guidelines, changes were made to the methods for deriving water quality guideline values (GVs) for toxicants (Warne et al., 2015; Batley et al., 2014). As these were applied to the derivation of new toxicant GVs, a number of issues were encountered that necessitated refinements to the documented methodology. These initially included more prescriptive definitions of what constitute acute and chronic tests for micro- and macroinvertebrates.

A number of examples were seen where the species sensitivity distributions (SSDs) used to derive the GVs spanned more than 4 orders of magnitude in concentration. In some instances, this was the result of a bimodal response, and a test for modality is recommended. In such cases, bioaccumulating chemicals are particularly problematic and the requirement for the use of a more conservative GV (PC99 rather than PC95) meant that the plots were extrapolating to unrealistically low values. This may be at least partly a function of the Burr distribution, since a log logistic distribution gave a more acceptable PC99 value. With bioaccumulating/biomagnifying compounds, the desirability of including multigenerational tests was added.

Small chronic toxicity datasets are a problem, given the need to consider converted acute data. The recommendation was to use a factor of 10 to convert acute LC/EC/IC50 data to chronic NOECs and a factor of 5 from chronic LC/EC/IC50 data to chronic NOECs. A factor of 2 from acute NOECs to chronic NOECs was deemed unreliable and not acceptable. Combining freshwater with marine chronic data is an option provided the toxicity is believed to not be different between the two media, but this lowers the reliability of the derived GV from that using chronic data from one medium only. The derivation of GVs for priority toxicants has allowed the derivation method to be thoroughly road-tested and, accordingly, improved.

Has sediment remediation in Homebush Bay reduced the concentrations of dioxins in fish and prawns from Sydney Harbour, Australia?

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Theme - Environmental analysis and monitoring

ABSTRACT

Historical industrial activities adjacent to Homebush Bay in Sydney Harbour have resulted in sediment contamination, in particular with polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and dioxin-like polychlorinated biphenyls (dl-PCBs). Highly contaminated areas in the Bay were remediated during 2006-10. Prior to this remediation, concentrations of dioxins (PCDDs, PCDFs and dl-PCBs) were measured in fish (Yellowfin Bream and Sea Mullet) and prawns (School Prawn and King Prawn) in the Bay and other locations in Sydney Harbour. The results showed that concentrations of dioxins were above a level considered safe for human consumption of 6 pg TEQ/g (pg dioxin toxicity equivalence per g).

A follow-up study was recently conducted to determine if concentrations of dioxins in fish and prawns had changed following remediation of Homebush Bay. The fish results showed there was no overall change in the concentrations in both species. This may be due to residual contamination in the area or indicate that insufficient time had passed since remediation to result in measurable changes. All fish samples analysed during the follow-up study had dioxin concentrations that were higher than the limit considered safe for human consumption (6 pg TEQ/g).

Dioxin concentrations in prawns showed a decrease when data were considered on a fresh weight basis. In all cases except one, concentrations were marginally lower than the limit considered safe for human consumption (6 pg TEQ/g). For the prawns, however, the lipid contents in the follow-up study were considerably lower than in the initial study. It was assumed this decrease in lipid content may have a limiting effect on the capacity of the prawns to accumulate dioxins. Therefore lipid normalised concentrations were also considered. These data showed no change in dioxin concentration over time. This result suggests that the decrease in concentration on a fresh weight basis may be driven by the observed decrease in lipid content. It is unknown if an increase in lipid content in the future would result in an increased dioxin concentration.

How different can it be? Impact of region-specific methodology on the environmental quality standard of nickel.

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Theme - Metal toxicity and environmental chemistry

ABSTRACT

In 2013, an Environmental Quality Standard (EQS) was established for nickel (Ni), which is classified as a Priority Substance under the European Union's Water Framework Directive. The Ni EQS is derived from a process that includes aggregating bioavailability normalized data from chronic laboratory ecotoxicity tests into a Species Sensitivity Distribution (SSD). According to EU methodology, an Assessment Factor (AF) ranging from one to five is applied to the resulting HC5 from the SSD; in the case of Ni, an AF of one was chosen, such that the EQS is equivalent to the HC5. Using a reasonable worst case approach based on water chemistry parameters (hardness, pH, and dissolved organic carbon) that maximized Ni bioavailability, a reference EQS of 4 µg bioavailable Ni/L was established. In other jurisdictions such as Australia/New Zealand, Canada, and the USA, Ni is also classified as a substance requiring a numerical standard that protects aquatic life. Existing standards for Ni in these jurisdictions are based on older, acute ecotoxicity data, and account only for water hardness. Guidance among the different regions follows the same general approach, but region-specific differences occur with respect to data selection, endpoint selection, and the choice of SSD models. To determine the impact of the different regional standard determination methods on the magnitude of a nickel standard, we applied current regional guidance from ANZECC, Canada, and the USA to the accepted EU chronic ecotoxicity database. Differences among the resulting regional standards were relatively minor. The choice of ecotoxicity data had very little impact on the resulting threshold concentrations, whereas the choice of the statistical approach used to determine the threshold had a more substantial effect. The concordance observed among the approaches indicates the possibility for harmonizing approaches among different jurisdictions.

How specific is site-specific? Guidance for selecting and evaluating approaches for deriving site-specific water quality guideline values

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Theme - Environmental management

ABSTRACT

While default water quality guidelines values (GVs) provide an important starting point for managing water quality, they cannot account for the large spatial and/or temporal variation in natural water quality, including variation in environmental variables that influence the bioavailability and toxicity of contaminants. Consequently, the past decade has seen increasing awareness of the need for site-specific GVs, with several jurisdictions (e.g. Australia, New Zealand, Canada, Europe) recommending them over default GVs where ever possible, and with some providing formal guidance on their derivation. In reality, there is a continuum of 'types' of water quality GVs, based on both temporal (e.g. annual, seasonal, daily) and spatial (e.g. national, regional, local) factors, which is far more complex than the simple comparison of default versus site-specific GVs suggests. Adding to this complexity, GVs can be derived or modified in various ways with varying robustness. When the above issues are considered in the context of the increasing use of site-specific GVs for regulatory purposes, both in Australia and overseas, it becomes apparent that there is a need for appropriate guidance for derivers and end users of site-specific benchmarks (i.e. regulators, industry, and consultants supporting both). This will help ensure site-specific GVs are derived in a rigorous manner and are fit-for-purpose.

This presentation addresses some key questions about site-specific GVs and, in doing so, aims to move towards clear guidance for their appropriate classification and consequent use.

Relevant aspects that will be discussed include:

- Guiding principles for deriving default and site-specific GVs;
- Factors to consider when determining the requirements for a site-specific GV;
- Detailed guidance for assisting those deriving and assessing site-specific GVs;
- Issues of spatial and temporal scale; and
- Methods for deriving site-specific GVs.

Examples, drawing on our experience in northern Australia, will be used to illustrate the key issues and to support recommendations.

Human Exposure to Legacy and Novel Brominated Flame Retardants via Contaminated Indoor Dust in Melbourne, Australia

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Theme - Human health issues associated with environmental contaminants

ABSTRACT

Polybrominated diphenyl ethers (PBDEs) are a type of brominated flame retardant (BFR) that have been incorporated into a variety of polymeric materials since the 1970's to impede the spread of fires. A number of PBDE congeners were listed as United Nations persistent organic pollutants (POPs) in 2009 due to their environmental recalcitrance, bioaccumulation capabilities and toxicity. PBDEs also volatilize from household products to contaminate indoor environments and are consequently regularly evident in human blood, milk and hair. Recent restriction and regulation of PBDEs throughout the world has driven a rise in the use of replacement "novel" brominated flame retardants (NBFRs). The structural and physicochemical properties that allow NBFRs to replace PBDEs in goods such as electrical equipment, foams and plastics however, also translate to similar toxicological profiles and human exposure risks. In this study, a total of 54 dust samples were collected from 12 homes, 8 offices and 8 cars in Melbourne, Australia, and analysed for PBDEs and NBFRs to determine human exposure risks from ingestion of contaminated dust. Samples were analysed using selective pressurised liquid extraction (S-PLE) and gas chromatography coupled to tandem mass spectrometry (GC-MS/MS). Legacy and replacement classes of BFRs were detected in all samples with overall median ?8PBDE and ?7NBFR concentrations of 2,090 and 1,800 ng/g, respectively. Risk assessment estimations revealed that the majority of exposure is likely to occur in the home for both adults and toddlers while PBDE congener BDE-209 and novel compound DBDPE contribute the greatest proportion to total exposure in Melbourne, Australia.

Hypersaline Sediments: Toxicity, Multiple Stressors and Management

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Theme - Environmental analysis and monitoring

ABSTRACT

The global production of salt is one of the biggest industries today, reaching 266 megatonnes (UGS, 2016) in 2016. Salt-refining operations comprise networks of shallow interconnected evaporative ponds of seawater with sodium chloride concentrations ranging from 30-35 g/L (seawater) to saturation at approximately 360 g/L, The restoration of aquatic ecosystems at decommissioned salt refining operations such as those at Dry Creek, South Australia (SA) is challenging due to factors such as salt crusts restricting benthic recolonization, legacy hypersalinity (inhibitory/lethal to many microbes and larger benthic organisms), and other stressors (e.g. sulfide) from partially and undegraded detritus. Remediation strategies need to consider how the presence of strong bioturbating communities can flush out excess salt ions, and facilitate the microbial degradation of organic matter and excess nutrients. Although largely overlooked, a greater understanding of these interactions may be a crucial step in remediating and restoring contaminated areas. Proposed remediation works for the salt ponds at Dry Creek, present some complex, non-contaminant stressor issues relating to both salt and sulfide. To address these, tests were undertaken to elucidate the acute and chronic tolerances of a range of benthic species to hypersaline sediments and pore waters (brines) from this region. Test endpoints included avoidance, survival and reproduction. Salinity survival threshold values for the amphipods Melita plumulosa and Victoriopisa australiensis was 70 and 50 ‰. Threshold values for the copepod Nitrocra spinipes, polychaete Neanthes succinea and for the crab Parasesarma erythodactyla were 60, 65 and 65 ‰ respectively. Chronic effects to reproduction in the amphipod M. plumulosa (EC10= 32 ‰) and cyst gastrulation with the brine shrimp Artemia salina (EC10 = 36 ‰) were also observed. The results of studies such as these will assist in the development of successful remediation/ mitigation processes to enable the recruitment of these organisms into these recovered habitats.

Identification of emerging contaminants in a dynamic aquatic ecosystem using high resolution accurate mass LC/MS, chemometrics and statistical analysis

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Theme - Environmental analysis and monitoring

ABSTRACT

Historically pristine sources of water are increasingly threatened by contamination from a plethora of point and non-point discharges. With over 15,000 new chemicals introduced into commerce daily it is impractical to monitor each one. Non-targeted methods using high-resolution mass spectrometry (HRMS) can identify many compounds but several compounds identified may not be important when studying changes in a water body. Determination of what components are significant and identifying them is critical, but difficult given the variability of environmental samples across time and season. This work examined LC/HRMS data of a river influenced by agriculture, hydraulic fracturing and domestic wastewater from January to November 2016 using multivariate statistics to determine compounds that are consistently being discharged into the environment and should be identified and monitored. Replicate samples of wastewater effluent, downstream, tributaries, field blanks and lab blanks were analyzed. Using chemometrics and statistical tests, the number of relevant features in the samples collected downstream of a wastewater plant compared to the effluent were reduced from several thousand around a hundred. Further, Non-targeted analysis using database of >12,000 compounds gave positive identification of some of these compounds that are constantly present in the water after wastewater discharge and require monitoring plus further toxicological evaluation for potential health effects relevance. The non-targeted database analysis also demonstrated that although compounds of interest can be determined, there are many more compounds that cannot using a limited database. Hence, the use of structure prediction software to identify some of these true 'unknowns' in the water. With the locations sampled across several months, statistical techniques are used to distinguish unknowns not in a database that appear consistently and thus should be identified to determine their importance as an emerging contaminant. This study provides a template for the identification of 'emerging' contaminants of relevance using statistical processes

Identifying Sources of PFAS to the Yarra River (Melbourne, Australia)

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Theme - Environmental analysis and monitoring

ABSTRACT

To date, few studies have explored the levels of PFAS within the Australian aquatic environment. The aims of this study were to investigate the contamination of PFAS in the Yarra River and two of its tributaries and assess the potential for storm water to be a source of PFAS to the Australian aquatic environment. Analysis of water samples was carried out using solid phase extraction (SPE) and high performance liquid chromatography coupled with mass spectrometry (HPLC-MS). Water samples were taken on three different days over a 5 month period from January to June 2017.

Two sampling days took place during periods of dry weather, where there had been little to no rainfall during the days leading up to the sampling. Another sampling day took place after 7 mm of rain had fallen over the 24 hours prior to sampling. 20 PFAS of interest were quantified and the results provided an insight into the background levels of PFAS in both the Yarra River and storm water. The mean total PFAS levels within the Yarra River were 41.9 ng/L, while the Merri Creek and the Maribyrnong River contained slightly higher levels of total PFAS, averaging 94.9 ng/L and 81 ng/L respectively. PFAS levels in the Yarra River increased substantially after the influx of water from both the Merri Creek and the Maribyrnong River, suggesting that these two tributaries are important contributors to the total PFAS load within the Yarra. The mean total PFAS levels in storm water discharging into the Yarra River was 219.4 ng/L. Although storm water contained the highest levels of PFAS, the input of storm water into the Yarra did not significantly change the total PFAS concentration in the river between dry and wet weather or before and after the locations of discharge. The identification of PFAS contamination within the Yarra River and two of its tributaries is an issue requiring further investigation, especially in regards to the sources of contamination further upstream.

Impacts of arsenic and antimony co-contamination on leafy vegetables grown in contaminated soils

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Theme - Bioavailability and toxicity of organic and emerging chemicals

ABSTRACT

Arsenic (As) and antimony (Sb) are metalloids that contribute significantly to water and soil pollution. In waters and soils, oxyanions in the tri-(III) and pentavalent (V) oxidation states are the most mobile and bioavailable forms, however, accumulation of As and Sb by organisms varies between species. Human health is known to be compromised through exposure to contaminated drinking waters and the consumption of plants grown in contaminated soils. Water spinach (Lipomoea aquatica) is a herbaceous aquatic or semi-aquatic leafy vegetable belonging to the morning glory family (Convolvulaceae), which has previously been used to monitor the bioavailable fraction of metals (e.g. Hg, Cd, Pb) in the environment. The aim of this study was to compare the toxicity and accumulation of As and Sb in water spinach exposed to soils contaminated with As and Sb separately, or as co-contaminants (As + Sb). Water spinach seeds were germinated in contaminated soils, and grown for 35 days within a controlled environment (day:night cycle of 14:10 h at 30 °C and 25 °C, respectively, and light intensity of 500 µmol m-2 s-1). Plant toxicity was assessed using measurements of tissue biomass, root/shoot elongation and chlorophyll content. Metalloid accumulation in tissues was also assessed and compared with the bioavailable fraction of the metalloids in the soils determined by sequential extraction procedures. Bioavailable Sb was proportional to Sb accumulated in shoots for both Sb-only and As+Sb treatments, whereas the maximum As accumulation in shoots was similar for both As-only and As+Sb treatments. Exposure to Sb-only showed no observed toxicity on the shoot biomass and elongation while both As-only and As+Sb treatments showed inhibition of shoot growth. There were no physical indicators of As accumulation other than reduced growth, and Sb did not inhibit growth at all, which may pose a risk in an agricultural setting with contaminated plants destined for human consumption showing no obvious physical effects.

In Vitro Assessment of Soil Arsenic Metabolism by Human Gut Microbiota

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Theme - Human health issues associated with environmental contaminants

ABSTRACT

Speciation analysis is essential when assessing the risk to human health associated with soil arsenic exposures. Arsenic toxicity to humans depends on different forms of arsenite (As(III)) and arsenate (As(V)), monomethylarsonic acid (MMA) and dimethylarsinic acid (DMA) Arsenic transformation by human gut microbiota and its distribution and intestinal absorption were evaluated. A colon microbial community in a dynamic human gut model and the intestinal epithelial cell line Caco-2 were cultured. These colon microbiota and Caco-2 cells were incubated with a range of soils containing arsenic. We determined arsenic speciation using high-performance liquid chromatography coupled with inductively coupled plasma mass spectrometry (HPLC-ICP-MS) and X-ray absorption nearedge spectrometry (XANES). Arsenic bioaccessibility in the colon phase was 1.8 to 2.8 times greater than that in the small intestinal phase. We found a high degree of arsenic methylation (mean 2 µg methylarsenicals/hr /g biomass) for the colon digests. Large amounts of As(III) were observed due to microbial reduction in the colon digests with about a 20% increase in As(III) of the soil solid phase. The cellular absorption of soil arsenic metabolites was slightly higher for MMA and As(III) than for DMA and As(V). Arsenic metabolism is a significant process in the human gut, and our study will result in more accurate risk assessment of human health associated with soil arsenic exposures.

Including individual species' variation in SSD derivation

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Theme - Transport, fate and exposure modelling of chemicals in the environment

ABSTRACT

Species Sensitivity Distributions (SSDs) are the cornerstone of ecological risk assessment as the tool with which to derive concentration limits for toxicants by evaluating the likelihood of adverse effects within a receiving system. SSDs use sensitivity data compiled from individual species' toxicity tests to produce a statistical distribution of the sensitivity of a community. Both the quality and quantity of data influence an SSD model and the protective or hazardous concentrations (PC/HCx) that are derived from it. This work examines the influence of these two issues in SSD derivation. First, variability around individual species sensitivity estimates is not included in SSDs, leaving out critical information about the variability of a species' response, and implying there is greater precision around an estimate than is reality. Secondly, SSDs are intended to represent an entire community with a range of species from several taxonomic or functional groups. However, SSDs are often comprised of a minimum number of species (ANZECC guidelines now recommend 8 species from 4 taxonomic groups), and just how representative this is of a much more complex multi-species community is unknown.

This talk will present a Bayesian SSD model which includes the variability around the individual species estimates and examines how this additional information changes the resulting PC/HCx values and their confidence intervals. Further, we present a comparison of SSDs comprised of different numbers of species estimates, including their confidence intervals, too see if the inclusion of estimate variability changes the minimum number of species required, and how the inclusion of additional values alters the confidence of derived HC/PCx estimates. By improving the methods with which SSDs are calculated we can better inform risk assessments and provide more reliable environmental quality guidelines.

Interlaboratory Study on The Analysis of Short Chain Chlorinated Paraffins

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Theme - Environmental analysis and monitoring

ABSTRACT

Short chain chlorinated paraffins (SCCPs) are produced in high quantities, are ubiquitously present in the environment and have adverse environmental effects. Accordingly, they have recently been recommended by the technical review committee (POPRC) of the Stockholm Convention to be added to Annex A of the Convention. They are also included in several regulatory lists such as the European Water Framework directive, in order to monitor them regularly in the European environment. Due to the complexity of the mixtures, the determination of SCCPs is, however, very challenging.

To investigate the current status and identify issues with the determination, an interlaboratory study (ILS) was carried out by QUASIMEME (Wageningen, the Netherlands) between 2012-2017. More specifically, we investigated i) which current analytical and cleanup methods were applied, ii) whether there was a difference in reported concentrations and how large these differences were, and iii) if we could explain these differences by the different analytical and/or cleanup methods reported. This was be done by comparing and evaluating the reported concentrations and methods by various laboratories.

The ILS existed out of four rounds. In those rounds, participants (n=9-11) applied a range of different analytical techniques, and large differences in reported concentrations were found (23-137%), showing that SCCP analysis in environmental matrices is still challenging. Nonetheless, overall the variability of this ILS was much lower than that of previous ILSs (factor of 100) and differences were found to decrease over time, suggesting improvement. In addition, the assigned value obtained by the reported concentrations for the test solution in round 4, agreed well with the true concentration, with 1.34 and 1.63 µg/g, respectively.

In all rounds, GC-ECNI-qMS was most commonly applied, while there was an increasing interest in the recent developed technique APCI-QToF-MS in the last round. While variability in reported concentrations did not seem to be negatively affected by using different cleanup methods, the choice of instrumental technique and quantification procedures could play a major role.

Is Virtual Curtain technology superior to lime for treating acidic, metalliferous mine waste waters?

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Theme - Toxicity of mixtures and multiple stressors

ABSTRACT

Lime or limestone is most commonly used for treating acidic waste waters such as those forming at metal mining sites due to acid rock drainage. There are significant limitations to these approaches, the most prominent of which is the large amount of waste sludge produced. Virtual Curtain (VC) is a licensed technology developed by CSIRO as an alternative treatment method for acidic waste waters that contain high concentrations of metals, metalloids and radionuclides. The technology utilises the in-situ formation of hydrotalcite (HT) minerals via adjustment of the Mg/Al ratio in the solute with an increase in pH to ~10. The technology is designed to rapidly remove problematic elements. Its advantages include: (i) reduction of sludge production; (ii) broad spectrum removal of a range of cationic and anionic contaminants; (iii) the ability to rapidly dewater and concentrate solids; (iv) the potential for recovery and recycling of elements to offset treatment costs; (v) avoiding issues related to scaling in the lime treatment plant; and (vi) in-situ treatment is rapid and results in stable precipitates. Treatments using both lime and VC technology were compared based on measurements of both chemistry and toxicity (2-day survival of a cladoceran and 3-day growth rate of a microalgae species) of acidic (pH 1.3-4.5), metalliferous mine waters from four mines (two gold mines, a uranium mine and an iron sulphide mine) with concentrations of metal(loid)s ranging from 0.2-3000 mg/L. Both lime and VC treatment substantially reduced the concentrations of most problematic metals and metalloids, however, treated samples were still toxic to both cladocerans and microalgae. This was attributed to a combination of elevated conductivity (1.2-65 mS) from major cations and anions and the persistence of some trace elements at above concentrations known to cause toxicity (e.g. Cu, Zn, Ni). The implications of this residual toxicity will be discussed in relation to the field application of VC technology.

Laterite associated waters: what the lack of major ions means to trace element bioavailability and toxicity

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Theme - Metal toxicity and environmental chemistry

ABSTRACT

Aquatic toxicity of metals and other contaminants has been studied more extensively for temperate than for tropical species. Although comparative analyses have generally concluded that tropical and temperate species are similar in their sensitivity to metals, this is based on comparisons with laboratory waters that are generally similar. It can however be expected that freshwater ion assemblages would be largely influenced by local geology. In the tropics, laterites and the related bauxites are an abundant class of soils and sub-soils. They are formed by extended weathering under tropical climatic conditions resulting in a leached profile enriched in some elements but depleted in those that are soluble under the specific conditions of formation. The unique ionic balance of laterite associated waters means that the current global efforts to assess major ion toxicity may not be relevant to large areas of the tropics, and it is hypothesised that organisms adapted to these waters have to regulate ions differently from organisms living in temperate waters. In this study, existing water quality data from various locations dominated by laterites worldwide, including South America, Africa, Southeast Asia and Oceania, was collated. Laterite associated water characteristics will be presented and typical ionic balance compared to European datasets. The implications for metal tolerance and the relevance of using existing biotic ligand models (BLMs) will be discussed.

Lead bioaccumulation in a native freshwater fish, the flathead gudgeon (Philypnodon grandiceps) following dietary exposure to a contaminated food source

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Theme - Metal toxicity and environmental chemistry

ABSTRACT

Victorian freshwater ecosystems contain detectable amounts of a range of bioaccumulative contaminants, including heavy metals. However, it is difficult to determine if the concentrations of these heavy metals are sufficient to bioaccumulate in freshwater fish found in south-eastern Australia. The heavy metal lead is widespread in the aquatic systems of the greater Melbourne area, with just over 10% of wetland sediments polluted with lead concentrations that exceed Probable Effect Concentration (PEC) sediment quality guidelines. This study investigated the potential for bioaccumulation of lead in the flathead gudgeon (Philypnodon grandiceps), which is a common and widespread fish indigenous to the urban waterways surrounding Melbourne. The focus of this study therefore, was to determine if P. grandiceps could accumulate lead from a dietary source, which was determined through a laboratory based dietary bioaccumulation experiment. Adult fish were fed lead-contaminated chironomid larvae (Chironomus tepperi) daily throughout a two-week uptake phase, followed by a two-week depuration phase. Analysis of whole body tissue homogenates revealed that P. grandiceps does accumulate lead following dietary exposure. This study aids in advancing the current understanding of heavy metal bioaccumulation in a local fish species, addressing the lack of baseline bioaccumulation studies that utilise a species indigenous to south-eastern Australian inland waters.

Life Cycle Benefit Assessment of Recyclables, Oil and Carbon Recovery

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Theme - Life cycle assessment

ABSTRACT

Since 1990 conventional life cycle assessment (LCA) has been developed to meet industry and consumer concern about reducing pollution and depleting resources [1]. Consequentially life cycle impact assessment (LCIA) models environmental degeneration rather than pollution reparation, resource regeneration and wellness outcomes essential or urgent for sustainability [2, 3 & 4].

To remedy this impediment to recognising and quantifying such vital outcomes the authors developed Life Cycle Benefit Assessment (LCBA) metrics. They did so by extending ReCiPe, TRACI and EcoIndicator 99 LCIA nomenclature, methods and algorithms.

Examples shown are from cradle to end of life fate (C2F) LCA with results that show:

- commercial grease diverter system for recycling of restaurant waste over 60 years
- residential waste diverter system for recycling of house hold waste over 60 years
- forest sequestered carbon in fibre diverted from sewage to regenerate soil for 20 years

These results are drawn from LCA of business as usual and best available technology. They were developed for publishing third party certified ecolabels and ISO 14025 compliant Environmental Product Declarations (EPD)s.

Key benefits shown derive from diverting post consumer material, grease and paper to reclaim resources, feedstock and renewable carbon from fates including emission to air, effluent to water and solid waste to landfill.

Diverting post consumer material to reclaim resources and feedstock solid waste to landfill

Diverting renewable carbon in toilet paper from fates including emission to air from sewage to regenerate soil is significant if it redresses LCA and widespread sustainability issues including the:

- 20-year horizon contribution to the pace and scale of oncoming climate tipping points;
- biomass emissions, especially from forest and paper industry sources;
- 60% of global radiative forcing caused by short-lived climate forcers;
- short-term climate benefits for 20 years of reducing methane emissions by 80%; and
- widespread mitigation opportunities in climate hot spots [5].

Longitudinal effects of metal oxide engineered nanomaterials for the remediation of arsenic (As) and lead (Pb) contaminated soils

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Theme - Environmental management

ABSTRACT

Engineered nanomaterials (ENM) are increasingly being proposed as remediating agents for the clean-up of contaminated soils This is due to the unique proprieties of ENMs such as nanoscale size (<100 nm), variable surface charge, high mobility and high surface area to volume ratio which makes them promising candidates for the absorption of many inorganic contaminants including arsenic (As) and lead (Pb). Although short-term studies (< 5 days) have demonstrated that applying ENMs to contaminated soils can significantly alter contaminant bioavailability, the long-term (i.e. ˜1 year) influence on contaminant bioavailability is not known. In addition, the long-term fate and mobility of ENMs applied to soils for contaminant remediation and the effect of such ENMs on the phytoavailability of essential soil nutrients and trace elements are also unclear. Without this information both the efficacy and overall safety of ENM-mediated environmental remediation cannot be guaranteed.

This study reports on the findings of a long term soil incubation experiment in which three As and Pb contaminated agricultural soils from southern Australia were amended with either nano-titanium dioxide (nTiO2), nano-cerium oxide (nCeO2) or nano zero valent iron (nZVI) at a concentration of 500 mg ENM kg-1 soil. All soils were incubated at 20 oC for 1 year at 60% water holding capacity (WHC) with periodic soil sampling to monitor changes in physiochemical parameters such as total As, Pb and trace element (TE) concentrations, plant-available (DTPA extractable) and mammal-available (SBET (Simplified Bioaccessibility Extraction Test) extractable) As and Pb plus As, Pb and TE concentrations in soil porewater.

Metabarcoding of benthic communities to determine the sediment toxicity of bifenthrin

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Theme - Emerging ecotoxicological techniques and test methods

ABSTRACT

Bifenthrin is a widely used pyrethroid insecticide that disturbs the sodium ion channels in the peripheral and central nervous system of target and non-target species of metazoans (multicellular organisms). Bifenthrin is moderately toxic to mammals (LD50 parts per million) but highly toxic to fish and aquatic invertebrates (LC50s parts per trillion). It is a suspected human carcinogen and has been banned for use in the European Union. Bifenthrin enters estuarine environments primarily through agricultural and residential use, and, because it is a hydrophobic compound, it has the potential to accumulate in estuarine sediments.

This study aimed to determine the effect of bifenthrin on benthic estuarine eukaryotic community structure using metabarcoding. A novel exposure method was applied, which brings intact sediment cores into the laboratory and exposes the benthic community by the addition of toxicant-spiked sediments to the sediment surface. The community structure was analysed after a two-week exposure to the following treatments: 1) field control - no added sediment, 2) laboratory control – clean reference sediment added, 3) low bifenthrin concentration (8.5 mg/kg), and 4) high (68 mg/kg) bifenthrin concentration (dry weight). Genomic DNA was isolated from the sediments and the eukaryotic communities were targeted by metabarcoding of the 18S rRNA, using Miseq Illumina sequencing. Our findings showed that that addition of bifenthrin altered the composition of the sediments, with differences in composition also detected between the low and high treatments. In general, the patterns produced by the sequenced data provided greater discrimination between the treatments than traditionally obtained end-points (meio- and macro-faunal composition). However, there were number of experimental artefacts associated with the experiment, most notably the effect of smothering from the addition of layer of DNA-free sediment. Here will discuss some solutions to address this limitation.

Keywords

Bifenthrin, benthic communities, metabarcoding, 18SrRNA, eukaryotes

Metal stable isotopes: a powerful tracer for biomedical research and environmental monitoring

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Theme - Transport, fate and exposure modelling of chemicals in the environment

ABSTRACT

Although still at an early stage, metal stable isotope profile provides an enormous potential in tracing environmental and biomedical processes, owing to the recent advance in ICPMS technology. Stable isotopes have shown many advantages over radio isotopes in terms of being safe to use and often having more than one choice within the same target element. Since every third protein is believed to require a metal cofactor, usually a transition metal such as copper, iron, zinc or molybdenum, the application of stable isotope tracing would enable us to gain more insight in areas of equilibrium and detoxification processes such as metal ion transport, metabolism and protein expressions in a living organism. Hence stable isotope analysis, traditionally being applied in geoscience field, is now gradually more frequently used in biological, biomedical and environmental researches. Metal stable isotopes are mostly likely to become essential tracing tools not only for nutritional studies and environmental monitoring but also for forensic evidence quest, and biological, biomedical and pharmacological researches. The Radiogenic Isotope Facility (RIF) at the University of Queensland houses a whole range of state-of-the-art mass spectrometers and is at its world leading position for radiogenic isotope analysis. We have successfully developed chemical treatment and mass spectrometric protocols for Cd and Fe isotope analysis and is in the process of trailing other stable metal isotope analyses such as Zn, Cu, Mg, Ca, Cr, Co, Ni, Mo and Hg.

On the use of DGT to predict metal mixture toxicity to two Antarctic marine microalgae

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Theme - Marine Ecotoxicology and Chemistry

ABSTRACT

Contaminants predominantly occur in mixtures, posing a challenge to environmental management which is predominately based on single-contaminant toxicity. Chemical interactions of the contaminants and non-specific biological responses to these mixtures may result in effects that differ from the sum of the toxicity of individual components. These differences can be classed as antagonism (less toxicity than expected from the sum of the individual contaminants in the mixture), non-interaction (toxicity equal to that expected from the sum of individual contaminants), and synergism (more toxicity than expected from the sum of individual contaminants). Diffusive Gradients in Thin-films (DGT) have been established as a robust method of analysing the biologically-available contaminants in situ and are well-positioned to predict the toxicity of contaminant mixtures.

This study investigated the use of DGT (with a Chelex-100 resin) to predict the toxicity of Cd, Cu, Ni, Pb, and Zn, mixtures to two common Antarctic marine microalgae: Phaeocystis antarctica and Cryothecomonas armigera. DGT devices were optimised for use in Antarctic conditions by determining diffusion coefficients for each metal and quantifying the metal-absorbing capacity of the resin in marine waters at 1°C. Preferential binding of metals to the resin was observed prior to reaching the resin's capacity, with Cd, followed by Pb, and Zn, outcompeting Cu and Ni, which retained linearity of uptake until capacity.

Non-interactive and synergistic toxicity was observed in the two algal species in response to increasing multiples of the environmental mixture (where the ratio of metals were based on reported concentrations at a historically contaminated Antarctic marine bay). Whereas, non-interactive toxicity was observed in response to an equitoxic mixture (five metals at their EC10 concentrations), as determined by Independent Action and Concentration Addition modelling.

Particle size distribution and metal content of suspended particulate matter in river and coal mine-affected water from the Fitzroy River Basin, Central QLD, Australia

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Theme - Environmental analysis and monitoring

ABSTRACT

This preliminary study aimed to characterise suspended particulate matter (SPM) from sites within a coal mining region of the Fitzroy River Basin, Central Queensland. SPM transported downstream may contain potential metal contaminants. Comparisons of SPM from the study area and from coal mine-affected water (CMAW) that is released into this freshwater system, have not been reported.

Sampling sites included an upstream location ("Ref" site) where no coal mining has ever occurred, a CMAW holding dam, as well as five sites (2, 3, 5a, 5b and 6) that were progressively downstream of several coal mines. Sites were not controlled for prominent land uses, i.e. agriculture or cattle grazing. Samples were only collected from flowing waters. No mines were releasing CMAW at the time of the study (March 2015).

SPM samples were collected on large diameter in-line filters. Nitric acid digests of samples and blanks were analysed for metals using ICP-MS. Particle size diameters of the SPM from the CMAW and from sites 2, 5a, 5b and 6 were determined using laser diffraction (no reliable readings for "Ref" (TSS=23 mg/L) and site 3 (TSS=17 mg/L) were obtained).

The concentration ranges (mg/kg) of particulate metals across the six sites were: V (0.90-8.97), Cr (0.39-6.92), Co (0.29-1.99), Ni (0.71-7.60), Cu (0.27-3.34), Zn (1.09-12.43), As (0.09-1.09) and Pb (0.12-1.67). Particulate metal concentrations (mg/kg) in the CMAW were much greater for all elements except Co (V= 56.70, Cr=28.95, Co=0.77, Ni=24.30, Cu=21.48, Zn=74.96, As=13.16 and Pb=18.13).

Site 2 (TSS = 69.0 mg/L) had the lowest concentration of metals and the largest particles (D10=14.3 µm, D50=65.4 µm and D90=289 µm). Sites 5a (TSS= 170 mg/L) and 5b (TSS=174 mg/L) - the head and tail waters of a weir - exhibited similar PSD (D10, 50, 90 = 0.295, 0.828, 7.76 µm and 0.299, 0.860, 11.5 µm, respectively). The PSD of the CMAW was: D10=1.96, D50=12.0 and D90=222µm.

Mixing studies in the laboratory using the CMAW sample and river water (site 5b) are being conducted to elucidate further the changes that may occur during a CMAW release into the receiving river.

Patterns of background concentrations of elements in Victorian soils and implications for environmental risk

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Theme - Environmental analysis and monitoring

ABSTRACT

Guidance for the assessment of potentially contaminated land in many countries, including Australia, now requires consideration of ambient background concentrations in soil when assessing environmental risk. Ambient background concentrations are the sum of geogenic concentrations plus concentrations from diffuse anthropogenic contamination that has been introduced from non-point sources. The project surveyed 320 soils formed on Tertiary-Quaternary basalt, Tertiary sediments and Silurian siltstone and sandstone of Greater Melbourne and regional Victoria (Mitchell, Ballarat and Geelong). In addition, suitable information was collated from open source data (environmental audit sites) after screening to ensure the soils were natural (not fill) and were representative of ambient background concentrations. Open source data added a total of 310 surface (0-0.1 m), 1376 sub-surface (0.3-0.6m) and 3826 deeper (>0.6m) soil samples to the database. Soils were tested for 25 metal(oid)s plus fluoride along with soil characteristics such as pH and texture. The following elements were found to be naturally enriched in some soils of the study area:

- Arsenic; predominantly in soils overlying Tertiary sediments of the Brighton Group and Silurian siltstone and sandstone of the Anderson Creek and Dargile Formation,
- Fluoride; predominantly in soils overlying the Anderson Creek and Dargile Formation,
- Nickel; predominantly in soils overlying Tertiary-Quaternary basalt of the Newer Volcanics, and,
- Copper; rare exceedances (<1 % of samples) in soils overlying the Anderson Creek and Dargile Formation.

The National Environment Protection Measure (Assessment of Site Contamination) currently assumes all ambient background concentrations of elements are of low risk generally and that, in particular, local flora and fauna are adapted to areas of enrichment. We will discuss soil and plant data that illustrate situations in which this may not be the case and where further risk assessment would be preferable to ensure protection of ecological and human health.

PCDD/F levels in different tissues from Dugongs (Dugong dugon) inhabiting the Queensland coastline

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Theme - Marine Ecotoxicology and Chemistry

ABSTRACT

Marine environments tend to be a sink for organochlorine contaminants such as polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/F). Due to their high affinity for particulates, PCDD/Fs have been reported at elevated levels in near-shore sediments along the coastline. Of particular concern are the seagrass habitats that are home to the only extant species of the family Dugongidae, the dugong. The Australian coastline is home to a large population of the world's remaining dugongs, extending from Shark bay in Western Australia to Moreton bay in the east. Listed as 'vulnerable' under the IUCN (International Union for Conservation of Nature), these herbivorous marine mammals feed almost exclusively on seagrass. A combination of their longevity, diet, high fat deposits, low reproductive rate, slow metabolism and close proximity to coastal sediment make them particularly susceptible to PCDD/F accumulation.

There are less than twenty published biomonitoring studies on the levels of organochlorine compounds in dugongs. The present study analysed multiple tissues of dugongs (5 male, 5 female) obtained from two different locations along the Queensland coast: males were from Townsville area while females were from the Moreton Bay. To our knowledge this is the first study undertaken to determine the level of PCDD/F in dugong tissues such as muscle and liver in addition to blubber. PCDD/Fs were detected in all samples with percent contribution being highest from PCDD congeners. OCDD and 1,2,3,4,6,7,8 – HeptaCDD were the dominant congeners in all tissues corresponding with previously published data. The overall 2,3,7,8- congener profile was similar across the different dugong tissue samples and matched the profiles found in marine sediments from the Queensland coast. Preliminary TEQ comparisons show the values are similar to those found in higher trophic humpback dolphins from the same region.

Data from this study offers the opportunity to extend the biomonitoring studies into modelling studies that focus on understanding the distribution and kinetics of the contaminants in marine mammals using dugongs as a model.

Plant roots activities at the microscale – Assessing element cycling in 2D

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Theme - Application of DGT to soil systems

ABSTRACT

The investigation of microscale processes in soil and sediment always has been challenging due to their inherent small-scale heterogeneity, especially if low nutrient or contaminant concentrations should be assessed. Much of our knowledge on interactions of roots with their immediate environment has been gained in systems where the spatial heterogeneity could not be addressed explicitly. Multi-parameter imaging using diffusive gradients in thin films and complementary techniques not only allows for mapping elemental distributions around roots, but also facilitates mechanistic interpretation of the cycling, solubilisation and immobilization processes.

Using multi-parameter imaging, we could show that roots of the marine seagrass Cymodocea serrulata are able to mobilize phosphorus and iron from carbonate-rich marine sediment by protolytic dissolution of Ca-phosphates, as well as by reductive dissolution of Fe(III)-oxyhydroxides. While the P mobilization capabilities of roots of terrestrial plants are well known, this is the first study to directly demonstrate that marine seagrasses, which are important ecosystem builders, are also able to actively forage for P and Fe. In a second study on the rhizospheric cycling of As(V) and As(III) in As-hyperaccumulating fern species, we observed strong mobilization of As(V) in the rhizosphere of Pteris vittata together with As(III) release from its roots, while P. quadriaurita showed only As(V) uptake. As(III) release from P. vittata roots might be a mechanism to limit As uptake to physiologically tolerable levels. Increased As(V), co-localised with As(III) release, indicates either As(III) re-oxidation or As(V) solubilisation from the soil matrix. Together with O2 images, our data highlight the importance of redox reactions in the rhizosphere of As-hyperaccumulating ferns in aerobic soil.

These studies demonstrate that chemical imaging campaigns should aim at determining sufficient parameters to allow for a mechanistic interpretation of the generated 2D datasets, and points out the need for further increasing the range of parameters that can be mapped simultaneously.

Preliminary Assessment of Surface Soil Metal Concentrations in Melbourne, Australia

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Theme - Metal toxicity and environmental chemistry

ABSTRACT

The objective of this study was to perform a preliminary assessment of the spatial distributions of surface soil metal concentrations in the Melbourne metropolitan area, Australia. The hypothesis of this study was that soil metal concentrations are elevated in older inner city areas and industrial areas and decrease with distance towards the newer suburbs. Fifty-eight surface soil samples were collected at a depth of 0-2 cm along three linear transects oriented across the Melbourne metropolitan area. Surface soil samples were also collected at a higher density in five Melbourne suburbs. Soil cores (0-50 cm) were collected in four locations, soil transects were collected at intervals with distance away from the roadway (0-50 m) in two inner city parks and one control soil sample was collected in a rural setting. Results indicate that soil metal concentrations were generally elevated near the central and western portions of the Melbourne metropolitan area and were lower in the outer suburbs to the north and east of the city centre. The only metal that exceeded regulatory guidelines was lead (Pb). The median soil Pb concentration of the soil transect samples was 173 mg/kg (range = 32 mg/kg to 710 mg/kg) and the median soil Pb concentration of the five suburbs was 69 mg/kg (range = 9 mg/kg to 1750 mg/kg). The suburb of Footscray had the highest soil Pb concentration with a median soil Pb concentration of 192 mg/kg (range = 40 mg/kg to 1750 mg/kg). Soil Pb concentrations decreased with distance from roadways in the two transects taken from urban parks and soil lead decreased with depth in the four soil cores. The soil Pb concentrations in the Melbourne metropolitan area appear to be lower than soil lead concentrations observed in inner city areas of Sydney New South Wales (NSW) and Newcastle NSW. The spatial extent of the soil Pb hazard remains undefined in portions of the Melbourne metropolitan area.

Primer development for soil carbon anhydrase monitoring

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Theme - Metal toxicity and environmental chemistry

ABSTRACT

Soil can either absorb or release carbon dioxide (CO2), and this process between soil and atmosphere is catalyzed by carbonic anhydrase (CA), which is a metalloenzyme that catalyzes the hydration reaction of CO2 to biocarbonate. Various human activities such as the reuse of organic and inorganic wastes in soil may lead to soil contamination with heavy metals. This will, in turn, change soil microbial community structures, which will eventually lead to changes in the CA activities of microbial community in soil. Also, since CA is a metalloenzyme, its activity can be affected by the presence of heavy metals in soil. Thus, this study was set to develop primers that can be used to monitor soil CA activities in response to soil contamination with heavy metals. In this presentation, the procedure for collecting meaningful gene sequences that are the basis for primer development will be presented. Briefly, the bacterial CA gene sequences were collected using the Kyoto Encyclopedia of Genes and Genomes (KEGG), which is linked to the National Center for Biotechnology information (NCBI) GenBank database. Two groups of CA genes were identified from the KEGG. In order to increase the reliability of the gene sequences, the annotation information of the sequences was verified by BLAST search against genome sequences of valid bacterial species. To develop a primer, which can be used to quantify CA activity in soil, CA gene sequences of soil abundant bacterial taxa will be selected among the CA gene sequence collection. CA gene sequences of well-known soil abundant bacterial genus including Pseudomonas and Burkholderia selected via literature review were aligned and grouped into clusters to design primera. Also, investigation of soil bacterial community structure of local soil environments is in progress using the next generation sequencing (NGS) approach. With the primers developed in this study, the soil CA activity can be monitored, which can be used as indicators for monitoring the impact of heavy metals on soil CO2 storage.

Prioritising the management of organic chemicals in raw sewage that could impact STP function and the quality of products re-entering the environment

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Theme - Transport, fate and exposure modelling of chemicals in the environment

ABSTRACT

Melbourne Water's Sewage Quality Management System includes a Quantitative Risk Assessment (QRA) which provides a toolbox of models developed specifically to help Melbourne Water and the Melbourne metropolitan water retailers understand Substances of Interest (SOI) in raw sewage and how they impact the sewage treatment processes, operations, beneficial uses of recycled water and biosolids, and freshwater and marine systems where these products re-enter the environment.

The Screening Tool for Organic Chemicals (STOC) is used as the first phase in the QRA to prioritise organic chemicals requiring a detailed risk assessment which may lead to the proactive management of the chemical to ensure the sewage treatment plant's current and future product quality (i.e. effluent, recycled water, biogas and biosolids) are balanced with environmental, human health and capital costs to the community.

To prioritise chemicals, the STOC uses four factors integrated into a standard risk matrix, which include:

Likelihood:

1. Fate Factor (19 variables): Likelihood of occurring in influent, passing through sewage treatment plant and being present in effluent or biosolids;

2. Exposure Factor (20 variables): Likelihood of movement through exposure pathways to receptors, considering degradation and partitioning behaviour;

Consequence or impact:

3. Effect Factor (18 variables): Impact on receptors such as humans or biota; and

4. Effect List (12 lists): Lists of identified known or potential toxicants from respected organisations across the world.

Data quality is scored for most variables and consolidated for each of the key 10 pathways considered and provides a risk rating qualified by the data quality used to determine it. Together these are used to recommend actions for each chemical and pathway. The STOC quickly identifies high risk chemicals that require further consideration, by utilising data predominantly from EPI Suite and the QSAR Toolbox. Preference was given to measured data over the modelled/predicted data.

This paper summarises the logic used to develop the STOC and the chemicals prioritised.

PSII-inhibiting herbicides vs. alternate pesticides in Great Barrier Reef catchments

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Theme - Environmental analysis and monitoring

ABSTRACT

Five photosystem II (PSII) inhibiting herbicides (ametryn, atrazine, diuron, hexazinone and tebuthiuron) were targeted by the Reef Water Quality Protection Plan (Reef Plan) in 2009 as pesticides that contribute to poor water quality entering the Great Barrier Reef (GBR) lagoon. In the 2013 revision of Reef Plan all pesticides are now targeted. As part of best management practices, farmers are encouraged to replace PSII (residual) herbicides in the GBR catchment area with alternate pesticides such as knockdown herbicides (2,4-D, glyphosate and paraquat). However, little is known of the transport, exposure, fate and therefore ecological risk of alternate pesticides. In 2012, laboratory analytical suites expanded and at least 49 different pesticides have been detected in catchments that flow to the GBR lagoon. Of the pesticides detected, only 12 have trigger values in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ 2000) with eight of these having low reliability trigger values. As part of the national revision of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality, new species sensitivity distributions (SSDs) were generated to calculate freshwater and marine protective guideline values (formerly termed trigger values) for a total of 28 pesticides commonly detected in GBR catchments. Newly-derived and revised guideline values for pesticides are vital for understanding toxicity and determining environmental risk. The SSDs used to calculate guideline values for individual pesticides are also used in the multisubstance potentially affected fraction (ms PAF) method to determine mixture toxicity and ecological risk assessments for GBR catchments. In this presentation, the SSDs and guideline values will be used to; 1) assess the relative risk posed by pesticides to determine whether the environmental impact of alternate pesticides are less than the initially targeted priority PSII herbicides, 2) assess the absolute risk posed by various concentrations of pesticides and 3) calculate the percentage of species likely to be affected by mixtures.

Remediation Criteria for Sediments with Impacts Spanning 100 Years: Apportioning Effects Between Legacy Hydrocarbons and More Recent Metal Contamination

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Theme - Bioavailability and toxicity of organic and emerging chemicals

ABSTRACT

Historical contamination of sediments due to large industrial operations that commenced before environmental regulations, e.g. legacies of the late 19th century through to the 1970s, are commonplace in many large international cities. Today, historical contamination is frequently overlain and mixed with more recent anthropogenic contamination. The remediation of contaminated sites within urban coastal waterways is often a very expensive exercise. As a consequence, the final remediation criteria reflect a trade-off between protecting human and ecological health, and the finances of those deemed responsible for the site clean-up. This presentation describes an assessment of estuarine sediments impacted historically by contamination from a gasworks site, within a large modern city. The major historical contaminants include polycyclic aromatic hydrocarbons (PAHs) and petroleum hydrocarbons, while elevated concentrations of metals exist throughout the region, largely due to ongoing urban stormwater discharges. The properties of the sediments strongly influence the bioavailability of both the metal and organic contaminants. The assessment considered the influence of both natural sedimentary organic carbon and also forms of black carbon (pyrogenic carbon - coal tars, charcoal) on the bioavailability of the hydrophobic organic contaminants. The relevance of equilibrium partitioning models for predicting the risk posed by PAHs is discussed. The relationships between the observed toxicity to benthic amphipod and copepod survival and reproduction, and the concentrations and predicted bioavailability of major contaminants, are considered in the development of remediation goals.

Remediation of per- and poly- fluoroalkyl substances (PFAS) - An industry perspective

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Theme - Per- and poly-fluorinated alkyl substances (PFAS): fate and effects

ABSTRACT

Per- and poly- fluoroalkyl substances (PFAS) including PFOS, PFOA and numerous precursor compounds have been used in a wide range of household, industrial and commercial products due to their unique surface tension and levelling properties. PFAS are also a major component in many Aqueous Film Forming Foams (AFFF) used in firefighting operations. Despite the health effects associated with exposure to PFAS remaining uncertain, PFAS have been demonstrated as persistent, bioaccumulative, potentially toxic and difficult to remediate in environmental settings.

This paper reviews existing and novel remediation technologies applicable to PFAS impacted soil and groundwater and provides a critical analysis of the mechanisms responsible for treatment. Long-term performance, ability to meet land-use criteria, waste generation, cost and regulatory acceptability are also evaluated.

The findings suggest that destruction or removal efficiency (DRE), long-term stability, scalability of solutions to move from the laboratory to the field, minimal waste generation and cost are critical to the feasibility of remediation solutions at PFAS contaminated sites.

Re-thinking ecotoxicology paradigms in the omics era

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Theme - Emerging ecotoxicological techniques and test methods

ABSTRACT

As technologies advance, the expectation is that we will become better equipped to understand the various ways that anthropogenic stressors are influencing the environment. When paired with standard toxicity bioassays, environmental omics (e.g., genomics, proteomics, and metabolomics) provide a wealth of information related to sub-lethal effects. However, the scope of omics data can also reveal sources of variance and confounding not readily apparent with traditional test endpoints. Considering the mounting concerns regarding irreproducibility in science, omics techniques should therefore also be viewed as an opportunity to critically evaluate and improve upon fundamental approaches used for ecotoxicology research. For example, standard bioassay protocols commonly use organic carrier solvents such as methanol to improve chemical dispersion and solubility, as a means of achieving target concentrations and establishing dose-response relationships. Recommended maximal solvent doses have been devised based on evidence of no effect on traditional 'apical' endpoints, but the suitability of carrier solvents when assessing sub-lethal physiological and metabolic pathways is unknown. Direct solvent toxicity is important, but an even greater question exists – are sub-lethal responses influenced by interactions between solvents and contaminants(s) of interest?

The present study applied untargeted 1H NMR-based metabolomics to investigate whether interactions occur between a common carrier solvent (methanol) and a pharmaceutical mixture. Results demonstrate considerable interactive toxicity, with differential metabolite response profiles between solvent and solvent-free approaches to chemical dosing. This could have profound implications for the broad field of aquatic toxicology, since it suggests that the widely accepted paradigm of using organic carrier solvents for chemical dosing may lead to erroneous conclusions about sub-lethal effects.

Risk assessment of harmful substances from petroleum activities into the marine environment

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Theme - Marine Ecotoxicology and Chemistry

ABSTRACT

The New Zealand Environmental Protection Authority (EPA) regulate the discharge of harmful substances from petroleum activities into the marine environment within the Exclusive Economic Zone (EEZ) and Continental Shelf (CS). The EPA use the European Oilfield Speciality Chemicals Association (Eosca) CHARM Calculator Software (NeCCS) as a tool to determine the risks of the discharged substances. The NeCCS software acts as a database that stores information about hazardous substances and offshore installations. NeCCS characterises the exposure and risks of hazardous substances discharged into the environment by running the Chemical Hazard Assessment and Risk Management Model (CHARM).

CHARM depends on the provision of substance specific composition and hazard data, as well as a knowledge of the platform or drilling rig a substance is discharged from. NECCS produces hazard quotients or risk quotients for CHARM using data that is entered about the hazardous substances and the installation where the substances are being discharged.

The assessment of environmental risks requires the determination of exposure in terms of Predicted Environmental Concentrations (PECs) and determination of effects in terms of Predicted Non Effective Concentrations (PNECs). PNECs can be predicted on the basis of available ecotoxicity information and by applying appropriate uncertainty factors. Risk or Hazard Quotients (RQ/HQ) are calculated by comparing PECs to PNECs. For substances that cannot be assessed using CHARM the EPA have developed an alternative assessment framework. This involves consideration of a substances toxicity, its potential to bioaccumulate and persist in the environment, and the discharge characteristics to estimate a RQ value.

Information from these assessments along with other relevant information, including other legislative considerations, allows the EPA to make a decision about whether or not harmful substances can be permitted to be discharged and if so what conditions there should be on their use.

Seasonal Toxicity Observed with Amphipods (Eohaustorius estuarius) at Paleta Creek, San Diego Bay, USA

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Theme - Bioavailability and toxicity of organic and emerging chemicals

ABSTRACT

Paleta Creek (San Diego Bay, California, USA) was identified by the California State Water Board as a high priority candidate toxic hot spot due to repeated amphipod sediment toxicity observations and the presence of multiple degraded benthic communities (SCCWRP 2011 and SPAWAR 2005). Modified standard 10-d (acute) amphipod (Eohaustorius estuarius) survival bioassays were performed ex-situ using intact sediment cores collected from the site on five occasions between 2015-2017 (July 2015, October 2015, February 2016, September 2016, and March 2017). In addition, a subset of October 2015 sediment cores were manipulated with a top layer of stormwater-associated particles (collected from 4-month deployed sediment traps placed at each station during the 2015-2016 wet season) as an additional measure of contributions of storm water particulates on contaminant exposure and bioavailability. Dry season events (July 2015 and September 2016) cores were largely non-toxic to amphipods, but wet season events routinely showed a spatial gradient of increased mortality with increasing proximity to the mouth of Paleta Creek, where up to 100% mortality occurred. In addition, mortality was greatest when the stormwater-associated particulates from sediment traps were added to moderately toxic October 2015 cores. These results suggest that stormwater-associated particulates are contributing to the recontamination of these sediments, and that the observed toxicity is relatively ephemeral. We quantified metal (Cd, Cu, Hg, Ni, Pb, Zn) and organic contaminant (polynuclear aromatic hydrocarbon [PAH], polychlorinated biphenyl, and pesticide) concentrations to assess possible causes of toxicity. Thus far, pyrethroid pesticides are the most highly correlated with amphipod toxicity. Summing the individual pyrethroid constituents using a toxic unit approach suggests that the observed toxicity to E. estuarius could be associated with pyrethroids.

Sorption and mobility of PFASs in Australian soils: how little do we know?

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Theme - Per- and poly-fluorinated alkyl substances (PFAS): fate and effects

ABSTRACT

Per- and polyfluoroalkyl substances (PFAS) such as PFOS and PFOA are highly persistent, toxic and bioaccumulative. PFOS is already on the Stockholm Convention list of POPs and PFOA is being considered. The legacy of these chemicals, such as the use in fire-fighting foam formulations, has caused major soil and groundwater contamination problems globally, including in Australia (e.g. Oakey and Williamtown). Assessing the sorption and mobility of PFAS is critical to assessing risk and determining management and remediation options at contaminated sites. Data from overseas may not be relevant to Australian soil conditions and could lead to erroneous conclusions. This presentation reviews aspects of PFAS-soil interactions to highlight these deficiencies.

Due to their unique properties (water-repellent, lipid-repellent, surface activity, surfactant like), conventional rules for predicting sorption and mobility do not apply to PFAS. Due to their hydrophobicity, oleophobicity, ionisability and charge characteristics, the interaction of PFAS with soil is complex. Soil properties such as organic matter, mineralogy, pH, salinity and nature of index cations all have an influence on sorption and mobility of PFASs in soils. Sorption of PFAS compounds to soil increases with carbon chain length, indicating the importance of hydrophobic interaction with soil components. However, several different mechanisms (such as electrostatic, hydrophobic, van der Waals) are expected to play a role in determining their sorption to soil. Consequently, organic carbon-based sorption coefficients (Koc) may not be a true representation of their likely behaviour in the soil environment. We believe that in estimating sorption coefficients (Kd) of PFAS the integrated properties of soils (organic, mineral matter, pH and salinity) should be taken into consideration. We propose this can be achieved through an integrated characterisation of soils using diffuse reflectance infrared spectroscopy. This hypothesis is currently being tested in our laboratory under a project funded by NSW Environmental Trust and will be discussed in this presentation.

Spatial differences in illicit drug use in Australia's capital and regional areas; initial results from the National Wastewater Drug Monitoring Program

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Theme - Environmental analysis and monitoring

ABSTRACT

Wastewater analysis, also called wastewater-based epidemiology (WBE), has become a useful tool for measuring community drug use – both licit and illicit. The central concept is that following the consumption of a given chemical it is metabolised in the body, excreted and ultimately ends up in wastewater. Therefore, samples collected from municipal wastewater treatment plants are representative of the entire community within the wastewater catchment. Data derived from these samples are objective, non-intrusive and can describe use of several substances of concern on a community level. In June 2016, the Australian Criminal Intelligence Commission commissioned The University of Queensland and the University of South Australia to develop a three-year National Wastewater Drug Monitoring Program. This program started in August 2016 and monitors illicit drugs, alcohol and tobacco consumption via wastewater analysis at sites in all Australian capital cities bimonthly as well as selected regional and urban centres on a four-monthly basis to provide both spatial and temporal trends. It is currently the largest national illicit drug monitoring program based on wastewater-based epidemiology at such a high frequency. The program aims to collect up to 7 days of wastewater influent from 20 capital sites across Australia bimonthly and an additional 30 regional sites quarterly. This represents more than 50% of the Australian population. Samples are analysed using validated LC/MS-MS methods to determine concentrations of illicit drugs (methylamphetamine, MDMA and cocaine), opioids (oxycodone and fentanyl), tobacco and alcohol. Wastewater flow volumes, population size and pharmacokinetic data are utilised to back-calculate population normalised consumption estimates. Initial results have revealed significant spatial differences in consumption rates of drugs between capital city and regional sites. In general, higher consumption rates (per 1000 people) of methylamphetamine, tobacco, alcohol, oxycodone and fentanyl were observed in the regional sites, whereas higher consumption of cocaine was observed in city sites.

Synchrotron-based imaging reveals the fate of selenium in striped marsh frog tadpoles

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Theme - Metal toxicity and environmental chemistry

ABSTRACT

Selenium (Se) is a nutritionally essential element that occurs naturally and ubiquitously in the environment in both organic and inorganic forms. Despite being essential for animal health and fitness, Se has a relatively narrow range between deficiency and toxicity, and excess Se can cause a variety of adverse effects in aquatic organisms. Selenium may pose serious long-term threats to aquatic ecosystems because it has the capacity to bioaccumulate and biomagnify in the food chain. The bioavailability and toxicity of Se oxyanions is known to differ, though little is known about their fate and biodistribution in aquatic organisms. Amphibians may be particularly vulnerable to dissolved contaminants during their larval aquatic life stage, because they can accumulate toxic ions through their skin, gills and digestive tract. Despite this, few attempts have been made to understand the tissue-specific uptake and speciation of selenium in larval amphibians. Synchrotron-based scanning x-ray fluorescence microscopy (SXFM) coupled with x-ray absorption near edge structure (XANES) imaging was used to explore the fate of Se in tadpoles of the native frog Limnodynastes peronii. Tadpoles were exposed to an environmental concentration (30 µg/L) of the two dominant dissolved forms that occur in surface waters, selenite and selenate, for 7 days followed by 3 days of depuration. Results showed significantly greater Se accumulation in tadpole exposed to selenite compared to those exposed to selenate, which is in accordance with previous studies. High-resolution elemental maps revealed that Se partitioned primarily in the digestive and excretory organs (i.e., liver, gut, mesonephros, gallbladder, pancreas), as well as the eye lens and retinal epithelium, which may directly relate to previously reported Se-induced impairments in these tissues. Speciation analysis confirmed that the majority of Se was converted to organo-Se forms in these tissues. Results provide new insights regarding the mechanisms and fate of Se in developing anurans that are essential for understanding the risks associated with Se exposure.

Synchrotron-derived crystal-chemistry of nickel in the coastal landscape of New Caledonia

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Theme - Transport, fate and exposure modelling of chemicals in the environment

ABSTRACT

About one third of New Caledonia is covered with peridotites. Because of their significant nickel (Ni) content, the long-term weathering of these rocks under tropical climate lead to the formation of Ni laterite ores that have been mined for more than 150 years. Although very important from an economical point of view, this mineral resource is also a matter of concern from an environmental perspective because of the potential toxicity of Ni.

During several years, we have collected synchrotron data in the various components of the coastal landscape of New Caledonia in order for acquiring a good knowledge of the crystal-chemistry and biogeochemical cycling of Ni that should help to better evaluate the environmental consequences of lateritic Ni mining.

The data collected in the Ni laterite ores shed new light on the formation of the hydrous Mg/Ni silicate deposits known as garnierite (Fritsch et al., 2016). They also emphasize the crystal-chemistry of Ni during the regolith formation by evidencing a vertical change from Ni-bearing phyllosilicates in the peridotites toward Ni-bearing goethite in the laterite (Dublet et al., 2012; 2015). The data collected in the sediments of mangrove downstream Ni laterite ores reveal the coupled biogeochemistry of Ni, Fe and S in such setting by showing the vertical change from Ni-bearing goethite and phyllosilicates in the oxic surface horizons toward Ni-bearing pyrite in the anoxic deep horizons (Noël et al., 2014; 2015). Further studies are in progress in order for confirming the importance of this latter coupling on the biogeochemical cycling of Ni in the lagoonal sediments. Beyond the single case of New Caledonia, all these data bring information that could reveal useful for better evaluating the global environmental impact of lateritic Ni mining, which account for 60 to 70% of the world's Ni resources (Butt & Cluzel, 2013).

Butt & Cluzel (2013) Elements, 9, 123-128. Dublet et al. (2015) GCA, 160, 1-15. Dublet et al. (2012) GCA, 95, 119-133. Fritsch et al. (2016) EJM, 28, 295-311. Noël et al. (2015) GCA, 169, 82-98. Noël et al. (2014) GCA, 136, 211-228.

Synthetic Recycled Fibre LCA of Supply Chains

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Theme - Life cycle assessment

ABSTRACT

For building fabrics, natural fibre is derived from current nature and synthetics from fossil feedstock. Life cycle analysis (LCA) of Australian, Asian, European and American made polymers was done to issue third party certified ecolabels and Environmental Product Declarations since 2010.

Obtaining data on supply chains is challenging. Background data was from IBISWorld and manufacturer's data was collected from 2009 to 2017. This was rolled up in datasets to retain confidentiality, compiled using Boustead life cycle inventory software and subsequently audited by external certifiers.

Life cycle impact assessments were calculated using egalitarian EcoIndicator 99, TRACI and or ReCiPe algorithms in LCADesignTM and Simapro 8 software. Greenhouse and ozone depletion emission factors were updated to those of 2013 International Panel on Climate Change.

Results for fitout for 20 years and buildings for 60 years included recovered:

- Nylon fishing nets remade into polyamide fibre carpet and upholstery;
- Polyethylene Terephthalate bottles remade into polyester fibre blinds and insulation;
- Glass bottles recycled remade into fibre reinforced non woven fabric and glass wool insulation.

Comparisons of novel low melting point polymers bonding ceramic and polymer yarns also included non woven reinforcing in room lining and insulation.

LCA results of polymer content and novel fibre chemistry show increasing upcycled post consumer recycled (PCR) content in building fabric. Across global supply chains trends include increasing reliance on regenerated content, renewable energy and emergence of full cradle to cradle building fabric.

Dramatic moves were found to integrate global supply chains in polyamide and polyester technology with each fully recyclable without downcycling or loss of quality so cradle to cradle recycling is now common.

Comparisons were made with sheepwool, cashmere and organic cotton meeting comparable product category rules. Results show sustainability attributes of synthetics can surpass natural fibre.

The Carbon Mineralization Characteristics of Victorian Biosolids

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Theme - Transport, fate and exposure modelling of chemicals in the environment

ABSTRACT

Biosolids produced as a by-product of the sewage treatment process have great potential as sources of organic matter for sequestering carbon in soil. To offset water corporations' carbon emissions, accurate carbon sequestration data is required. Victorian biosolids products fall in one of the four major groups based on stockpiling duration and treatment type; viz. <3 year stockpiled, >3 year stockpiled, composted and thermally dried. These biosolids products are used for a variety of purposes, but are most commonly used as a fertilizer and soil conditioner for pasture and fodder production. The major differences in the biosolids products are the varying concentrations of clay and carbon which are caused by the age and type of dewatering and maturation processes used. This study found that the clay and carbon content in biosolids can vary across the four groups ranging from 5 37% and 5-39%, respectively.

Mineralisation studies were undertaken to determine biosolids carbon sequestration rates. Two incubation experiments were designed to investigate the mineralisation rates of the four biosolids groups and the effect that clay type and concentration has on the carbon mineralisation rate. The two experiments ran in parallel over 300 days using CO_2 passive sampling techniques. The results show that each of the four biosolids group have significantly different carbon mineralisation rates and the age of the biosolids stockpile was found to have the greatest effect on the mineralisation rate. The clay types used in the experiment (kaolinite, bentonite and drying pan clay) and the clay concentration (ranging from 10-50%) had no significant effect on carbon mineralisation. The results of this study will provide important information to water authorities in Victoria to take advantage of federal government initiatives to sequester carbon in agricultural soils.

The comparative effects of a biological (Metarhizium acridum) and a chemical (Fipronil) pesticide on arid-zone grassland ecosystems

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Theme - Environmental analysis and monitoring

ABSTRACT

Along with State and local pest control agencies and landholders, the Australian Plague Locust Commission (APLC) manages locust populations across two million square kilometres of arid and semi-arid grasslands in eastern Australia. The APLC uses several pesticides to manage locust population increases, but of these, the effects of fipronil (a phenyl pyrazole), and the biological agent, Metarhizium acridum (Green Guard®) on vertebrate and non-target invertebrate communities are poorly known.

The aim of this study was to monitor the effects of fipronil and M. acridum on non-target aridzone biota. We studied the responses of reptile, invertebrate and microbial assemblages, and decomposition processes in a large, field-scale study with replicated control and sprayed treatments, which simulated the scale of aerial-based locust-control operations in Australia.

Neither reptile abundance nor community composition was significantly affected by locust-control treatments. Arthropod community composition was not significantly affected by either locust control treatment. However, significant short-term treatment effects were found for Collembola, Acarina, Coleoptera, Psocoptera, Gryllidae and Diptera. We also found effects of fipronil on two common ant species (Rhytidoponera mayri and Iridomyrmex purpureus) but no such effects of M. acridum. The suppression of R. mayri abundance persisted after one year, while I. purpureus had fully recovered. There was no detectable impact of either locust control treatment on termite activity, bait mass loss or termite community composition, nor was there a significant pesticide treatment effect on litter decomposition or bacterial community functional diversity. Overall, the ecology of this arid zone region was more influenced by drought and sporadic rainfall events than the pesticide treatments.

The temporal variation observed across biota indicated that climate and environmental factors are likely to be stronger drivers of arid zone ecology than single aerial applications of low-dose aerial pesticide treatments used to control locusts in arid and semi-arid regions of Australia.

The effect of sterilisation methods to remove background organisms prior to performing a whole-sediment chronic algal bioassay

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Theme - Emerging ecotoxicological techniques and test methods

ABSTRACT

The use of a battery of whole-sediment toxicity tests is recommended when assessing the risks posed by contaminated sediments. Representing a vital component of sediment ecosystems, benthic algae are poorly represented globally in the range of organisms available for assessing the risk of chronic effects to benthic biota. Recently we have added to our suite of methods a new benthic algal growth bioassay that appears sensitive to a range of contaminants. Indigenous biota that exist within test sediments may potentially impact the results of many whole-sediments bioassays. In the case of the benthic algal bioassay, both background algal populations and meiofauna may create positive or negative interferences with the test endpoint. We investigated the use of a range of sterilisation methods to remove these indigenous organisms, including freezing, autoclaving, gamma irradiation and nitrogen bubbling. Treatments with and without sterilisation of the sediment were used to remove indigenous organisms prior to testing and assessed by the improvement in the assessment of algae growth rates in uncontaminated and contaminated sediments. In this presentation we discuss each sterilisation method with respect to the degree of variability between replicates and the influence of the sterilisation method on the contaminants bioavailability and toxicity. All methods of sterilisation increased the amount of chlorophyll a extracted (surrogate for test algal growth) and reduced replicate variability. Overall, the most effective method was bubbling overlying waters with nitrogen, which was effective for removing meiofauna (most impact on the test endpoint) with minimal influence on background chlorophyll a, and the least impact on sediment contaminant chemistry.

The impacts of suspended sediments on coral fertilisation - pathways, thresholds, and risk probabilities

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Theme - Marine Ecotoxicology and Chemistry

ABSTRACT

Sediments introduced to and disturbed within the marine environment near sensitive areas like coral reefs present a water quality concern for marine resource managers. Using an ecotoxicological approach, cause–effect pathways, concentration–response thresholds, and risk probabilities were determined to assess the implications of suspended sediments on fertilisation of broadcast spawning corals. We found that sediments containing mineral clays and sticky organic matter (extracellular polymeric substances) mediated the formation of sediment–sperm flocs that reduced the number of sperm available to fertilise the eggs. These sediments presented the greatest impact to coral fertilisation whereas sediments lacking these 'sticky' components resulted in higher effect thresholds. When effect thresholds were compared against in situ water quality data from three major dredging programs in Western Australia, the increase in risk probabilities during dredging compared with background conditions was limited, and occurred most notably within a few kilometres of the operations.

The importance of selecting an appropriate pH buffering method during toxicity testing

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Theme - Emerging ecotoxicological techniques and test methods

ABSTRACT

Given the importance of pH in influencing the speciation, bioavailability and, ultimately, toxicity of contaminants in solution, numerous methods have been developed for controlling pH in ecotoxicological tests. Commonly used methods include chemicals that specifically control pH (for example Goods Buffers), carbonate buffering and acid/base addition, which all may control pH, but also have associated limitations. Hence, it is important to select a method that delivers the desired pH control but has a limited effect on test organism performance. We explored pH control and effects on test organisms of two types of buffering method; pH controlling chemicals and carbonate. Three pH controlling chemicals, MES, MES sodium salt and HEPES, were trialled using two tropical species; the duckweed, Lemna aequinoctialis, and a pulmonate snail, Amerianna cumingi. MES adequately controlled pH for both species at the lowest concentration tested, whereas HEPES did not sufficiently control pH (<0.3 change in pH) at any of the concentrations for A. cumingi and only at concentrations >2 mM for L. aequinoctialis. All buffers reduced the reproduction of A. cumingi, even at the lowest concentrations tested. However, L. aequinoctialis growth rate was not affected. Carbonate buffering was also trialled with L. aequinoctialis. During ammonia toxicity testing with a carbonate buffer, a dramatic decrease in pH was observed in treatments with low concentrations of ammonia compared to the control (ammonia = 1.1 pH unit decrease, control = 0.3 pH unit increase after 96 h). In conclusion, MES was a suitable buffering chemical for use with L. aequinoctialis, while carbonate buffering and HEPES were not feasible. None of the chemicals trialled were acceptable for A. cumingi as they reduced reproduction, and further investigation is required to establish a buffering method for this species. Observed differences in sensitivity and efficacy of buffers across species highlight the importance of selecting a pH control method that is suitable to your test species as well as the test system in question.

The new Australian and New Zealand Guidelines for Fresh and Marine Water Quality website

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Theme - Environmental management

ABSTRACT

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Water Quality Guidelines), formerly known as the ANZECC and ARMCANZ (2000) guidelines, are a definitive and 'best practice' tool for managing and assessing water quality. They are a joint initiative between the Australian and New Zealand governments and the Australian state and territory governments, and have been used by practitioners since 1992 to manage water quality. In Australia the Water Quality Guidelines form part of the National Water Quality Management Strategy, a joint national approach to improving water quality in Australian waterways.

The Water Quality Guidelines have recently been revised and updated to incorporate the best available science and guidance on water quality management and assessment. The new dedicated and easy-to-use website is fully interactive and allows users to tailor their experience to their personal circumstances and local conditions.

This presentation will take you on a journey through the website to show you some of the key revisions to the Water Quality Guidelines, including the:

• updated and expanded water quality management framework

• revised toxicant default guideline values

• new physical and chemical stressor information for more ecoregions

• weight-of-evidence process for assessing and managing water quality

• indigenous cultural and spiritual values.

The phototoxic effects of hydrocarbon fuels on coral larval settlement

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Theme - marine ecotoxicology and chemistry

ABSTRACT

Some polycyclic aromatic hydrocarbons (PAHs), common to oil and petroleum fuels, exhibit phototoxic properties whereby toxicity increases in the presence of ultraviolet radiation (UVR). Globally, many exploitable oil reserves are situated in tropical marine environments in proximity to shallow-water coral reef systems, however only a handful of studies have examined the phototoxic effects of hydrocarbon fuels on scleractinian corals. The sensitivities of Acropora millepora and Acropora tenuis, two common reef- building corals, were assessed through static exposures of planula larvae to water accommodated fractions (WAF) of heavy fuel oil (HFO), diesel and three individual PAHs. The toxicity of HFO and diesel WAFs doubled in the presence of UVR exposures expected in shallow coral reef habitats. UVR exposure interacted with the PAHs anthracene and pyrene strongly, increasing their toxicities by 10- and 40-fold, respectively. However, this phototoxic effect was highly dependent on PAH structure with no increase in toxicity observed for phenanthrene. A previously unrecognised response to PAHs was observed whereby coral larvae divided or fragmented into smaller yet motile and potentially functional clones. Further work is needed to investigate whether this phenomenon is analogous to autotomy which can occur in some members of Fungiidae and Actinaria. The recruitment of scleractinian corals may be severely affected by exposure to petroleum hydrocarbons, potentially preventing or delaying the natural recovery of reefs after accidental spills. The results from this study indicate that by ignoring phototoxicity, the risks posed by oil and fuel spills may be significantly underestimated in shallow-water tropical coral reef systems.

Impacts of nickel on different life stages of corals

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Theme - Marine Ecotoxicology and Chemistry

ABSTRACT

The mining and production of Ni is increasing in tropical regions. The potential impacts of these activities on the valuable coastal ecosystems are poorly understood. Specifically, there is little information available on the effects of Ni to corals. Scleractinian corals are keystone species for coral reefs forming vital structural habitats that support other species, resulting in habitats with high species richness and diversity. For these reasons, it is important that future research provides data which can inform the sustainable development of Ni operations in tropical regions.

This study aimed to investigate the effect of dissolved Ni exposure to the scleractinian coral Acropora muricata. Utilising the facilities at the National Sea Simulator (SeaSim), flow through chambers (2.5L) were used to test the effects of Ni and Cu on adult corals and its associated microbiota. Copper was tested alongside Ni to allow for comparisons with past studies.

Four replicate chambers were used for; control, 50, 100, 500, 1000, 10000 µg/L Ni and 5, 20, 50, 100 µg/L Cu. Each replicate chamber contained 3 coral fragments (5-8cm in length). After a 96-h exposure, 1 fragment from each chamber was sacrificed for 3 different analytical purposes. One replicate was air blasted to remove tissues which were flash frozen and later used for DNA and RNA sequencing of the microbiota to observe if the bacterial community structure changed in response to metal exposure. A second fragment was air blasted to remove tissues, which were then acid digested and analysed by ICP-MS to determine metal concentrations in the coral tissues. A third replicate was frozen for subsequent metal uptake and distribution analyses using elemental mapping techniques including CT scanning and XRF-ITRAX.

Control treatments remained healthy throughout the exposure. After 36 h, bleaching was observed in corals exposed to 50 and 100 µg Cu/L and 10000 µg Ni/L. At 96 h significant discolouration of corals was observed in Ni treatments 500 and 1000 µg Ni/L. The effects of Cu and Ni on adult corals and associated microbiota will be discussed.

The sorption of PFOA in Australian soils

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Theme - Transport, fate and exposure modelling of chemicals in the environment

ABSTRACT

Emerging contaminants, such as perfluorinated alkyl substances (PFASs) are of increasing concern in the environment due to their stability, longevity, bioaccumulation and potential toxicity. These attributes have led perfluorooctanesulphonic acid (PFOS) to be placed on the Stockholm Convention for persistent organic pollutants (POPs) and perfluorooctanoic acid (PFOA) is currently being considered. Concentrations of PFASs in soils varies greatly from pg/L to mg/L in the literature but are particularly high in contaminated sites such as fire-fighting training grounds and airfields (mg/L). Once exposed in the environment their behaviour and interactions with soil are not completely understood. Small scale studies, < 10 soils, in terrestrial systems have indicated that there are relationships between retention of PFAS compounds and soil organic matter content, clay content and iron oxides. In this study one PFAS compound, 14C-perfluorooctanoic acid (PFOA), was tested for its sorption capacity to 100 characteristically different soils from an Australian national soil archive. The soils were randomly selected to provide a wide range of properties such as pH, total carbon content, cation exchange capacity and clay content. Soil-water partitioning coefficients (Kd) varied from 0.6 to 14.7, a similar range to currently used pesticides and other organic contaminants. This research will be extended to include other PFASs in more soils to allow for the modelling of PFAS mobility in the environment. This information will be important in better understanding the properties of soils that could influence the fate and transport of PFASs in soils.

Key words

PFOA, partitioning, soil.

Toxicity of Dissolved Barium to a Freshwater Alga (Chlorella sp. 12) and Water Flea (Ceriodaphnia dubia)

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Theme - Metal toxicity and environmental chemistry

ABSTRACT

Dissolved (<0.45 µm filtered) barium is a geogenic contaminant that can be present at high mg/L concentrations in produced waters from coal seam gas (CSG) and shale gas extraction, however, there is no internationally available barium water quality guideline to assess the impacts of dissolved barium on freshwater biota. There are also no published toxicity data that separate the effects of dissolved versus precipitated barium. The solubility of barium as barium chloride in solution is controlled primarily by the precipitation of barium sulfate with increasing sulfate concentration. Predictive modelling of dissolved barium concentration using Visual Minteq (and confirmed experimentally), demonstrated that 0.1-82% of total barium would be in dissolved form in the standard USEPA synthetic soft water (SSW) used to conduct toxicity tests with freshwater organisms as a result of barium precipitation. To test the toxicity of dissolved barium rather than precipitated barium, we modified the SSW by substitution of sulfate salts with chloride salts and conducted chloride control toxicity tests in parallel with barium toxicity tests. We performed chronic algal growth rate inhibition tests with the tropical freshwater alga, Chlorella sp. 12 at 27°C and acute immobility tests with the water flea, Ceriodaphnia dubia at 25°C. These bioassays represented acute and chronic toxicity of different taxonomic groups at subtropical/tropical temperatures. Filtered and unfiltered barium was measured at test initiation and termination to confirm solubility. Based on measured dissolved barium, the chronic algal growth rate inhibition IC10 was 14 mg Ba/L (geometric mean, n=2) and the acute water flea immobility EC50 was 16 mg Ba/L (geometric mean, n=2) which became 1.6 mg Ba/L when converted to a chronic EC10 using a default acute to chronic ratio of 10. These effect concentrations may contribute to a database for barium guideline derivation in the future that assists industry and regulators with setting discharge limits of CSG produced water to receiving freshwaters.

Toxicity of mining contaminant mixtures to tropical freshwater species

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Theme - Toxicity of mixtures and multiple stressors

ABSTRACT

Magnesium (Mg), uranium (U), manganese (Mn) and ammonia (NH3) are primary Contaminants Of Potential Concern (COPCs) from the Ranger uranium mine, Northern Territory. Following extensive research on the toxicity of these individual COPCs on local biota, site-specific guideline values (GVs; to protect 99% of species) are currently in place for Mg (3 mg/L), Mn (75 µg/L), U (2.8 µg/L) and NH3 (interim GV of 0.7 mg/L TAN based on international data corrected to site-specific pH and temperature). As these GVs were derived using single-toxicant tests, there is a need to confirm that the GVs are sufficiently protective when these contaminants occur as a mixture.

Exposure of six local species to a mixture of the COPCs at their site-specific GV concentrations at background Ca resulted in toxicity to four of the species. The reduction in either growth or reproduction, compared to the control, was: duckweed Lemna aequinoctialis (100%); green hydra Hydra viridissima (27%); green alga Chlorella sp. (14%); and cladoceran Moinodaphnia macleayi (12.5%). Further data will be collected to determine the COPC or combination thereof responsible for toxicity.

Historical Direct Toxicity Assessment (DTA) data from groundwater and pond waters have also been analysed. The analyses indicated that U was likely to be the primary COPC causing effects. A limited DTA of one groundwater source showed greater toxicity than expected to H. viridissima but lesser adverse effects on L. aequinoctialis and Amerianna cumingi. This groundwater had elevated, Mg (350 mg/L), Ca (70 mg/L), Mn (350 µg/L), and SO4 (1450 mg/L), but low U. The observed effects may have been associated with interactions with other metals and/or major ions. These data will be supplemented with comprehensive DTAs of various mine water types with different COPC concentrations and compositions to further understand interactions between COPCs and associated implications for water quality GVs. This will inform rehabilitation standards for individual contaminants, and ensure they are protective of the aquatic ecosystems where these contaminants will occur as mixtures.

Toxicity of terrestrial contaminants to the Antarctic soil nematode Plectus murrayi

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Theme - Metal toxicity and environmental chemistry

ABSTRACT

Anthropogenic activities in Antarctica have led to chemical contamination of terrestrial ecosystems, with main contaminants of concern being hydrocarbons and metals from fuel spills and past waste management practises. Remediation targets and guidelines for clean-up of contaminated sites require estimates of the sensitivities of local species. A challenge for Antarctic terrestrial toxicity assessments is the low biodiversity and the absence of soil macrofauna, which limits the number of species available for testing. One of the most common microinvertebrates, distributed throughout ice free areas in Antarctica, is the endemic soil nematode Plectus murrayi. This species is slow growing and has a long life cycle compared to standard nematode toxicity test species. Both culturing methods and toxicity test protocols have now been developed with this species.

Initial results on the sensitivity of P. murrayi to copper in aqueous toxicity tests, and in tests on elutriates of contaminated soil collected from an Antarctic diesel spill site currently undergoing remediation, are presented. This species displays the slow response to contaminants typical of most Antarctic biota. Juveniles were highly sensitive to Cu with a 21 d EC50 of 41 µg/L (based on normal movement) and an LC50 of 460 µg/L. Sensitivity increased with increasing exposure time, with an LC50 of 246 µg/L at 24 d. Egg hatching success and time to death declined with increasing Cu concentration. Plectus murrayi showed a concentration response to diesel elutriates with 50% reduction in the number of mobile juveniles following 17 d exposure to 100% elutriate treatments.

Plectus murrayi is a suitable test organism to derive contaminant sensitivity data to contribute to the development of Antarctic terrestrial soil quality guidelines for fuels and metals. Further testing with P. murrayi will include exposure to elutriates of aged diesel spiked soil, as well as diesel contaminated soils at different stages of remediation. This will help us answer the question of “how clean is clean enough?” in the remediation of Antarctic terrestrial environments.

Trace Element Contaminant Uptake in Phytocap Vegetation and Implications for Koala Habitat, Lismore, Northern NSW

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Theme - Environmental analysis and monitoring

ABSTRACT

Phytocaps are increasingly regarded as effective, economical and environmentally-friendly alternatives to conventional landfill caps. In 2013, the first licensed phytocap in NSW was established on a historic landfill site in Lismore and is comprised primarily of koala habitat species. Plants established on landfills are potentially exposed to elevated levels of trace metals, storing them in their leaves and releasing them into the food-chain. This study sought to determine foliar trace element contamination of the Lismore phytocap and potential risks to grazing koalas. Soil contamination was also investigated. Eucalyptus tereticornis and Acacia melanoxylon were studied as the key koala food tree and reference native species respectively. Samples were analysed via ICP-MS at a NATA accredited laboratory. Foliar trace element concentrations were higher in phytocap vegetation than that growing on the uncontaminated reference site (Southern Cross University (SCU) campus) though differences were of little significance besides As which was higher than SCU at all sampling sites ($p=<0.001 df=19$). Maximum concentrations of As, Zn, Pb, Cu and Ni in E. tereticornis foliage were 0.5, 114.7, 6.1, 11.9 and 9.7mg/kg respectively, detected in samples from the northern side of the phytocap. Average concentrations in E. tereticornis foliage were compliant with national and international standards for contaminants in animal feed (NSW, 2010; WHO & FAO, 2015). Trace element levels in phytocap soil were below Australian soil and sediment quality guidelines (ANZECC & ARMCANZ, 2000; NEPC, 1999). However, data was highly variable within and between sampling locations. Upper ranges of foliar Pb and As, and soil Zn, Mn and As were borderline by some regulatory measures. The benefits derived from the phytocap are thought to overshadow risks to koala health posed by trace element uptake. However, further investigation is advised and monitoring is required, particularly of individual trees favoured by koalas. The importance of soil condition for plant health and thereby phytocap performance should not be overlooked in future designs.

Transport and fate of per- and poly-fluoroalkyl substances (PFAS) in groundwater in Greater Melbourne

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Theme - Per- and poly-fluorinated alkyl substances (PFAS): fate and effects

ABSTRACT

Per- and Polyfluoroalkyl Substances (PFAS) are a family of persistent organic pollutants that have made their way into every biome on Earth's surface from over 50 years of use. The purpose of this study was to investigate the transport and fate of PFAS in groundwater from a variety of suspected sources including recycled water, landfill leachate and industrial waste. A number of sites in the newer volcanic formation west of Melbourne, VIC were sampled, extracted using solid phase extraction (SPE) and analysed with liquid chromatography-tandem mass spectrometry (LC-MS/MS QQQ). Average PFBA, PFOA and PFOS concentrations were 7.05±1.35 ng L-1, 3.53±1.65 ng L-1 and 5.45±2.25 ng L-1 respectively (n = 12). The highest concentrations of each analyte measured were at one site 16.92, 20.69 and 26.12 ngL-1 for PFBA, PFOA and PFOS. Furthermore, results from continuing sampling campaigns will be discussed.

Turtle Time Machines; How Scutes Can Help Us Evaluate Temporal Trends for Trace Element Exposure Investigations

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Theme – Marine Ecotoxicology and Chemistry

ABSTRACT

Biomonitoring for indications of elevated trace element exposure in endangered marine megafauna (such as green turtles) is often limited to small volumes of blood. While blood is considered a suitable matrix for evaluating relatively recent trace element exposures, green turtles also have external keratinized scutes (homologous to fingernails) that cover their dorsal shell and which integrates a longer time period of trace element exposure. Significant correlations between turtle blood and scute concentrations were found for Co, As, Mo, Sb, and Cd for populations that are presumed to experience relatively stable exposure conditions. In the absence of toxicokinetic models for these elements in turtles, simple linear regressions between blood and scute concentrations were taken to represent the steady-state relationship for these elements. A conceptual model was proposed to predict how an elevated exposure would affect blood and scute concentrations relative to the steady-state regression plot. Using turtle blood and scute collected from three populations foraging at coastal sites subject to differing anthropogenic stressors, it was possible to identify recent vs past exposure profiles predicted by the conceptual model. On-going exposure investigations at these sites are expected to provide a sufficiently long investigation period to validate the conceptual model. In the interim, individual turtles from the coastal sites that have already been recaptured and sampled across a few years nevertheless allow us to visualise changes that are generally in-line with the model predictions. Biomonitoring of paired blood and scute trace element concentrations provide a simple and reasonably accurate method for evaluating temporal trends in trace element exposure.

Updating the ANZECC water quality guidelines for copper and zinc

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Theme - Metal toxicity and environmental chemistry

ABSTRACT

The ANZECC (2000) water quality guidelines are currently being updated after being in use for 15 years. In New Zealand, there is considerable interest in updates of guidelines for copper and zinc, mainly due to their concentrations in stormwater and downstream receiving environments. The process for this update is the same as for pesticides and emerging contaminants that also being updated currently, with two key differences that will be discussed in this presentation. Firstly, in contrast to other contaminants, there is no shortage of toxicity data for these metals. For example, an initial search of toxicity databases for copper in marine waters yielded over 3000 lines of data. This required considerable data filtering to include only data from chronic tests, which measured metal concentrations, and reported important water quality characteristics.

Secondly, the metals are also highly influenced by water quality factors, such as hardness, pH and dissolved organic carbon (DOC). In freshwater, increases in hardness reduce the aquatic toxicity of zinc, and increases in pH increase the toxicity. In fresh and marine waters, the presence of DOC reduces the aquatic toxicity of copper, as copper binds to DOC, decreasing bioavailable free copper. As part of the guideline derivation we developed new algorithms for adjusting the conservative default guidelines based on these water quality factors. The freshwater zinc guidelines have adjustments for both hardness and pH. The copper guidelines for freshwater and marine waters have an adjustment for DOC. These adjustments result in substantial changes to the guideline value, implying that site-specific measurements of water quality factors will be required in the future to avoid applying excessively stringent default guidelines. The marine zinc guidelines have no adjustments for water quality characteristics.

High reliability guideline values were derived for copper and zinc in fresh and marine waters, based on at least 19 different species from at least 5 taxonomic groups. All guidelines incorporate multiple species native to, and resident in, New Zealand and Australia.

Uptake of poly-and perfluorinated substances by terrestrial plants - a review

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Theme - Per- and poly-fluorinated alkyl substances (PFAS): fate and effects

ABSTRACT

Poly- and perfluorinated-alkyl substances (PFASs) have raised concern recently in Australia due to contamination of soils and waters from use and spills of aqueous film-forming fire-fighting foams (AFFFs). These substances have been in use worldwide since the 1950s and are extremely persistent in the environment, but whether they cause adverse effects on human health is still unknown. The main compounds investigated to date are perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA), and perfluorohexanesulfonic acid (PFxHS), although there are numerous precursor molecules that are under investigation. One exposure pathway of human intake is the consumption of food grown on soils contaminated by PFASs either through land re-use of solid wastes (e.g. biosolids), liquid wastes (e.g. sewage effluents) or irrigation using contaminated water containing these chemicals. Food Standards Australia New Zealand (FSANZ) has proposed low trigger concentrations in fruit of 0.6 ?g/kg (total PFOA+PFOS+PHxHS) and 1.1 ?g/kg for vegetables for investigation of PFAS contamination. Little is known of the uptake of these chemicals into food species – it appears the pathway of entry into plant roots is markedly different for PFOA compared to PFOS, with the former being transported across root membranes by metabolic processes whereas PFOS may be transported through aquaporins in the cell wall. Shorter-chain length PFAS compounds appear to be more bioavailable to plants than longer chain length compounds. Considering current bioaccumulation factors and typical soil concentrations at contaminated sites, risks to humans from the soil-to-plant exposure pathways are likely low.

Using wastewater analysis to find population and demographic markers in wastewater

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Theme - Environmental analysis and monitoring

ABSTRACT

Wastewater contains excretion products of chemicals which humans have been exposed to and/or consumed. Therefore, wastewater analysis of samples from municipal wastewater treatment plants can be a useful tool for determining chemical exposure and consumption for the associated wastewater catchments. The use of wastewater sampling and analysis contributes to a broader field that is referred to as wastewater-based epidemiology. A major benefit of wastewater based epidemiology is that per capita estimates of exposure to a given chemical within a population can be made allowing for both spatial and temporal analysis. This can be conducted quantitatively, quickly and cost effectively. The approach for back estimating consumption relies on measuring the concentration of specific metabolites in representative wastewater samples, multiplying by the volume of wastewater represented by the sample, dividing by the population size from which the sample originates and correcting by factors such as the excretion factor of the metabolite.

It has previously been determined that the population size is the largest uncertainty for WBE estimates. In an earlier study we tried to address this uncertainty by identifying potential population markers in wastewater samples collected from 10 wastewater treatment plants during the 2011 Australian Census which allowed for accurate population counts to be determined. The potential markers (mostly pharmaceuticals and personal care products) were combined in a Bayesian inference model to estimate the daily (de facto) population size. This sampling approach was applied more comprehensively during the 2016 Australian Census for approximately 100 wastewater treatment plants covering approximately 70% of the population. Work has commenced on analysing these samples to allow for recalibration of the previous model and to screen for additional population and demographic markers.

Validating bioanalytical approaches for screening chemical mixture exposure in whole blood of sea turtle populations from the Great Barrier Reef

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Theme - Emerging ecotoxicological techniques and test methods

ABSTRACT

Many populations of the globally endangered green turtle, Chelonia mydas, spend a large part of their life foraging in narrow home ranges of coastal and estuarine environments. In these habitats, they are exposed to mixtures of both known and unknown chemicals which are structurally diverse and in a constant state of flux. Thus, difficult and costly to characterise and monitor with traditional target analyses. The objective of this study was to validate and apply effect-based methods by which whole blood can be used to screen internal exposure across a wide range of chemical properties and groups. Whole blood samples were collected from immature adult green turtles with long-term foraging grounds in agricultural, urban and remote areas of the Australian Great Barrier Reef. The blood was extracted using a QuEChERS method recently developed for multi- and non-target instrument analysis of lipid rich matrices, and validated across a wide range of physico-chemical properties. The blood extracts were then dosed to a battery of in vitro bioassays (AhR-CAFLUX, AREc32, NF?B-bla, VM7Luc4E2, Microtox), each with a different mode of actions in order to cover a wide range of bioactive chemical groups. The results demonstrate the feasibility of in vitro screening of chemical mixtures using QuEChERS extracted whole blood, with no matrix interferences observed across the different bioassays. Application of this method to the three turtle populations identified distinct differences in chemical mixture exposure with higher inductions of AhR-CAFLUX, AREc32 and Microtox in blood from turtles foraging in the agricultural compared to the urban or remote areas. Overall, the results from this study suggest that dosing of QuEChERS extracted blood to quantify effect-based measures of chemical mixture exposure could be a suitable tool for characterising internal exposure of organisms to complex chemical mixtures. When applied within a multidisciplinary framework, such capabilities could offer valuable information for understanding links between exposure and health in vulnerable and endangered species or other organisms.

Validation of soil leaching protocols for determining PFAS mobility in soils

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Theme - Per- and poly-fluorinated alkyl substances (PFAS): fate and effects

ABSTRACT

The use of poly- and perfluoroalkyl substances (PFASs) and their precursors in some firefighting foams has led to contamination of land in Australia and overseas. PFAS can leach from soils over time and can be transported long distances in groundwater. Measurement of leachability of PFASs from soils is therefore important for assessing contaminated sites, but validation information for PFAS leaching protocols is lacking. This study used three PFAS contaminated soils obtained from fire training grounds to assess:

1. the variability amongst PFAS concentrations in leachates using the Australian Standard Leaching Protocol (ASLP) with unbuffered reagent water

2. the difference between leachate results based on different soil preparation methods, i.e. soil sub-sampled after drying and sieving (homogenised) compared to soils sub-sampled prior to drying and sieving (non-homogenised)

3. the effect of leachates storage time, prior to filtering and analysis

Aims 1 and 2 were also investigated using Toxicity Characteristic Leaching Procedure (TCLP) at pH 5.

For PFOS, the relative standard deviation was < 25 % for all treatments. Leachate results for PFOS in two of the three soils were =1.2 times higher in non-homogenised compared to homogenised subsamples. In the third soil, the trend differed, with PFOS 6.8 times higher in homogenised compared to non-homogenised subsamples. In all cases the differences were significant (t-test, $p < 0.05$). Time taken to filter leachates did not have an effect on PFOS concentrations (t-test, $p > 0.05$ in all cases). Similar trends regarding variability and differences between soil pre-treatments (homogenised or non-homogenised) were observed in the TCLP leachates.

Overall results show that variability introduced when using typical soil leaching procedures is acceptably low and demonstrates these methods are useful for comparing soil leachability between different contaminated sites. Further work is required to validate differences in leachability of PFASs at different leaching pH, which may influence the potential adoption and leaching properties of PFASs.

Weight of evidence evaluations to inform water quality guideline values: Case studies using magnesium from Northern Australia

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Theme - Environmental management

ABSTRACT

Biological-effects data used for water quality guideline value (GV) derivations for contaminants may be sought from a spectrum of exposure conditions, from laboratory single-species systems with control over the conditions that influence toxicity, to more realistic and complex field settings, studying assemblages in natural conditions. All approaches have their advantages and disadvantages. Field exposures in natural systems provide environmental realism but are often confounded by multiple stressors or environmental variation unrelated to the contaminant of concern and may lack pre-disturbance data. For two locations in northern Australia, Ranger Uranium Mine (RUM) and the Argyle Diamond Mine (ADM), extensive laboratory, field experimental and field observational (community level) studies were conducted to inform magnesium GV derivations for receiving waters. For both locations, there was consistency in the candidate GVs derived amongst the three lines of evidence (LOEs): for RUM, GVs of <5 mg/L Mg, and for ADM, GVs ranging between 14–18 mg/L Mg. The ranges reflected the soft and hard-water receiving environments of both locations respectively.

Guidance on determining a GV from a number of candidate values is limited, but includes: using the mean or a percentile of the values; weighting the different LOEs on weight of evidence criteria, including certainty in the underlying science or models; conservatism (most protective value); or regulatory precedence. For RUM, consistency amongst candidate GVs and the high conservation value of receiving waters favoured averaging of the candidate GVs. For ADM, some receiving water quality exceeded candidate GVs but the receiving ecosystems were adjudged as slightly-moderately disturbed, and supporting key ecological services despite the absence of salt-sensitive leptophlebiid mayflies. In this case (ADM), no worsening of water quality was a recommended condition for water quality management at the site. Thus, apart from technical determinations, other local factors need to be considered when making decisions about converting GVs to local water quality objectives.

POSTER PRESENTATIONS

A high-throughput direct injection method for analysing 14 phthalate metabolites, 5 bisphenols and triclosan in urine

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Theme- Advances in analytical chemistry

ABSTRACT

Phthalates, bisphenols and triclosan have all been identified as chemicals of concern due to their widespread use and possible adverse human health effects. Phthalates are used widely as plasticisers and in personal care products and have been studied for their associations with several health effects such as cancer and reproductive effects. Bisphenols are used to produce polycarbonate plastics and epoxy resins. Increasing concerns over the endocrine-disrupting effects of Bisphenol A (BPA) has led to its substitution in consumer products by other bisphenols which have not been studied as widely and may have similar health effects. Triclosan, an antibacterial agent, may contribute to the increase of antibiotic-resistant bacteria and possible cancer development.

Accurate human exposure data for these chemicals is vital. Current methods typically rely on online or offline-SPE to concentrate and clean up samples. A novel method is presented here which avoids lengthy concentration steps and utilises direct injection of small volume samples. Samples are analysed by high performance liquid chromatography/tandem mass spectrometry and use isotope dilution for quantitation. The mass spectrometer is operated in scheduled multiple reaction monitoring mode with negative electrospray ionization. To our knowledge this is the first analytical method capable of simultaneously measuring 14 phthalate metabolites, 5 bisphenols and triclosan without pre-concentration steps.

The method has been validated and procedural blanks, quality control samples, inter- and intra- batch replicates and certified reference material are added to each batch as quality control. Application of the method to inter-laboratory proficiency trial samples yielded results within the acceptable ranges for the seven phthalate metabolites and BPA covered by the programme.

The high-throughput nature of this method facilitates large scale monitoring programmes, and has already been applied to determine urinary levels in large cohorts of pregnant women (n = 880) and children (n = 200). The method is being adapted to other matrices such as follicular fluid.

Accurate determination of titanium dioxide nanomaterials (nTiO2) in environmental matrices

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Theme- Advances in analytical chemistry

ABSTRACT

Conventional digestion techniques such as aqua regia and nitric acid which are commonly used for soil and plant digestions respectively did not perform well for the recovery of nTiO2. However, the use of a mixture of H2SO4: HNO3 (1:2) with either a block heater or microwave assisted digestion provided good recoveries of Ti when compared with the traditional HF-H2SO4 based digestion. Sulphur oxide interferences on the major Ti isotope (m/z = 48) were overcome, using an ammonia reaction gas during ICP-MS analysis for Ti. While results for the conventional muffle furnace (MF) - potassium hydroxide (KOH) fusion technique were comparable with the H2SO4: HNO3 (1:2) microwave assisted digestion technique, the MF technique had slightly better digestion efficiency and was less labour intensive and quicker. This work demonstrates that common digestion techniques may underestimate a number of nanomaterials present in environmental matrices and highlights the importance of validating proposed analytical techniques for the recovery of emerging contaminants such as nanomaterials prior to conducting more extensive contaminant dynamic experiments.

Australian Building LCA History

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Theme - Life cycle assessment

ABSTRACT

The authors review key developments in Australian building industry-specific Life Cycle Assessment (LCA) implemented since 1995.

This work partly focuses on the single project coherent building product LCI from Sydney's Green Olympic Games held in 2000.

The scope includes progress achievements in global supply chain Life Cycle Inventory (LCI) development integration with automated whole building LCADesignTM and Simapro Life Cycle Impact Assessment (LCIA) tools. It includes business as usual (BAU) and brand specific eco-labelled product LCA.

The result is the only Australian LCI that meets the requirements of third party certified ecolabelling mapped to Green Building Council credits and other organisational building and product assessment needs including personal care and cleaning industry supply chain LCI.

This paper compares scope, applications and examples of these developments from the:

1. Local and imported brand-specific as well as BAU building product and fit-out LCA and Environmental Product Declarations (EPDs).

2. LCADesignTM software which enables fast cost effective whole building LCIA in real-time take off from building information models (BIMs).

3. LCADesign product databases developed for Australian and international supply chains which enable comparison of whole building intensities in design, supply, fit-out and procurement LCIA for BAU, preferred and ecolabelled options.

4. Applications of GlobalGreenTag LCARate ecolabelling schema on brand name products which cover dermatological and ergonomic issues.

5. LCARate LCIA and GreenRate assessment for building products are directly mapped to Green Building Council credits. Thus brand-specific products in LCADesign allow design teams to finesse real building ecological impacts by product choices in the detailed design stage.

Avian-Keratin Refinement

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Theme – Bioavailability and toxicity of organic and emerging chemicals

ABSTRACT

Annually, landfills worldwide receive millions of tons of poultry feathers that take decades to biodegrade and cause a variety of environmental issues. They can carry diseases that endanger human health as well as that of flora and fauna. A portion of these waste feathers is incinerated, producing CO2 and harmful SO2 emissions. However, these feathers contain over 90 % keratin protein, which can be used for many applications such as cosmetics, healing products, and tissue engineering. The aim is to reduce the disposal of and better utilise feather waste, which the poultry industry currently pays for. Using chicken feathers as a sustainable source of keratin instead of materials like wool would reduce emissions (since poultry farming is less carbon-intensive than sheep farming) and utilise a major waste stream of the poultry industry (rather than wool, which has many other applications). The extraction process we have developed is greener than current technologies and will reduce the production time and cost, while increasing the yield.

Biomarker Responses and PAH Ratios in Fish Inhabiting an Urban Waterway

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Theme - Biomarkers and biosensors

ABSTRACT

Black bream (Acanthopagrus butcheri) were sampled in an artificial urban embayment created on the shorelines of a remediated site. A suite of biomarkers of fish health were measured e.g. condition factor (CF), liver somatic index (LSI), gonadosomatic index (GSI), hepatic EROD activity, polycyclic aromatic hydrocarbon (PAH) biliary metabolites, serum sorbitol dehydrogenase (s-SDH) and branchial enzymes cytochrome C oxidase (CCO) and lactate dehydrogenase (LDH) activities. EROD activity, and pyrene- and B(a)P-type biliary metabolites confirmed recent exposure of the fish and that they were metabolizing contaminants. Relative to a reference site, LSI was higher in fish collected in the remediated site as were the metabolic enzymes CCO and LDH activities. However, CF, GSI, s-SDH and naphthalene-type metabolites were at similar levels in the artificial inlet relative to the reference site. PAH biliary metabolite ratios of high molecular weight to low molecular weight PAHs suggest that fish from the remediated site are exposed to pyrogenic PAHs, likely from legacy contamination and road runoff entering the embayment. Similarly, the sediment PAH ratios and the freshness indices suggested legacy contamination of a pyrogenic source, likely originating from the adjacent historic gasworks site and a degree of contamination of petrogenic nature entering the embayment via stormwtaer discharge. Biomarkers of exposure and effect confirmed that black bream collected in Claisebrook Cove, Western Australia, are currently exposed to legacy contamination and are experiencing metabolic perturbations not observed in fish collected at a nearby reference site.

Development and evaluation of a diffusive gradients in thin films (DGT) technique for measuring vanadium, molybdenum and uranium in marine sediment porewaters

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Theme- Metal toxicity and environmental chemistry

ABSTRACT

Vanadium (V), molybdenum (Mo) and uranium (U) are redox-sensitive trace metals that enrich or deplete in marine sediments to differing degrees, depending on the prevalent redox conditions. As such, these elements can provide an insight into the concentration of dissolved oxygen in the water-column at the time of sediment deposition, which is useful for tracing oxygen concentrations in both the recent and ancient past. However, to accurately interpret these 'paleoredox' tracers, their biogeochemistry must be well characterised. Conventional sediment porewater sampling techniques (e.g. squeezing or slicing at the centimetre scale) fail to provide adequate spatial resolution. The use of a high-resolution technique for sediment porewater analysis, such as the diffusive gradients in thin films (DGT) technique, can provide an ideal tool for studying the the biogeochemistry of these trace metals in marine sediments, yet such a technique has not yet been validated under the conditions typically encountered in marine sediment pore waters (i.e. high concentrations of ferrous iron and bicarbonate). Here we report the development of a DGT technique, based on a titanium dioxide binding layer, for the measurement of V, Mo, and U in marine sediment porewaters. This method was tested over a range of ferrous iron concentrations (0 – 1 mmol L-1) and bicarbonate concentrations (2 – 20 mmol L-1) representative of those in productive marine sediments. Following this, DGT samplers containing the tested binding layer were deployed into sediment cores collected from the Gold Coast Broadwater, Australia, for 24 hours. Following retrieval they were sectioned at 1 mm intervals, eluted, and analysed by ICP-MS. Concentration profiles obtained from the DGT samplers were compared to those determined by slicing the sediment cores at 1cm intervals, centrifuging, and directly analysing the porewater by ICP-MS. The superior spatial resolution and minimal disturbance of the DGT approach confirmed its utility for investigating the biogeochemistry of V, Mo and U in marine sediment porewaters.

Ecoprofiles of Hospital Grade Disinfectants in Ecolabelling

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Theme - pharmaceuticals and personal care products in the environment

ABSTRACT

The authors conducted life cycle analysis of best and worst case hospital grade disinfectants. The literature review showed Healthcare Associated Infections (HAIs) kill more people globally than car accidents each year.

Most common are central line methicillin-resistant Staphyloccocus aureus and vancomycin-resistant enterococci bloodstream infections and Clostridium difficile surgical site infections.

Responsible for most HAIs in Australia, Staphylococcus aureus organisms can remain virulent on dry surfaces for >10 days. For acquiring Clostridium difficile environmental contamination with spores is a well accepted risk factor.

Without adequate cleaning microbes contaminate hands or air currents that infect nearby patients. Surface disinfection during hospitalisation can prevent infections absent at patient admission.

EPA registered high level disinfectants for use in medical facilities must kill Staphylococcus aureus, S enterica and Pseudomonas aerugionsa microbes found in healthcare settings. Effective against most fungi, viruses and:

- vegetative bacteria are low level disinfectant phenols and quaternary ammonium ompound;
- vegetative bacteria, tuberculosis (TB) and some spores are intermediate level disinfectant alcohols, hypochlorite, hydrogen peroxide, phenols or quaternary ammonium compounds;
- bacteria, TB and some spores are high level disinfectants glutaraldehyde, o-phthalaldehyde, hydrogen peroxide or peracetic acid;

This study found common precleaning chemicals and low and intermediate level disinfectants have higher human health and environmental impact than any high level disinfectant used at the final step. While the worst high level disinfectants were low impact all require precleaning and most intermediate and low level disinfectants, cleaning chemicals and solvents have serious human and ecological health impacts.

Exposure to cleaning chemicals accounts for over 35% of childhood injury in US. Even at <1% most anionic surfactants used harm the environment. Typical organic solvents used in precleaning have considerable environmental and human health impacts.

Ecotoxicity of nickel and potential human health hazard in New Caledonia - an integrated research program

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Theme - Emerging ecotoxicological techniques and test methods

ABSTRACT

The CNRT “Nickel and its environment” is a public/private funding agency devoted to applied research and technology development in New Caledonia’s mining industry. Its overall mission is the promotion of a rational use of mineral resources that respects the exceptional natural heritage and human environment of New Caledonia.

New Caledonia contains about 10% of the world’s nickel reserves, together with the presence of cobalt, chromium and manganese. Mining increases dispersal of potentially toxic trace metals in the environment and may affect people who are living in the vicinity of mining sites.

Such a dispersal and human exposure are studied under a pool of three complementary projects aiming to (i) improve our knowledge about the dispersion mechanisms of trace metals in the caledonian environment, (ii) evaluate their potential impacts on freshwater and lagoonal biotic compartment in the mining context of New Caledonia, and (ii) assess the human exposure linked to the living place.

- Dispersion mechanisms are mainly studied across the abiotic compartments (air, soils, freshwater, SPM, sediments) by modeling particle transport and mapping metal deposits around mining sites, assessing fluxes of metals in freshwater and towards sediments, and determining the propensity of particules at releasing trace metals.

- Potential effects on biotic compartment are evaluated through the quantification of trace metals bioaccumulation in freshwater and lagoonal organisms (biofilms, fishes, crustaceans, bivalve molluscs, gastropods), completed by experiments of Ni trophic transfer (from biofilm to grazer fish). Ecotoxicity bioassays are carried out on selected tropical bivalve species (caging) and marine invertebrate embryos and are completed by the study of trace metals influence on coral reef growth.

- Human exposure to nickel, cobalt and manganese is evaluated through a biomonitoring survey across New Caledonia that seeks to evaluate and describe the main determinants of exposure (geological settings, location near a mining or industrial site).

Keywords

Nickel, metals, dispersion, human exposure, bioaccumulation

Evaluation of the diffuse gradients in thin films (DGT) technique for predicting nickel toxicity to a marine amphipod in sediments with varying properties

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Theme - metal toxicity and environmental chemistry

ABSTRACT

Developing and implementing robust guidelines for sediment quality is critical to achieve adequate ecosystem protection. Research into metal toxicity has focused on Cu, with little research undertaken into the toxic effects of Ni. Ecotoxicological assessment is often time consuming with long bioassays required to determine the biological effect of bioavailable metals. The use of diffusive gradients in thin films (DGT) has proven a useful method for assessing bioavailable metal concentrations within a system. DGT devices allow for in situ and rapid sampling, without the need for long and logistically difficult testing. Continued development into DGT technology could see a paradigm shift in toxicity assessment, allowing for more efficient, time integrated measurements.

In sediments, metal bioavailability to benthic organisms will be dependent on the chemical form (speciation) of the metal, the properties of the sediment and the varying exposure pathways of the organisms. The current study aims to improve our understanding of the role that sediment geochemistry plays in influencing nickel bioavailability and toxicity, and whether this can be predicted using the DGT technique. To do so, this study determined the sub-lethal adverse effects of nickel contaminated sediment on the reproduction of the epibenthic amphipod, Melita plumulosa. A concentration series of nickel-spiked sediments were prepared using three field collected clean sediments, representing silty, silty-sandy, and sandy environments. For environmental relevance, two field nickel contaminated sediments were also collected and tested. DGT deployment in these sediments during the exposure allowed labile metals present in the pore-water and weakly bound to the particulate phase to be assessed in a time-integrated manner in situ. This allowed us to compare traditional dose-response relationships of metal bioavailability with DGT-labile metals to determine whether DGT can be used to predict nickel bioavailability and improve the interpretation of exposure-effect relationships to predict toxicity.

Hive Environmental Health for Personal Care Products

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Theme - pharmaceuticals and personal care products in the environment

ABSTRACT

The paper examines bee environmental health issues through literature review and Life Cycle Inventory of apiary personal and health care products. The most common domesticated “Dark” honeybee Apis mellifera constructs perennial, colonial wax nests as a home, nursery and food store.

Australia is one of the last nations reportedly free of common colony collapse disorder as well as the Varroa mite devastating North American hives. So environmental health outcomes related to widespread colony collapses were compared for these areas.

Honey is used as an antibiotic. Propolis is used as an antimicrobial, anticoagulant, anti-inflammatory, anti-plaque agent, topical medicine, sealant and insecticide. It is also used as a personal care product emollient, anti viral and immunostimulant. Pollen and royal jelly are also used as health supplements.

In warm climes, such as Australia, honeybee products are higher in organic and wildflower nectar and pollen biomass, so hive supplements are largely unnecessary. In Australia, while biodiversity and other benefits remain from pollination life cycle impact assessment results of processed and packed product show wax and propolis have higher environmental impact, feedstock energy, forager kilometers and carbon emissions than honey.

Due to the biomass feedstock concentration and despite higher foraging emissions, beeswax 21kg CO2eq/kg, propolis 15kgCO2eq/kg and honey 2kgCO2eq20/kg 20 year carbon sequestration is intense. The benefits include braking of radiative potential for climate change over their respective shelf lives.

Comparison of the US pollinator versus Australian producer apiary made differences more distinct and the evidence suggests that:

•Without broad spectrum pollen and enzymes colonies’ lack nutrition, gut resilience and vigor.

• With limited genetic stock colonies lack hive hygiene and propolis’ insecticides against Varroa.

• On high GI supplements, low in Vitellogenin, foragers lack endurance for pollen laden return flights.

• When forager death rates are high, younger ones die early leaving only brood and food in the hive so the hive collapses.

Impacts of neonicotinoid pesticides on the Sydney Rock Oyster Saccostrea glomerata

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Theme - bioavailability and toxicity of organic and emerging chemicals

ABSTRACT

Neonicotinoids, are an emerging class of insecticides with potential for aquatic toxicity that have been used within the last decade as agrochemicals and to protect plants from sucking insects. These insecticides can eventually get into water bodies through run-off, drift movement and leaching, with potential to cause a number of deleterious impacts on aquatic biota. Varying impacts of neonicotinoids in aquatic insects and crustaceans have been established, but little is known on the impacts in molluscs, such as oysters.

Oysters, are ecologically and economically important species. They are filter feeders and as a result, can bio accumulate toxins from the surrounding water. In this study, the Sydney Rock Oyster (Saccostrea glomerata) will be exposed to environmentally relevant concentrations of the neonicotinoid, imidacloprid and bioaccumulation in the oyster flesh will be investigated. Also, the sublethal impacts on the physiology and immune system will be examined.

Bioaccumulation in the flesh of the oyster will be investigated by solvent extraction and analysed using High Performance Liquid Chromatography (HPLC) equipped with Mass Spectrometry detector. The biodistribution of the insecticides in the tissues of the oyster will also be investigated using Mass Spectrometry imaging. A range of concentration from 50 - 200µg/L will be used to establish EC50 values using immune assays such as haemocyte count and phagocytosis. Physiological stress indicators will be tested using standard methods for condition index, gill glycogen, adenylate energy charge, acetyl cholinesterase (AChE), and oxidative stress (e.g. lipoperoxidation (LPO), glutathione S-transferase (GST) and catalase (CAT)). Fertilisation and larval development of the oyster when exposed to environmentally relevant concentrations of imidacloprid may also be determined. It is expected that this project will contribute to our knowledge of the impacts of neonicotinoids insecticides on aquatic organisms and establish the vulnerability of the Sydney Rock Oyster to imidacloprid.

Impacts of polyethylene nanoplastics from the North Atlantic oceanic gyre on freshwater or marine organisms (microalgae and filter-feeding bivalves)

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Theme - nano-risk research: toxicity of micro pollutants

ABSTRACT

Each year, from 6.5 to 8 million tons of plastic waste dumped into the oceans accumulates in large oceanic gyres that represent real plastic soups. Under the effect of several abiotic factors, in particular UV, plastics of macro-wastes are fractionated into microplastic (MP), reaching the nanometric size (nanoplastic NP). The ingestion of MP has been identified in several marine organisms but the actual impact of MP and especially of the NP fraction is still very little studied on freshwater or marine organisms.

In order to reveal potential toxic impacts of the nanometric fraction of plastics, two microalgae, Scenedemus subspicatus (freshwater green alga) and Thalassiosira weissflogii (marine diatom) were exposed for 48h at 1, 10, 100, and 1000 µg/L of reference polyethylene NP (PER) or PE from the North Atlantic gyre (PEN, 7th continent expedition in 2015). The results show that PER and PEN do not influence the cell growth of T. weissiflogii, but the PEN exposure causes growth inhibition of S. subspicatus for all exposure concentrations tested. This growth inhibition is enhanced for a higher concentration of PER and PEN (10,000 µg/L) in S. subspicatus, possibly related to a change in the assimilation of CO2 affecting photosynthesis. The marine diatom T. weissflogii appears to be more resistant to plastic pollution than S. subspicatus. At the same time, freshwater filter-feeding bivalves, C. fluminea, were exposed to 1,000 µg/L of PER and PEN for 48h to study a possible modification of their filtration or digestion capacity of S. subspicatus. Exposure to NPs does not lead to any alteration of their algae filtration capacity, however, faecal and pseudo-faecal production is decreased, suggesting an impact on their digestive ability.

Influence of coating agents on the effects of silver nanoparticles on Pseudokirchneriella subcapitata

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Theme- Nano-risk research: toxicity of micro pollutants

ABSTRACT

The applications of silver nanoparticles (AgNPs) are growing exponentially, especially their use in many consumer products due to their excellent antimicrobial properties. Large amounts of AgNPs from these products enter freshwater aquatic ecosystems. Therefore, concerns are also growing among regulatory agencies and the general public about possible negative effects to the environment and human health. The effects of AgNPs on freshwater biota are governed by the physicochemical properties of AgNPs with surface functionalization a critical factor. The aim of this study was to investigate the effects of silver nanoparticles coated with three different organic ligands (tyrosine, epigallocatechin gallate (EGCG) and curcumin) and Ag+ on the freshwater green alga Pseudokirchneriella subcapitata. The stability of AgNPs in the algae medium, their toxicity, together with bioaccumulation and sub-lethal effects were assessed. Stability tests revealed that the type of coating significantly influenced the aggregation of AgNPs in the medium. The 48-h EC50 of T-AgNPs, E-AgNPs, C-AgNPs and Ag+ were found as 0.163, 0.243, 0.155 and 0.051 mg L-1 respectively. Associated Ag content in algae was positively correlated with increased concentrations for all AgNPs & Ag+. Also, toxicity was positively correlated to the associated Ag content in algae. All three types of AgNPs and Ag+ activated the antioxidant enzymes GST and CAT in algal cells. However, consistent difference in response was not identified between differently coated AgNPs. In summary, this study confirms that surface functionalization influences the fate and behaviour of AgNPs in algae medium, algal toxicity and bioaccumulation in algae. Therefore, it is recommended to consider the type of coating on AgNPs as a critically important factor in environmental risk assessment.

Synthesis and Characterisation of Isotopically-enriched Three-layer Core-shell Nanoparticles

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Theme - Nano-risk research: toxicity of micro pollutants

ABSTRACT

The unique physical and chemical properties exhibited by nanoparticles has resulted in their prolific utilisation in consumer and industrial products. The novel properties exhibited by nanoparticles has driven the development of a myriad of more 'complex' nanoparticles to serve a multitude of functions, including coating-functionalised, nanocomposite, and multi-layered varieties. Despite the prolific utilisation of nanoparticles in society, there is a general lack of understanding of their fate, transformations, and toxicity in natural systems which is impeding their regulation, particularly 'complex' nanoparticles. Due to the inherent reactivity and rapid transformations that nanoparticles undergo in aquatic systems, a major challenge of many studies has been to discriminate between toxic effects resulting from their 'nano' size compared to those from the bulk material and dissolved metals released from them via dissolution.

The current study investigates methods for the discrimination between toxic effects related to 'nano' size and dissolved metals. To investigate the 'nano' effects, a method developed for the synthesis of stable, isotopically-labelled, silver-core, gold-intermediate, silver-surface-layered nanoparticles is being employed. The use of stable isotopes in the labelling of these nanoparticles affords the use of environmentally-relevant treatment concentrations and ultra-trace level detection limits when coupled with inductively coupled plasma mass spectrometry. In addition, the use of isotopically enriched layers separated by an insoluble intermediate layer in such nanoparticles facilitates the measurement of effects related to particulate and dissolved forms of the metal. The extent of metal dissolution from outer layers of such nanoparticles appears to be contingent on outer layer thickness, matrix composition, and exposure time. Future work with such nanoparticles will examine the contrasting nano-specific and dissolved metal fate, transformations, and toxicity of such nanoparticles.

Levels and determinants of exposure to metals in New Caledonia

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Theme - Human health issues associated with environmental contaminants

ABSTRACT

Background/Aim

The New Caledonian archipelago contains about 10% of the world's nickel reserves, together with presence of cobalt, chromium and manganese in the ore. Mining activities and erosion of hill slopes contribute to exposure of local populations through contamination of air, food and water resources. We conducted a biomonitoring survey to evaluate exposure to the four metals of interest across the islands and to describe the main determinants of exposure.

Methods

A stratified sample of 732 adults and children (>3) was built from consultants of 20 health centers across the whole archipelago. Urine was collected and analyzed by ICP-MS for determination of metal concentrations. A face-to-face interview was conducted to document sociodemographic characteristics, lifestyle habits, occupation and living distance to mining areas, and dietary habits. In two areas with or without mining activities, environmental samples (soil, house dust, water, foodstuff) were collected.

Results

Nickel and chromium are the main metals present in urine at levels higher than reference values derived from national surveys elsewhere in the world. Large variations are observed by aqe, sex and region. Geocoding and analyses of environmental samples are underway to document contributions of various uptakes to the overall exposure.

Conclusion

This is the first nationwide survey of metal exposure in New Caledonia. It will contribute to the set up of recommendations to reduce exposure, and should be completed by the evaluation of potential health risks associated with these levels of exposure.

Lichen and compositional data analysis: a new approach to investigate areas influenced by Ni mines dusts

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Theme - Environmental analysis and monitoring

ABSTRACT

In New Caledonia, thirty active Ni opencast mines have been reported in 2012. All mining operations (ore extraction, transportation by trucks or by conveyors, outdoor ore drying and ore treatment) are expected to release dust rich in heavy metals such as Ni, Co, Cr and Fe. Lichen is a well-known biomonitor organism for heavy metals deposition. However, metals concentrations within the thallus depend on their age, their biological performance, the dynamics of metal uptake and release, on particle interception and on physiological processes. Thus, metals concentrations within the thallus depend on lichen specie and on environmental parameters. The aim of this study is to explore a new approach to overcome these problems and to make the use of lichen accurate as a biomonitor of Ni mines dusts in New-Caledonia. Metal contents were analysed in epiphytic lichens, collected in the vicinity of Ni mines and plants and in places known to be preserved from mining. A centred log-ratio transformation, clr(.) was applied to Ni, Cr, Co, Fe, Zn, Cu and Ti raw contents in thalli. Compositional data in the lichens were then explored by multivariate analysis. The sample scores for the first principal componenent (PC1) explain de main variability between Ni, Cr, Co and Fe, originating from mining activities, and Ti of crustal origin. On a map, PC1 scores can then be used as a deposition indicator highlighting areas under Ni mining and metallurgical activity. This new approach is a promising approach since it allows providing valuable information about airborne particles deposition and relative air quality. It allows ranking location more or less exposed and can be relevant for decision-maker operating in the management and protection of environment. Finally, it's a cheap method and easy to achieve.

Lifetime bioaccumulation of cadmium in endangered green turtles (Chelonia mydas) as revealed by PBTK modeling

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Theme -Special theme: marine ecotoxicology and chemistry

ABSTRACT

Elevated levels of metals and metalloids have been identified in a number of sea turtle populations in Australia as well as worldwide. Many green sea turtles inhabit coastal areas often in close proximity to anthropogenic activities (e.g. mining, dredging and agriculture) and potential associated run-off of pollutants. Recent studies have shown a strong correlation of exposure to metals and health indicators in sea turtles. The impact of these contaminants on wildlife health is considered to be highly relevant, but difficult to fully understand without knowledge on the relationship between the external exposures, and the uptake and distribution to different tissues (toxicokinetics). The aim of our study was to develop a species-specific physiologically based toxicokinetic (PBTK) model, by which such relationships can be evaluated in green turtles, using cadmium (Cd) as the initial model compound. The PBTK model is divided into two parts: the structural framework and the statistical supplementation. The structural framework consists of mathematical equations describing the relationships between the physiological parameters of green turtles and the physicochemical properties of Cd. The statistical supplementation incorporates: a) a global sensitivity analyses to select the most sensitive (physiological or physicochemical) parameters in the PBTK model; and b) a Bayesian approach executed with Markov chain Monte Carlo simulations to fine-tune estimates for those more sensitive parameters. Until now, PBTK models were not available for any turtle or reptile species, hence, we would like to introduce a fully developed and evaluated PBTK model for lifetime bioaccumulation of Cd in green turtles. This mathematical modelling technique not only provides a framework for assessing and predicting the kinetics of Cd in this particular species, but can and should be expanded in future work to cover a range of environmental relevant chemicals and other animal species, serving as an easy applicable and cost-effective tool for risk assessment of chemical contaminants in the aquatic environment.

Measuring in vivo EROD activity of Seriola lalandi larvae exposed to the water accommodated fraction of Australian crude oils

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Theme - Biomarkers and biosensors

ABSTRACT

Ethoxyresorufin-O-deethylase (EROD) activity is a commonly used biomarker in the field of ecotoxicology. EROD activity provides an indicator of the level of hepatic cytochrome P450 detoxification enzymes. Ethoxyresorufin biotransformed from resorufin by these enzymes is able to be detected spectrofluorometrically at the appropriate wavelength. In fish, EROD activity is regularly measured in the S9 fraction of the liver. Current in vitro methodology used to assess EROD activity is both labour and cost intensive; and involves euthanasia of the animal. Recently, an in vivo method of assessing EROD activity has been developed. In this method, larval fish were exposed to a known EROD inducer for approximately 4 days. Just prior to yolk sac consumption, larvae are placed in a medium consisting of seawater and ethoxyresorufin for 5 hours; during this period the larvae to act as a biotransformer of ethoxyresorufin to resorufin. The medium is then read spectrofluorometrically to provide a level of resorufin excreted by the larvae. This in vivo method has been shown to have a direct correlation with the commonly used in vitro method; however this method has not been tested using real world, complex contaminants such as crude oils. This research proposal aims to modify the methods of the previously developed in vivo method for use with an Australian species (Seriola lalandi), and then assess suitability in detecting exposure to the water accommodated fraction of Australian crude oils. It is hypothesised that in vivo measurement of EROD activity using Seriola lalandi larvae and field collected water samples will prove to be a useful tool in the monitoring of oil spills.

Metabolomics as a method for detecting physiological changes in developing striped marsh frog tadpoles exposed to treated wastewater effluent

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Theme- Emerging ecotoxicological techniques and test methods

ABSTRACT

Wastewater effluent has become increasingly recognised as a source of bioactive and accumulative compounds entering waterways. Detection of compounds such as pharmaceuticals in final effluent and surface waters has become a concerning factor for the health of individual aquatic organisms, ecosystems, and the use of recycled water. The low concentration but consistent exposure that is presented by wastewater effluent is likely to have more subtle effects than typical agents. Smaller developing organisms such as the tadpoles and frogs have been found in several effluent impacted environments, including storage lagoons and wastewater wetlands used. Field studies of tadpoles in wastewater wetlands have suggested that exposure to dilute wastewater results in tissue abnormalities, and high concentrations has additional potential to delay development. Metabolomics is a scientific field focused on the study of the chemical processes involving metabolites, low weight organic molecules found in cells, tissues, and biofluids. It provides a more comprehensive view of the physiology of cells and metabolic pathways, which is advantageous in the exploration of organism exposures to non-lethal concentrations of xenobiotic substances, such as those found in wastewater mixtures. The combination of metabolomics with a visible metamorphosis allows for an in-depth exploration of the effects of wastewater.

In this study, we exposed developing striped marsh frog (Limnodynastes peronii) tadpoles to control water and 6.25, 12.5, 25, and 50% treated domestic wastewater from the Gold Coast, Australia. After a month long exposure, we measured the effects on development, and the metabolites present in hepatic tissue and the whole organism. Early results indicate that high wastewater exposure limited the development of tadpoles and subsequent liver and body weight.

Metabolomic data of hepatic tissue and the whole organism will be presented alongside analysis of the metabolic pathways impacted by exposure, supported by developmental bioassay.

Molecular approaches to assessing the bioremediation potential of Polybrominated Diphenyl Ethers (PBDEs) in soils

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Theme - Emerging ecotoxicological techniques and test methods

ABSTRACT

Polybrominated Diphenyl Ethers (PBDEs) are a group of flame retardants that have been found to be ubiquitous in the environment, and are recognized as Persistent Organic Pollutants (POPs) by UNEP for their toxicological impacts and persistence in the environment. Despite this, little is known about their fate in the soil compartment. This study utilized molecular biological techniques to probe PBDE contaminated soils, utilizing a functional gene approach (quantitative PCR) and whole community analysis using Next-Generation Sequencing (NGS). Degenerate primers representative of two biphenyl dioxygenases, bphA and BPHD were used to develop a functional gene assay to indicate the biodegradation potential of a contaminated soil. This study is one of only three to utilize NGS to observe the community assemblage of PBDE contaminated soils (n=15) with the aim to identify relationships between PBDE contamination and PBDE degrading taxa abundances. The results from the soil survey confirmed that the soils harboured organisms capable of utilising PBDEs; Rhodococcus biphenyl dioxygenase genes were present, although expression did not correlate with PBDE concentrations. A considerable amount of research has previously identified Polychlorinated Biphenyl (PCB) degrading bacteria to be significant contributors to PBDE degradation. The results from this study suggest that PCB pathways may be inappropriate surrogates for the basis of qPCR assays to determine the innate potential of soils to remediate these pollutants. It is also possible that the expression of biphenyl dioxygenase measured in this study was induced by PCBs in these soils; a number of studies report they are usually found in parallel with PBDEs at similar or greater concentrations. Further research into the presence of bacterial genera such as Sphingomonas, Pseudomonas, Rhodococcus and other PBDE degraders found to be present in PBDE contaminated soils, represent potential degrading genera that are likely to harbour individual OTUs that will be efficient indicators of a soil's PBDE degrading potential.

Novel and Legacy Brominated Flame Retardants in The Urban Soils of Melbourne, Australia

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Theme - Environmental analysis and monitoring

ABSTRACT

A range of brominated flame retardants (BFRs) have been incorporated into polymeric materials like plastics, electronic equipment, foams and textiles to prevent fires. The most common of these, polybrominated diphenyl ethers (PBDEs), have been subject to legislated bans and voluntary withdrawal by manufacturers throughout the world. They were replaced with novel brominated flame retardants (NBFRs) that share similar hazardous properties to PBDEs. This study examined the levels of PBDEs and NBFRs in soils from Melbourne.

A total of 30 soil samples were collected from an area spanning approximately 40 km x 120 km across the Greater Melbourne region, Australia. Sample sites were categorized by land-use as manufacturing industries (n=18), waste disposal facilities (n=6) or non-industrial sites (n=6). Eight PBDEs (-28, -47, -99, -100, -153, -154, -183 and -209) and six NBFRs (PBT, PBEB, HBB, EH-TBB, BTBPE and DBDPE) were analysed in soil samples by selective pressurized liquid extraction (S-PLE) and gas chromatography – triple quadrupole mass spectrometry (GC-MS/MS).

PBDEs were detected in 29/30 samples with S8PBDE soil concentrations ranging nd-13,200 ng/g dw and S7PBDEs (excluding BDE-209) levels of nd-70.5 ng/g dw. NBFRs were detected in 24/30 soil samples with S6NBFR concentrations ranging from nd-385 ng/g dw. HBB was the most frequently detected compound (14/30), while the highest concentrations were observed for DBDPE, followed by BTBPE. Electronic waste recycling and polymer manufacturing appear to be key contributors to NBFR soil contamination in the city of Melbourne. A significant positive correlation between S8PBDEs and S6NBFR soil concentrations was observed at waste disposal sites to suggest that both BFR classes are present in Melbourne's waste streams, while no association was determined among manufacturing sites.

This research provides the first wide-ranging account of PBDEs in Australian soils and indicates that NBFRs possess a similar potential to contaminate soils as PBDEs in the City of Melbourne.

Seawater analysis for trace metals with the use of a new generation ICP-MS (ICP-MS QQQ) technique

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Theme - Advances in analytical chemistry

ABSTRACT

The determination of toxic metals in seawater is still an analytical problem due to their low concentrations and potential interference of the salt matrix. Pre-concentration of the metals on a chelating resin with the following elution and detection using inductively coupled plasma mass spectrometry (ICP-MS) is a common way of their analysis at present. Significant dilution of seawater samples (normally 20 times) and their ICP-MS analysis using standard addition method in seawater matrix enables identification of some metals. Such approach minimizes the interference of the salt matrix, but significantly increases the method detection limit and low levels of the metals can not be accurately quantified.

With the introduction of the Triple Quadrupole ICP-MS (ICP-QQQ) instrument this approach has been further perfected. An octopole collision cell located between two quadrupole mass filters and more reactive gases can now be used in a controlled way to minimise the effect of a sample matrix. This advantage along with the availability of the online sample dilution system opens a good opportunity for the accurate quantification of trace levels of toxic metals in seawater.

The work represents the results of the development of ICP-MS method for the analysis of seawater for trace elements using ICP-QQQ. The different experimental conditions will be considered and discussed. The optimal methodology will be presented and evaluated.

Targeted and untargeted analysis of PFAS in Victorian Wastewater

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Theme - Environmental analysis and monitoring

ABSTRACT

In Australia Per- and polyfluoroalkyl substances (PFAS) are a contaminant of emerging concern. PFAS have unique properties that make their use in industry and manufacture desirable. However, PFASs are persistent, bioaccumulative and potentially toxic to organisms. Hence, these compounds are important for monitoring and remediation purposes. Traditionally, studies have focused on analysis of a few perflurocarboxylic and sulfonic acids which have been detected in aqueous matrices world-wide. Few studies on newer fluorinated compounds in wastewater and recycled water are available. The occurrence data for alternative classes of PFAS in Australian wastewater is currently unavailable while data for PFCAs and PFSAs is limited. The current study employed unique workflows for the comprehensive analysis and identification of PFASs in two Victorian wastewater treatment plants. Targeted quantification of 15 PFAS was performed using stable isotope dilution on an LC-MS/MS QQQ and LC-QTOF. Further, the samples were screened for the presence of 65 PFASs using a custom database with levels of verification ranging from confirmation of fragments from validated MS/MS spectra to identification of molecular mass and isotope fidelity etc. Finally, software tools such as MassHunter molecular feature extractor (MFE), mass profile professional (MPP) and molecular structure correlator (MSC) were used to propose and identify fluorinated compounds in the water samples not present in the database. The combined targeted and untargeted analysis provides a more complete picture of PFAS contamination in Australian wastewater and recycled water. This study provides additional information to Australian regulatory agencies on point-source PFAS emissions to the environment.

Transfer of Ni, Cr, Co, Mn and Fe from mining activities to freshwater trophic webs in rivers of New Caledonia

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Theme - metal toxicity and environmental chemistry

ABSTRACT

Mining activities in New Caledonia are responsible of Ni and other associated metal trace elements (Cr, Co, Mn and Fe) release in the environment and especially in the upper part of rivers. Nevertheless, the potential accumulation and transfer of these metals in freshwater trophic webs has been poorly studied so far, especially in the area of Mont Koniambo. The aim of this study conducted in May 2016 was thus to describe the potential transfer and accumulation of these metals in several aquatic organisms representative of the rivers in this region.

Periphytic biofilms (major primary source in freshwaters) were developed on immerged artificial glass slides for 5 weeks in 3 sites of the Taléa river (under the more or less influence of mining activities) and in 2 sites of a reference river, the Tivoli. They were collected in the same time than river rocks biofilms to compare the bioaccumulation capacities of biofilms developed on artificial or natural substrates.

By electric fishing, several species of crustaceans and fish were collected in 3 sites along the Taléa river and in 1 site of the Tivoli river, and metals analyses were realized in several organs, along with morphometric measurements.

The first results of metals analyses in these compartments revealed the huge ability of biofilms to accumulate metals, especially in the upper part of the river under the influence of mining activities. For crustaceans and fish, we observed a gradient of contamination following the release of metals from upstream to dowsntream for the 5 metals analyzed in livers of eels (Anguilla marmorata) and hepatopancreas of crustaceans (Macrobrachium amelum), suggesting a major accumulation by the trophic way.

Using integrative passive sampling devices to obtain more meaningful and cost effective data on potential impacts from 21st century contaminants in stormwater runoff

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Theme - Pharmaceuticals and personal care products in the environment

ABSTRACT

Polar Organic Chemical Integrative Samplers (POCIS) have been extensively evaluated and optimized for the detection and quantification of markers of human activity associated with wastewater or septic sources, particularly with respect to household, personal care, pharmaceutical, and endocrine disrupting compounds. However, POCIS devices have not been routinely used to detect illicit discharges and assess potential impacts from these 21st Century contaminants in stormwater runoff from watershed sources. Here we describe a monitoring study that incorporated POCIS deployments into a network of monitoring stations that were established in Sinclair and Dyes Inlets of the Puget Sound in Washington State, USA to assess stormwater runoff from industrial areas of Naval Base Kitsap, as well as commercial, residential, and rural areas within the watershed (e.g. Sinclair and Dyes Inlets, Port Orchard Passage, and Hood Canal in Western Puget Sound). POCIS were deployed and recovered on an ongoing basis from Fall 2015 through Spring 2017, with each deployment ranging from approximately 2 weeks to 1-2 months and spanning cumulative rainfall amounts of 5 – 16 in. The POCIS were deployed in a wide range of receiving water environments including nearshore estuarine and marine sites, a freshwater lake downstream of a stormwater retention pond, and a freshwater stream draining rural and residential land use. Thus far, the POCIS have shown that a broad spectrum of organic compounds could be reliably detected from the surveillance monitoring which should prove very useful for finger printing likely sources of contamination in stormwater runoff in the areas monitored.