Emerging pollutants in freshwater ecosystems

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Valorization of treated wastewater in organic hydroponics

POSTER #51

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The results obtained concern the fertilizers it contains wastewater, which are biological fertilizers in hydroponics, and the cultivation of some cultivated species to give better results. Results of hydroponic pea, bean and tomato tests during germination and growth for electrical conductivity showed that plants immersed in distilled water gave low electrical conductivity (lack of salts). The plants immersed in the treated wastewater, the higher electrical conductivity by contribution to the first test. The plants immersed in the treated wastewater allows a higher stem height compared to plants plunge into distilled water. With the recovery of wastewater, it is possible to guarantee the production of vegetable seedlings in a few days and with costs almost nil. Self-production of vegetable seedlings in organic hydroponic nurseries at home is an approach to be developed in the context of sustainable development.

Suitability of silicon passive sampler for monitoring TBT concentrations in surface water

POSTER #33

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Polymer based passive samplers are increasingly used in studying harmful substances in different environmental matrices. The samplers measure freely dissolved chemical concentration which is the most harmful to organisms. The samplers are deployed until the equilibrium between the sampler and the surrounding media has been reached. This enables the determination of low concentrations which in convenient grab water samples remain below the detection limit. The average concentration of studied chemical in the surrounding media can be calculated as the sampler-water partition coefficient is known. The environmental quality standard concentration (EQS) of tributyltin (TBT) in surface water is very low (0.2 ng/L) and in many cases near the laboratory detection limit. However, if TBT is not detected it doesn't mean it is not present in the environment. With passive sampling the TBT content can be enriched to the measurable level. The partition coefficient of TBT between water and a silicon passive sampler was determined in a laboratory trial by analyzing the TBT concentrations by high-resolution GC/MS. Once the coefficient is determined it can be used to estimate dissolved TBT concentrations in marine, surface and effluent water. With silicon passive sampler the presence of TBT in aquatic environment can be revealed which further enables more reliable risk assessment.

Human health risk associated to the presence of pathogenic protozoa in reused water

POSTER #23

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Water reuse for agriculture irrigation can mitigate water scarcity. The presence of waterborne protozoan parasites as *Giardia* and *Cryptosporidium* is a potential problem in wastewater reuse and a threat to human health. In the context of risk assessment, Consumer Safety Margin (CSM) was introduced as a new risk characterization to measure the distance between the exposure and the dose-response and to address the effect of uncertainties. In this study CSM has been applied to the presence of pathogen protozoa as *Cryptosporidium* and *Giardia* in leafy green vegetables when irrigated with contaminated waters. Irrigation samples, influent-effluent, were collected from three wastewater treatment plants. Results showed that using influent as irrigation water a low uncertainty in the safety margin for *Cryptosporidium* was observed. No margin can be observed for *Giardia*. Exceedance probability (EP) show a low probability (0.005) to intake a leafy green vegetable contaminated with *Cryptosporidium* in a concentration to be able to produce infection and consequently to get sick. *Giardia* probability is around 0.07. When effluent is used as irrigation water, a wide safety margin and very low uncertainty for both microorganisms can be observed. EP in both cases is also very low. *Cryptosporidium* and *Giardia* should be included in standard regulations for wastewater reuse. Study supported by Spanish Ministry of Economy and Competitiveness, grant JPIW2013-095-C03-02 (Water JPI) Pilot Call.

Bearing the burden of diffuse waterborne pollutants a confession from phytoplankton communities

ORAL SESSION III

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Freshwaters collectively represent about 0.01% of the World's water, nonetheless this tiny proportion has disproportionally high ecological, economic and cultural values. These quintessential ecosystems are currently facing multiple anthropogenic threats, amongst which contaminants present at sub-lethal levels can be an additional burden. Using natural lake phytoplankton communities as study model, we aimed to investigate if diffuse chemical pollution can interfere with the ability of phytoplankton communities to maintain essential properties. Using a non-invasive mesocosm approach, phytoplankton communities from two lakes were exposed to a contaminant mixture consisting of 12 pharmaceuticals and personal care products that are commonly observed in European lakes and rivers. A gradient of five increasing concentrations (at least 10 times lower that the effective concentration (EC50) of individual substances) of the contaminant mixture were tested. The exposed communities were regularly monitored over three weeks. Our results showed that diffuse contaminants have a drastic persistent impact on the phytoplankton communities. The threshold-like response observed along the concentration gradient tested strongly indicate that contaminants (at environmentally relevant concentrations) can increase the vulnerability of aquatic

ecosystem to shift in an alternative undesirable state associated with lower productivity and contrasting community structures.

Why does the European Water Framework Directive not set standards for surface water used as source for drinking water?

POSTER #10

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The European Water Framework Directive (WFD) and the European Drinking Water Directive (DWD) are linked through citation 24 of the WFD which states “Good water quality will contribute to securing the drinking water supply for the population.” However, until this day no specific environmental quality standards have been set in the European Union for surface water used for the abstraction of drinking water. This makes Member States (MS) of the European Union (EU) reluctant to set national standards as it might contradict with other EU principles such as a level playing field in commerce. It results in a focus on targets for chemical status and ecological status that apply to all surface water bodies. As the requirements for the protection of water supply abstraction points are often different to those for protection of aquatic biodiversity until now WFD article 7 goals are neglected in some MS. WFD Article 7.3 specifies that ‘Member States shall ensure the necessary protection for the bodies of water identified with the aim of avoiding deterioration in their quality in order to reduce the level of purification treatment required in the production of drinking water’. There is no guidance document under the Common Implementation Strategy (CIS) for the WFD on reduction of the level of purification treatment required in the production of drinking water. As no such guidance is available at this time MS are forced to develop their own methods on how to comply with WFD Article 7.

X-ray measure of hydrogen bonding for water green chemistry and filtration applications

POSTER #50

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A direct measure of hydrogen bonding in water under conditions ranging from the normal state to the supercritical regime can be derived from first-principles calculations for the Compton scattering of inelastically scattered X-rays. First, one can show that a measure of the number of electrons n involved in hydrogen bonding at varying conditions can be directly obtained from Compton profile differences. Then, one can use first-principles simulations to provide a connection between n and the number of hydrogen bonds N. We have shown that the relationship between n and N is linear, allowing for a direct measure of bonding and coordination in water by coupling simulations with experiments. In particular, the transition to supercritical state is characterized by a sharp increase in

the number of water monomers but also displays a significant number of residual dimers and trimers. This transition is important because there are new applications for supercritical water as a green solvent including the oxidation of hazardous materials. Moreover, similar Compton scattering studies of water confined in carbon nanotubes can be used to design new filtration systems by reducing water viscosity. Finally, recent advances in Density Functional Theory will allow to perform increasingly accurate first-principles simulations of water under different thermodynamic and confinement conditions.

Decision support tool for establishing an action plan aiming to decrease the discharge of micro pollutants into sewage system networks

ORAL SESSION I

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The innovative decision support tool assists in ranking pollution sources and different urban watersheds, based on potential local emissions and the sensibility of the receiving water bodies. The potential local emissions are calculated by coupling characteristics of pollution sources to data bases containing potential emission coefficients of micro pollutants:, 1) Industrial/artisanal activities: APE (principal activity code) - emission (kg/year) by substance and by APE (mean values from national and local data bases): 2) Stormwater runoff: surface type (from national data bases and interpretation of satellite pictures) - emission (kg/year) by substance and by type of surface (literature data) and dependent on typical local rainfall: 3) Domestic: number of habitants - emission (kg/year) by substance and by habitant (literature data). The level of (eco) toxicity of each substance allows to transform potential emissions in potential pressures (PP). The hydraulic model of the sewage system network allows to affect parts of the local potential pressures to the water body. For each water body, a sensibility index (SI) is calculated based on its physico-chemical characteristics and its functions. The ratio PP/SI allows for ranking pollution sources. The coupling to a data base describing solutions for emission reduction for different pollution sources (substitution, treatment, education,..) will allow elaborating an action plan associated to a socio-economic evaluation.

Secondary amine N-nitrosation processes contribute to the increase of genotoxicity of nitrate-rich wastewater under UV-C treatment

ORAL SESSION V

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UV-C treatments are commonly implemented for wastewater disinfection and reuse in irrigation. However, they imply the formation of N-DBPs due to the photoreactivity of nitrate ions. Up till now, the increase in genotoxicity of the UV-C treated wastewater has been linked to the formation of

nitrophenols but N-nitrosation processes of secondary amines have probably been overlooked. Consequently, the major contribution of this work was to investigate nitrosation reactions as a source of genotoxicity in nitrate-rich wastewater under UV-C irradiation using target compounds. The main results revealed that N-nitrosociprofloxacin was more stable than N-nitrosodimethylamine while N-nitrosodiclofenac spontaneously transformed into 4-nitrodiclofenac due to a Fisher-Hepp type rearrangement. The formation of N-nitroso-ß-N-methylamino-L-alanine (BMAA) was of concerned since N-nitrosation of BMAA results in a toxic alkylating agent. Peroxynitrite (ONOO-) was assumed to be the major reactive species accounting for nitrosation reactions. ONOO- production and the formation of N-nitroso compounds was not only dependent on the UV dose but also on the amount of dissolved organic matter (DOM). Genotoxicity was investigated by measurements of histone H2AX phosphorylation and 4-nitrodiclofenac was found genotoxic. Acknowledgements: The authors would like to thank the EU and the ANR for funding, in the frame of the consortium AWARE financed under the ERA-NET Cofund WaterWorks 2015 Call.

Pesticide mixtures in the aquatic environment: risks of neonicotinoids and other pesticides to aquatic biota

ORAL SESSION III

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Neonicotinoid insecticides were included in the EU watch list substances for emerging water pollutants (Decision 2015/495) and are toxic to beneficial organisms, especially insects. They are very persistent contaminants in soils and water and continuously discharge into the environment, therefore found in water bodies worldwide very often. However, neonicotinoids are not present in the water environment alone, as complex mixtures of pesticides are usually found. This is the case also in Finland, what may indicate that Finnish water ecosystems are also at risk. In our study, we investigated some aspects of pesticide pollution. First, we monitored three rivers from South West Finland for pesticides and second we investigated the toxicity of pesticide mixtures to *Chironomus riparius* (*Diptera*: *Chironomidae*) in chronic and pulse exposures. The results showed that complex pesticide mixtures were present in the three rivers. The neonicotinoids clothianidin, thiamethoxam and thiacloprid were found. Other pesticides found continuously were azoxystrobin, metalaxyl, metazachlor and azole fungicides, among others. The toxicity tests indicated that exposure of the larvae to a mere 0.5 µg/L of thiacloprid already caused a significant inhibition of growth. Overall, the addition of other pesticides at concentrations of 1 µg/L did not increase the toxicity caused by the single neonicotinoid, pointing at dominance of neonicotinoids in the toxicity caused to this organism.

An innovative composite silicone-based passive sampler to study the transfer of polar and apolar pollutants in surface waters

POSTER #34

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Passive sampling has been developed to obtain, at lower cost, more representative evaluations of the average concentrations of contaminants in aquatic environments. An innovative silicone-based passive sampler (named PACSiR, for Polar Apolar Composite Silicone Rubber) was designed to address sampling, detection and quantification of a wide range of organic contaminants (native or metabolites) present at ultratrace levels in waters. The PACSiR passive samplers, of small size (2 cm length), were applied in different aquatic media (surface or underground waters), typically for periods of 1 week, to evaluate the contamination by a wide range of pesticides and metabolites. They were also tested for their capacity to monitor several hormones and pharmaceuticals. The nature and mass of contaminants sorbed on the passive samplers exposed in situ were used as qualitative or comparative measures, to highlight the presence of compounds or to easily assess trends and gradients of contamination in aquatic environments. For quantitative purposes, the estimation of the average concentration of contaminants in water required the prior determination of kinetic parameters (sampling rate, equilibration time) through laboratory experiments. We demonstrated that this reactive, single-use and low-cost passive sampler can be used for multiple research or operational purposes, thanks to the different levels of data acquisition, from qualitative to quantitative approach.

CWPharma: Clear waters from pharmaceuticals

POSTER #20

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Active pharmaceutical ingredients (APIs) have beneficial effects on human and animal health, but their undesired occurrence and effects in the environment is a global concern. Residues of e.g. hormones, anti-inflammatory drugs, analgesics and antibiotics have been detected in the Baltic Sea water or fish, but their environmental fate and effects on biota are still poorly known. The EU Water Framework Directive considers the contamination of water with API residues as an emerging environmental concern. CWPharma strives for more sustainable water management and protection, and evaluates the efficiency of different measures that reduce the load of APIs into the aquatic environment. Means to reduce API emissions include e.g. development of advanced wastewater treatment technologies, improvement of take-back and disposal of unused medicines and environmental permitting of pharmaceutical plants. A wide list of APIs will be screened in case studies to get a more complete picture of their sources, emissions, environmental concentrations and risks. The project aims to increase the awareness of policy-makers, regulators and permitting authorities on environmental risks of APIs to accelerate the implementation of the emission reduction schemes. CWPharma has partners from seven Baltic Sea countries, covering the majority of the

Baltic Sea catchment area. The three-year (2017-2020) project is funded by the EU's Interreg BSR programme.

Modeling fate of emerging contaminants in soil aquifer treatment experiment: insight into new modelling tools

POSTER #14

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The use of treated wastewater in indirect non-potable reuse (IPR) practices are frequently happening in worldwide. However, unknowns still raise concerning transfer to surface waters and groundwater of emerging contaminants and pathogens that adversely affect aquatic life as well as human health. The 3-years project FRAME funded by the Water JPI program has been done to investigate the IPR practices. Among the different tasks targeted by the project, one is to simulate the fate and transport of emerging contaminants in soil aquifer treatment (SAT) experiments. The modelling approach is based on the use of the flow and reactive transport code MARTHE-PHREEQC. Flow rate is simulated according to the Richards' equation. Advection-dispersion equation is used to describe mass transfer in aqueous phase while gas diffusion is simulated by Fick's law. To describe reactivity, microbial driven degradation reactions of emerging contaminants, aerobic respiration and nitrification as well as adsorption reactions (both hydrophobic and electrochemical sorption reactions) are taken into account. The transition of redox states during the SAT experiment through 90 cm of soil has been accurately simulated. Simulations are able to give new insights on the complex degradation pathways of atenolol, diclofenac, acyclovir, iopromide and its transformation products. The impacts of sorption reactions on the breakthrough behaviors of emerging contaminants in soil are also described.

Chloramphenicol as an emerging environmental pollutant and a potential driver of antimicrobial resistance

ORAL SESSION VII

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Antimicrobial resistance (AMR) is a major health issue. It threatens to undermine the very core of modern medicine. To combat this global health issue an understanding of the drivers behind AMR is needed, and it is becoming increasingly clear that the accumulation of antibiotics in the environment due to anthropogenic sources is one such driver. However, there is very little knowledge on the accumulation of antibiotics in the environment, and their fate in the context of AMR. Moreover,

there is a lack of understanding of the role stereochemistry of an antibiotic plays in driving the development of AMR, or whether any stereo inversion occurs within the microbial community. Here, the fate and effects of chloramphenicol (CAP) on environmental microbial communities have been studied to help address these questions. CAP resistant bacteria isolated from wastewater were genome sequenced and used in absorbance based nanocosm experiments. Hyphenated liquid chromatography and mass spectrometry techniques were then used to investigate the fate of two different CAP isomers when exposed to waste water derived bacteria. Through understanding the biodegradation by single microbes of the relatively simple antibiotic chloramphenicol it is hoped that a better picture of how the accumulation of antibiotics and their different isomers in the environment influences the development of AMR.

Development of new adsorbents for silver removal in highly-contaminated effluents

POSTER #38

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Unusually-high silver concentrations were encountered in a river within a touristic area of Morocco. This results from brassware activity, an important economic sector as well as a traditional activity in Moroccan society. Due to its antibacterial efficiency (Khowdiary et al., 2017; Saravanan et al., 2018), silver presence in the water leads to the degradation of the system used in the local waste-water treatment plant. There is therefore an urgent need for an adsorption step allowing an effective silver removal before the treatment plant. The purpose of our work was to test local resources (bentonite and diatomite) for silver adsorption and improve their characteristics through thermal treatment at 550, 750 and 950°C. As a matter of fact, this was proven to enhance the chemical properties of bentonite (Bertagnolli et al., 2011; Vieira et al., 2010). In this study, the used protocol covered a wider range of temperatures than that already found in the literature as well as an optimized heating duration. It has to be underlined that such a study was never performed for diatomite. The physicochemical properties of the raw and calcined materials were characterized by XRD, FTIR, thermal analysis, SEM-EDX porosity measurements, BET and 3D-fluorescence. Then, for each material, the adsorption kinetics and isotherms were carried out and modelled with various orders of Ag concentrations in matrices of increasing complexity to finally work with the targeted brassware effluents. Thus, such complete study allowed concluding on the efficiency of calcination on improving the physical-chemical properties of widespread materials but also on the resulting adsorption efficiency towards a worrying trace metal.

Occurrence and distribution of contaminants of emerging concern along the Ergene River during dry seasons

ORAL SESSION VII

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Ergene River spans Thrace from northeast to southwest and joins to Maritsa River, then falls to Aegean Sea at Turkey-Greece border. Ergene River is the most polluted river in Turkey. The pollution is mainly due to the extensive discharges from different industries, domestic discharges and runoff from agricultural fields, animal farms and solid waste disposal sites. Since the river connects to the Maritsa River which is an interboundary river, water quality of Ergene River has an international importance. In this study, we screened 250 contaminants of emerging concern (CEC) in 75 samples taken along the river in August and November 2017 using liquid chromatography tandem mass spectroscopy with multiple reaction monitoring (LC-MSn/MRM). 18 heavy metals and 134 organic CECs were detected at least one point. Concentration of CECs ranged from 10 ng/L to 300 mg/L. CECs detected in most of the samples include heavy metals (e.g. Ni, Pb, Cu, Al, Co, V, Cr, Ba), PCBs, antibiotics (e.g. ofloxacin, azithromycin, norfloxacin), corrosion inhibitors (e.g. 1,2,3-Benzotriazole, 5-Tolytriazole), surfactants (e.g. nonylphenol diethoxylate, benzalkonium chlorides), pesticides (e.g. Diuron, prochloraz, acetamiprid, carbendazim) and metal coating agents and resins such as hexa(methoxymethyl)melamine (HMMM). As a result, this study is the most comprehensive watershed based water quality evaluation study done in the region which may be a useful example for similar studies in progress in Europe.

Emerging pollutants in superficial waters: a case study in Southern Spain

POSTER #32

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The aim of this work was to evaluate the occurrence and distribution of emerging organic pollutants in 15 streams of the Rivera de Huelva River and to establish their relation to soil activities in their watersheds. The results have shown a good preservation state of the streams, in comparison to the higher concentrations of emerging pollutants in similar aquatic systems reported by some international studies. An analytical method was developed and validated for the determination of 71 emerging organic pollutants, from different chemical families. The results obtained revealed the presence, at concentrations in the range from 0.04 ng/L to 488.4 µg/L, of 89% of the monitored compounds. Linear alkylbenzenesulphonates (LAS), nonylphenolethoxylates (NPE), di(2-ethylhexyl)phtalate (DEHP) and pharmaceutical compounds were the compounds most frequently detected and at their highest concentration levels. Such concentrations were explained by specific pollution sources, such as wastewater effluents affecting some of the streams, and also to diffuse pollution sources related to agricultural activities. Despite the low incidence found in this study, the potential environmental and health risks due to the presence of the emerging pollutants have been

evaluated, preventive and corrective solutions proposed. The analytical methodologies developed and validated are suitable for being transferred to other laboratories to monitor and to control these emerging pollutants in similar scenarios.

Removal rate, mass load and environmental impact of 27 pharmaceuticals in an urban wastewater pilot-scale A2O system with integrated fixed-film activated sludge

POSTER #43

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In this study, mass balance, removal efficiencies and environmental impact of 27 pharmaceuticals (PhCAs) have been studied in a pilot-scale A2O system, with and without integrated fixed-film activated sludge (IFAS). The pilot-scale plant treats up to 6 m^3/d urban wastewater from the pre-treatment unit of the full-scale WWTP Murcia Este. The investigation was divided into two operations periods, phase I, which operated 104 days as a conventional A2O system, and phase II, which operated 105 days as A2O IFAS process. The total average influent mass load of the target compounds under study were ca. 22.6 g/d/1000 inh, having the analgesic/anti-inflammatory drugs (AIADs) the higher mass load percentage (90.2%). Significant better removal efficiencies were obtained for the most biodegradable target compounds in phase II (76%, 63%, and 41% for lipid-regulators, AIADs and antibiotics, respectively) compared to phase I (38%, 32% and 24%, for lipid-regulators, AIADs and antibiotics, respectively). Therefore, up to double the total amount of PhACs were discharged in phase I (5.2 g/d/1000 inh) compared to phase II (2.2 g/d/1000 inh). The environmental impact of the PhCAs under study were calculated by means of the risk quotient that is the ratio between the average PhACs concentration in the effluent and the predicted no-effect concentration. As a result, seven pharmaceuticals posed high-risk quotient in phase I, while, only four pharmaceuticals posed high-risk quotient in phase II.

The adaptation of phytodepuration techniques in the optimisation of pond water quality in an Irish local authority area

POSTER #49

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Fingal County Council (Ireland) is the responsible local authority for north Co Dublin covering an area of 448 km^2 and encompassing rural, urban and suburban communities. It has been proposed to use phytodepuration techniques as an adaptable technology in the protection and improvement of surface pond water quality. This approach uses defined vegetation profiles that are designed to modify the water quality of the selected ponds as a means of controlling in-stream water quality. This work sought to: (i) assess the nature of defined pollutant chemical and biochemical components

within the ponds of the river basins as a determinant of treatment species composition: and, (ii) assess the potential impact on surface water quality of integrating a dynamic and site-specific system of phytodepuration at defined points in the steam-pond network. Preliminary outputs of the study suggest that the use of contextualised phytodepuration setups holds considerable promise as an adaptable water quality control technique, particularly with regard to emergent pollutants. The hydro-morphological and hydro-dynamic character of the setting is important and needs careful consideration at the design and implementation phase. The potential to integrate field data from pond phytodepuration units with the nature and source of pollutant transport and propagation represents a novel contribution which seeks to couple Landscape input to Stream-scape management for effective water quality control.

Evaluation of watershed resilience for water quality protection

POSTER #6

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Human land use has altered the natural ecological functioning and structure in many catchments around the world, resulting in both chemical and biotic impairment in most of the aquatic ecosystems. Biogeochemical processes of a watershed result from a unique combination of its bio-physical properties, and some watersheds can absorb/resist and response/recover more rapidly from land use alteration than others. This is called resiliency of the system. Resiliency-based watershed management has been emphasized particularly by climate change adaptation programs to reduce possible climate change effects on water resources. However, different approaches for resilience estimation are also found in the literature. In this study, a simple watershed resiliency index was calculated for nutrient loading in Finnish agricultural catchments, through eco-hydrological modeling. Secondly, a multivariate analysis of watershed variables explaining watershed resilience was carried out. The result show that watershed resilience index reflects the degree of watershed area impairment, however, the resilience index vary for different substances. Watershed resilience index is a potential tool to identify priority areas for restoration for water quality protection and early warning of catchment impairment.

Occurrence and removal of compounds of emerging concern during soil aquifer treatment

ORAL SESSION v

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It is widely known that compounds of emerging concern (CECs) can be detected in various water matrices. Precursor substances of pharmaceuticals, pesticides, industrial chemicals as well as their human metabolites and transformation products (TPs) enter the water cycle by different routes, e.g. by incomplete removal during wastewater treatment. Soil aquifer treatment (SAT) is a promising advanced technique to further purify effluents from wastewater treatment plants (WWTPs). In this study an analysis method for more than 150 CECs including precursors as well as metabolites and TPs was developed and validated for different water matrices. It was then applied to samples from an SAT system built at a WWTP in the Costa Brava region of Spain. More than 90 CECs could be detected in the feed water, with only 6 CECs exceeding threshold values from water quality guidelines and directives. For all CECs, removal during soil passage could be observed. Furthermore, some TPs were formed during treatment.

Applying a novel approach for monitoring microplastics in wastewater effluent

POSTER #31

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Concern is growing over the widespread presence and possible harmful effects of microplastics within the environment. It is likely that a large proportion of microplastics derived from consumer products will enter wastewater streams via household inputs or urban drainage systems. Subsequently, a proportion of these particles will likely be released to rivers in effluent or in sludge applied to land. Consequently, there is a vital necessity to develop a better understanding of the occurrence, fate and behaviour of microplastic particles entering wastewater treatment works, with a view to monitoring or mitigating microplastic release to the wider environment. The aim of this study is to investigate the efficacy of tertiary treatment of wastewater compared to secondary treatment alone. Effluent is collected before and after tertiary treatment and analysed to determine whether tertiary treatment processes (for example disc filters) aid in the removal of microplastics from the effluent stream. This pilot study uses a new method (designed by Mintenig et al., 2017) based on a custom-made piece of equipment that allows large volumes of water or effluent to be pumped and filtered to 10 µm on-site. Sample processing involves digestion of organic matter, microscopic and spectroscopic analysis. We also assess the suitability of this method for wider application as part of a novel approach for the monitoring of microplastics in wastewater effluent, potable water and river water.

Destruction of old chemical ammunition of the Great War on the western Front. The hundred-year-old forgotten contaminations

POSTER #46

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During the Great War, ammunition had been used on an unprecedented scale. Between 2.5 to 3 million tons of hazardous old ammunition have been disposed during the interwar period. New methods for safely breaking down chemical shells were developed by civilian companies to recover valuable materials of the rounds. After defusing, the rounds were emptied by perforation, by washing-out for TNT explosive shells and by open-burning. These processes caused severe soil contaminations especially on burning-grounds of chemical shell. Recent research has been conducted on 9 burning-grounds in France and Belgium. To this day, no vegetation grows at some locations due to extreme high grade of heavy metal (Zn, Pb, Cd,…), ranging for Zn from 10 to 100 g/kg DM, chlorinated dioxin & furan (1 000 to 400 000 ng/kg DM), and arsenic (2 to 110 g/kg DM) when shells loaded with the sternutators diphenylchlorarsine and diphenylcyanoarsine were open-burned. Inorganic arsenical compounds are associated with organic by-products produced by the oxidation (diphenylarsinic acid) or thermal decomposition (triphenylarsine, As-PAH) of diphenylchlorarsines. Brominated dioxin, nitroaromatic compounds and thianes (impurities of yperit) have been measured too. Two sites will be decontaminated because of the up-take of pollutants by crops (barley) or fresh water pollution caused by run-off. Further research is needed to assess these forgotten contaminations and theirs related environmental risks.

Fate of organic matter and selected antibiotics in wastewater treatment plant and the discharge to the environment

POSTER #16

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Conventional WWTP does not completely remove all anthropogenic compounds thereby WWTPs become point sources of complex contamination of receiving water via effluent discharges. Moreover, a major portion of organic matter and micropollutants ends up in the environment upon final sludge disposal. We report on mass balance of selected antibiotic compounds and the organic matter in the wastewater treatment followed by sludge treatment and disposal. The antibiotic compounds were analyzed on the trace level by a multiresidue analytical method using SPE-LC-MS/MS and matrix-matched standards. The characteristics and abundance of humic- and protein-like organic matter in the wastewater influents, effluents, and the reject water released from the sludge treatment and disposal were monitored by size exclusion chromatography (SEC) with UV and fluorescence detection. The components of a wastewater are separated according to their molecular size (high, intermediate, and low) into fractions of protein-, and humic-like compounds. The combination of several SEC chromatograms with UV and fluorescence signals of individual fractions represents a unique fingerprint of dissolved organic matter. It allows monitoring fate of

anthropogenic organic matter in wastewater treatment, urban hydrological cycle, and the environment. As an example, we provide a case study of WWTP of Jyväskylä, which discharges effluent to Lake Päijänne and disposes sludge to local landfill Mustankorkea.

A framework to assess and manage contaminants of emerging concern in indirect potable reuse: Water-JPI FRAME project

ORAL SESSION I

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The practice of the purposeful addition of highly treated wastewater after passage through an environmental buffer to a drinking water supply is referred to as planned or intentional indirect potable reuse (IPR). IPR provides options to maintain sufficient water quantities for communities in the future. However, there is concern regarding potential adverse environmental and human health effects and the application of IPR technologies is still limited by a heightened risk perception and regulatory constraints., The FRAME project aims include i) the development of an evaluation and monitoring scheme for IPR processes ii) design and testing of reliable and cost-effective treatment strategies iii) providing water utilities and agencies with reliable decision support tools. For the application of comprehensive monitoring strategies, analytical methods for a suite of chemical, biological and toxicological parameters have been developed. For the analysis of CECs these include several multi-residue, sensitive mass-spectrometry-based analytical methods for the determination of up to 272 individual CECs as well as methods for the detection/identification of unknown contaminants (non-target methods). The application of advanced treatment options in a multiple-barrier approach is applied at laboratory- and full-scale to test novel and effective treatment options, specifically to improve the removal of CECs, inactivation of pathogens and improvement of other health-related parameters.

Safe water systems in Arsenic polluted agricultural areas using a novel Schwertmannite-based adsorbent

ORAL SESSION V

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Although the occurrence of arsenic (As) and its environmental relevance has been known for a long time, there are still some gaps in knowledge. One significant issue is the impact of agricultural practices on soil conditions and the mobility of As. The research project AgriAs contributes to closing existing gaps as it deals with the evaluation and management of As in agricultural soil and water. The federal state of Saxony (Germany) has areas with a widespread contamination of As caused by long-lasting mining activities. Thus, such an area was used as study site to demonstrate the interaction of soil, water and plants. In order to achieve safe water systems in agricultural areas, it is necessary to consider both the purification of polluted water and the interruption of transport ways between soil, water and plants. An integrated approach can be offered by using a novel Schwertmannite-based adsorbent which is produced microbially from acidic mining water rich in iron and sulphate using a patented process developed by G.E.O.S.. Reusing the waste product from water treatment for environmental remediation of As contaminated sites offers a sustainable strategy for water management in a region that is dominated by mining activities. Several projects have already proven the successful removal of As from polluted waters using this special adsorbent, while the use as soil amendment is part of the upcoming investigations on the establishment of safe water systems in agriculture.

Water fingerprinting to inform the state of the environment and public health

KEYNOTE SESSION I

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This talk will introduce the concept of environment fingerprinting, an innovative solution to current problems with rapidly identifying and responding to deteriorating public health and environmental conditions. We will focus on urban water fingerprinting as it provides anonymised but comprehensive and objective information on the health status of a population and surrounding environment in real time as urban water (sewerage system and receiving aqueous environment) pools the endo- and exogenous biomarkers of that population. Several chemical groups including pharmacologically active compounds, endocrine disruptors and antimicrobial agents will be discussed. The phenomenon of their stereochemistry, which is often overlooked in environmental research, will be discussed in the context of environmental risk assessment. This talk will also explore new avenues in the utilization of urban water fingerprinting in the assessment of population health and health risk prediction.

Transfer of emerging organic contaminants in common vegetables in response to varying cultivars

POSTER #26

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Due to the reduction of water resource, irrigation with treated wastewater is increasingly adopted in many water-stressed regions, especially in the climate change context. However, insufficient treatment of organic pollutants leads to a direct release of a considerable fraction of these pollutants in the environment and contamination of irrigated vegetables. Therefore, understanding the transfer of emerging organic contaminants (EOCs) from treated wastewater to plants is essential to assess the feasibility of use of treated wastewater in agricultural activities and their influence on human health. The aim of this study is to investigate the uptake of 37 pharmaceutical residues and endocrine disruptors and their accumulation factors in tomatoes and lettuces in response to varying cultivars under field conditions. Two parcels were cultivated identically with four cultivars of tomato plants and lettuces. The first parcel was irrigated with alluvial groundwater and the second with treated wastewater. Soil and soil solution were also sampled using a PTFE-Quartz cup porous at the end of growing season. We demonstrate that EOCs accumulation varies significantly with lettuce and tomato varieties. In addition, the average EOCs concentrations in lettuce (250 ppb) is much higher than in tomatoes (35 ppb). This study points out the importance of the cultivars in the accumulation process of organic compounds in common vegetables and consequently the choice of varieties for production.

Migration of antimony from polyethylene terephthalate bottles to water samples during their storage

POSTER #28

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Polyethylene terephthalate bottles are commonly used for food, beverages and mineral waters storage. One of the element used as a catalyst during their production is antimony. The problem of Sb occurrence in PET bottles is widely discuss in the literature. This element can be leached from vessel material. Maximum permissible concentration of Sb in water intended for human consumption is 5 µg/L. In presented work leaching of antimony from PET bottles to groundwater samples was checked during their long storage. Groundwater from public spring used for drinking purposes was collected to new, unused PET bottles in different colors. The pH of examined water was 7.2-7.8 and TDS was 0.7-0.9 g/L. The samples were analysed after their immediate transport to a laboratory, after two weeks and after 1.5 month of storage in dark and cold place. Inductively coupled plasma mass spectrometry was used for Sb determination. After one and a half of month of water storage concentration of Sb increased about 0.1 µg/L in transparent bottle, 0.2 µg/L in brown bottle, while during the first analysis Sb was not detected. In case of blue and green PET bottle Sb concentration raised about 0.1 µg/L after two weeks and is similar to this obtained after 1.5 month of storage.

Multiple use of PET containers for collecting groundwater and an influence of these bottle storage in sunny and warm place on Sb concentration was not considered and is a further part of work.

The occurrence of bisphenol A in selected bottled water – preliminary results

POSTER #27

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Bisphenol A is a chemical produced in large quantities for use primarily in the production of polycarbonate plastics and epoxy resins. Due to its properties it is commonly used for the production of plastic bottles, tableware and different containers for food storage. In 2011, the EC adopted a directive prohibiting the use of BPA in bottles dedicated for baby feeding. In 2017 BPA was included in the list of substances requiring special supervision, as a very high-risk substance which cause a toxic effect on reproduction. Despite this BPA is still used in production i.e. bottles for water storage. PET bottles should be free from BPA, however researchers indicated that it could be found in water stored in such type of vessels. It may be related to occurrence of BPA in material of water installation or in bottles caps. It could also origin from recycled PET used. Different studies showed that the presence of CO_2 could also affect the migration of some plastic constituents or influence their elimination during storage. The aim of the research was to determine BPA concentration in selected bottled water. During the preliminary studies groundwater with different total dissolved solids amounts and carbon dioxide concentrations were chosen. Solid phase extraction followed by GC-MS detection was used for determination of BPA concentration. The amount of this compound in analysed waters varied from below the method detection limit to several ng/L.

The role of conventional and advanced wastewater treatment technologies in antibiotics resistance dissemination to the environmental waters

POSTER #42

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Antibiotic resistance is an urgent threat to global society. The constant release of antibiotics in natural waters not only causes toxic effect on aquatic organisms but also spreads antibiotic resistant genes (ARGs) to the environment. Urban wastewater treatment plants (WWTPs) are the hot spots for environmental bacteria to mix and exchange genetic material with pathogenic ones. Pathogens resistant to nearly all clinically relevant antibiotics have been reported in WWTPs. Our studies shown, that operational conditions significantly affect the removal of emerging micropollutants (EMs) such as antibiotics in WWTPs. In particular, low temperatures in Finland significantly decreased the removal and thus higher amounts of antibiotics could be expected to pass through WWTPs to water bodies, especially during winter seasons. Studies of alternative biological treatment technologies

(Membrane Bioreactors) showed notably higher removal efficiencies for EMs at cold conditions. Advanced polishing treatment steps (advanced oxidation processes etc.) also have potential to increase the antibiotics removal, however ARGs are not necessarily removed. Additionally, microplastics demonstrated the potential to carry ARGs from the WWTPs to the environment. The ongoing two-year project is dedicated to the fate of ARGs and their transmission pathways from WWTPs to the environmental waters. The aim of the study is to assess preferable strategy for controlling antibiotic resistance dissemination.

Modeling approach of microplastics in aqueous and cell environments

POSTER #13

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Micro- and nanoplastics are tiny plastic particles with size less than 5 and 1 mm, respectively, and they come from a variety of sources, including degradation of larger plastic fragments and direct release of micro- and nanoparticles from household and customer care products. Microplastics is a global pollutant in marine that may be affecting the behaviour of fish and marine and freshwater ecosystems. From aquatic ecosystems microplastic can end up to foodstuffs and tap water which could potentially increase exposure of chemicals to humans and thus can be risk to human health. However, the human health effects are still unknown. The chemical analysis of microplastic by using mainly FTIR methods will reveal chemical composition of microplastics and their physico-chemical properties that can be used for estimating their effects on human. To study the possibility of human exposure we are performing molecular simulation to examine the transport of microplastics across cell membranes. At first, model compounds are used and later we apply the information from chemical composition of microplastics obtained also by mass spectrometric and NMR methods. Simulation runs provide us information about the possibility of microplastic to transport via cell membrane. In addition, we are studying the possibility of microplastic to interact with certain receptors. Modeling studies will be evaluated with cell viability assays.

Emerging pharmaceutical compounds in private wells and well fields of a typical alluvial aquifer – a geochemical approach

POSTER #24

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Drinking water supply well field and private wells implanted in accompanying alluvial aquifers nearby surface water bodies may be exposed to the emerging organic contaminants present in stream water due to the release of waste water treatment plant (WWTP) effluents in the environment. Up to now pharmaceutical compounds as well as their fate in the environment are better characterized in

surface water and WWTP effluents than in groundwater. The objective of this study is to evaluate the origin, potential impact and fate of emerging pharmaceutical compounds during the transfer process from stream water to groundwater in a typical alluvial aquifer. The studied aquifer is a quaternary sediment formation deposited by an ancient Rhône river channel, the Vistrenque aquifer, located in southern France. Out of the 34 compounds searched for on 54 GW samples, 13 compounds were detected and showed concentration in the range of several 10s of ng/L. High detection frequency, between 60 to 30 %, were observed for carbamazepine, roxythromycin, epoxy carbamazepine and ofloxacin. The origins of the compounds were tracked back to stream water using an array of evidences including temporal variations of the signal and comparison with co-tracers including K, EOC fingerprint and water isotopes. Attenuation factors of 10 to 100 were observed depending on the detected molecules. Hence potential contamination of wells with such products must be accounted for in water supply management scheme.

Pharmaceuticals in the environment – time to act

POSTER #9

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The continuous growth of the EU market for both human and veterinary medicine highlights the region's heavy reliance on pharmaceuticals. The increasing demand for pharmaceuticals, however, can lead to them ending up in the environment, either in the form of the original active pharmaceutical ingredients (APIs) or as metabolites and transformation products. There is increasing evidence that even low concentrations of pharmaceuticals can pose environmental risks. Although several studies report very low risks for human health at the concentrations measured in the environment, long-term effects on humans as a result of chronic exposure to pharmaceuticals has not been yet explored. Pharmaceuticals can be released into the environment at all stages in their life cycle - from manufacturing to disposal. However, there are a number of gaps and inefficiencies in currently pharmaceuticals management practices at all stages of this life cycle. At an EU level, the issue of pharmaceuticals in the environment is mainly addressed in legislation relating to veterinary medicinal products but is less recognised in legislation dealing with medicinal products for human use. This presentation will pose and attempt to answer the question: to what extent will the upcoming European Commission Strategic Approach to Pharmaceuticals in the Environment ensure the sustainable and prudent management and use of pharmaceuticals?

Chemical status of freshwaters in Finland, Europe

ORAL SESSION I

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Harmonized assessment of the quality of European waters has taken large steps in the 2010's with commonly defined Environmental Quality Standards (EQS). However, monitoring practices and preferences still vary between countries leading to different "chemical status". WFD has defined persistent, bioaccumulating and toxic compounds as "Priority Hazardous Substances". Actually, they determine the chemical status of freshwaters in Finland, as in most European countries – if measured. We have measured these compounds (Hg, PBDE, PFOS/PFAS, PCDD/F) in perch throughout Finland during this decade. In the 2nd WFD status assessment, e.g. mercury is estimated to exceed EQS in ca. 50 percent of the waterbodies, dominantly in humic lakes in Central Finland. We have shown that perfluorinated compounds, both restricted PFOS and PFOA and their substitutes are constantly leaking to water systems in many areas. New hotspots are found, and we cannot assume knowing them all. WFD Watch List campaigns have revealed also hormones, diclofenac and neonicotinoids in our river systems. Passive samplers have shown to catch temporally variable substances like pesticides more efficiently than traditional sampling. Risk management is not possible without first knowing where the problems are. Screening and monitoring will help us to focus the risk reduction measures and risk communication, including adaptation.

Hydrogeological behavior of antibiotics in groundwater: A challenge for water resources management

POSTER #18

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The occurrence of antibiotics in groundwater, whether human or veterinary, is widely documented. Nevertheless, there are still few papers that address the hydrogeological factors governing their migration, paramount to control groundwater quality. A study in the Baix Fluvià alluvial aquifer (NE Catalonia) provides remarkable insights about antibiotic distribution, potential sources and migration processes (Boy-Roura et al., 2018), and through the unsaturated zone. Several facts related to water resources management arise: 1) the representativeness of the sampling wells in a complex flow-field of simultaneous pumping wells, 2) the sorption and degradation of antibiotics, considering the multifaceted aspects of their geochemical behavior, 3) the extremely variable antibiotic content of the applied manure, and 4) the patchy distribution of input zones determined by those crops that accept manure as fertilizer (cereals, forage) and those that not (orchards). These facts indicate that inconsistent monitoring of antibiotic polluted groundwater will provide erroneous information, which will hardly support adequate management decisions. The outcome of this JPI project indicates the way that groundwater antibiotic data must be handled to efficiently support management actions for antibiotics and other emerging pollutants as well. Boy-Roura et al. (2018). DOI: 10.1016/j.scitotenv. 2017.09.012. Funded by projects EU-JPI/Water 2013-118, and CGL2014-57215-C4-2-R.

Nanoparticles and their fate in the environment, health impact and risk assessment

ORAL SESSION VII

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The basic foundation of nanotechnology is that engineering the size and shape of materials at the nanometer scale produces distinct, novel properties with potential functional and commercial value. The specific properties of nanomaterials (NM) and their resulting unique environmental behaviour and potential effects have led to the concern that current environmental risk assessment (ERA) methods, endpoints and approaches may not be adequate. Progress is needed in the prediction of environmental distribution, concentration and form (speciation) of nanomaterials, to allow early assessment of potential environmental and human exposure and risks, to facilitate safe product design and to include these aspects in nano regulation. This presentation will combine results generated in the EU FP7 project NanoFATE and the follow up Horizon 2020 project NanoFASE to highlight the state of the art in NM ERA. Both projects were and are multi-disciplinary efforts involving analytical chemists, ecotoxicologists, material scientists and fate and exposure modellers and used both commercial ENPs from high-volume products, e.g., fuel additive, personal care and antibacterial products (CeO2, ZnO, Ag of varying size, surface and core chemistries) and purpose-made model ENPs for mechanistic work following their post-production life cycles i.e. from environmental entry as spent product, through waste treatment to their final environmental fates and potential toxic effects.

Mitigation of waterborne microbiological and chemical health risks – options and costs to reduce the source water contaminants

ORAL SESSION I

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Aquatic contaminants – pathways, health risks and management (CONPAT) project (2012-2016) investigated the occurrence, fate, and health and economic impacts of microbial and chemical contaminants in Kokemäenjoki river water course in Finland. The water course is impacted by municipal wastewater and agriculture with minor industrial activity. The river water, which is used for drinking water production, is lead after pre-treatment to artificial groundwater recharge process in an esker. Faecal pathogens (norovirus and campylobacter), were present in river water in infectious levels. Emerging pollutants (pharmaceuticals, artificial sweeteners and perfluoroalkyl substances) were detected in river water indicating clear anthropogenic impact to the water course. Feacal pathogens were efficiently removed during the artificial groundwater recharge process. However, the chemical contaminants passed through the water treatment raising concerns on human health risks. Comparison of health impacts and risk mitigation actions provides valuable information for stakeholders from industry to policy-makers on the true cost of contaminated water. Traditional

disinfection methods (chlorination, UV-disinfection) against pathogens are usually the cheapest methods available, while membrane techniques, which remove harmful chemicals and microbes, are the most expensive options. Regarding to health risks it seems that the low-cost techniques are the most cost efficient for protecting human health.

Drinking water disinfection at small/individual scale: electrochemical disinfection at flow conditions

POSTER #48

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Availability of efficient and affordable water treatment technologies that decrease bacterial, viral and protozoan burden in rural communities is still a challenge. Despite the high efficiency of chlorination, it generally requires storage of the disinfectant and its qualified use. Electrochemical disinfection is regarded as one of the reagent-free alternatives to chemical chlorination due to its possibility to generate free chlorine from chloride ions naturally presented in drinking water. The inactivation efficiency of electrochemical disinfection system is mostly dependent on many parameters, such as electrode material, cell configuration, electrolyte composition, microbial load and type, current density and electrolyte flow rate. Moreover, the overall design of the system must support simple and rapid production of disinfected water. Here we present a system (EDI-001) suitable for water treatment at flow conditions. Tests with titanium oxide-based ceramic electrodes at laboratory conditions have demonstrated that it is possible to generate enough free chlorine from tap water (Cl- 10 mg/L) and obtain suitable disinfection efficiency (5 log *E. coli*) after 15 min of operation at low current density conditions (30.9 A/m^2). Thus, the system can be applied for disinfection purposes. Further research involves optimisation of the system to generate/neutralise residual chlorine concentration that is accepted by health authorities.

Advanced metagenomic analysis to elucidate the role of reused water as a dissemination vehicle and possible reservoir of the emergent pathogen *Helicobacter*

POSTER #22

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Health and environmental safety conditions under which wastewater may be reused are not regulated at the EU level, which can lead to an increased risk of human infection. Among all the emerging waterborne pathogens, *Helicobacter pylori* is one of the most concerning ones, since it is the directly related to gastric cancer. Hepatobiliary cancers are caused by infection with *Helicobacter* species, such as *H. hepaticus*, in a manner that is similar to *H. pylori* in gastric cancer. Evaluating

the presence of *Helicobacter* in reused water, which is mainly used to irrigate crops, is a priority. The aim of this work has been to apply metagenomics and qPCR to the study the presence of *Helicobacter* in wastewater samples (after secondary treatment and after UV disinfection) used for irrigation. Four samples from secondary treatment and two from tertiary effluent were positive for *H. pylori*. Metagenomics analysis showed the presence of both *H. pylori* and *H. hepaticus* in the effluents. To the best of our knowledge, this is the first time that *H. hepaticus* has been detected in wastewater. The obtained information is of great value for improving our knowledge about the role of reused water as a reservoir and infection source for *Helicobacter*, and about the risk they pose for Food Safety and Public Health. Supported by the Spanish Ministry of Economy and Competitiveness AGL2014/53875-R grant and by the Spanish Ministry of Economy and Competitiveness Program International Joint Programming Actions JPIW2013-095-C03-02.

Contaminants of emerging concern in Sub Sahara African aquatic systems

ORAL SESSION III

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Contaminants of emerging concern (CECs) have been reported to be present in many aquatic systems in many countries including in the developed world. The problem of the occurrence off CECs in the aquatic environment may be more severe in African countries which are known to be importers of industrial products from the developed world. Pharmaceutical products, industrial chemicals, agricultural chemicals (fertilizers, pesticides, herbicides, etc.) are imported to almost every African country. For various reasons, many of these chemicals end up in the environment. Moreover, waste and wastewater treatment plants in many African countries are very inefficient in treating such kinds of wastes, which contain residues of CECs. A study that was conducted in some of the African aquatic systems show that a number of CECs do survive the treatment procedures in a number of wastewater treatment plants. The study reveals that residues of antifungal drugs, psychoactive drugs, statins, fibrins, nitromusks, etc. are present in the eluents of wastewater treatment plants. This observation raises health risks to human, which may aggravate problems such as drug resistance to the population. This implies that something has to be done to address the problem. This paper highlights the extent of the problem and also suggest some possible remedy to the problem that may be relevant to the African context and possibly extrapolated to suit other regions outside the African continent.

Assessment of large-scale metal contaminated soils in Saxony (Germany) - is there an impact on the soil-to-water pathway?

POSTER #45

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About 1,000 km² of soils in Saxony have elevated loads of metals due to the aftermath of mining and ore processing activities in combination with the geochemical situation found in the Ore Mountains. Management of this takes a regional approach: geochemical surveying and regional risk assessments take place followed by a specific mapping according to a regional regulation called soil planning area ("Bodenplanungsgebiet"). During the regional assessment process, the question was addressed, if the large-scale contamination of soil has also had an impact on ground water quality (via leachate). Altogether 2,970 natural subsoil samples were investigated on their pseudototal metal content (aqua regia extraction) and metal mobility by using a 24 hour and 1:10 w/w water extraction procedure. Results showed quite poor correlations between pseudototal and water extractable concentration for As, Pb and Cd as well, even if pH is included in statistical models or when looking at different parts of the region or when excluding uncontaminated samples. Regarding the latter, only 15.2% of the samples meet the German regulation on soil material regarding pseudototal arsenic concentration. Regarding metal extractability 75.4% of the samples meet the regulation by showing very low extractability for arsenic - although their pseudototal metal concentration in general is strongly elevated. These results will be also compared to regional groundwater background concentration as well.

Antibiotic resistance, an emerging pollution in river environments in Indonesia

ORAL SESSION VII

Muziasari W, Narita V, Hultman J, Fadlillah L, Pradikta L, Hadi P, Subaryono, Dwiprahasto I, Stedtfeld R, Tiedje J, Virta M*
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Water environments are known as the hotspots of antibiotic resistance gene (ARG) transfers between bacteria in human, animal and the environment. The information on the antibiotic resistance in the environment is building up in the developed countries. However, there is still lack of data on the status of antibiotic resistance in less developed countries such as Indonesia. To fill in this gap, we measure the ARGs and mobile genetic elements and analyse the bacterial community in surface river water. Our results show that the urban activities including hospital wastes are the main source of ARG pollutions in surface river water in Indonesia. The impact of animal farms on ARG profiles in the river is different compared to the urban activities. Most of the ARGs are diluted in the estuary, however some are still detected especially that are associated with the mobile genetic elements. This leads to the spread of ARGs in the environment that may disseminate back to bacteria in human and animals. Human activities also impact the bacterial community in surface river water. We propose that a research unit is required to do the surveillance on antibiotic resistance in the

environment in Indonesia. Also, it is important to improve the awareness on antibiotic resistance in the general public and the importance to improve the regulation of antibiotic use in human and animals.

Technologies for the removal of pharmaceuticals from wastewaters

ORAL SESSION V

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Different technologies such as membrane filtration, oxidation and adsorption are commonly proposed as a solution for the removal and degradation of emerging micropollutants e.g. pharmaceuticals from wastewaters as well as drinking waters. The aim of this study is to point out the advantages and disadvantages of different technologies for the removal of pharmaceuticals from human based wastewaters. Different technologies do not only have an effect on the concentration of micropollutants, but they also affect their structure and other compounds, such as nutrients. Many of the pharmaceuticals are efficiently degraded in the existing biological wastewater treatment processes, but not all. Tertiary treatment technologies (adsorption, oxidation and membrane filtration) are therefore tested in this paper with real wastewater from two municipal wastewater treatment plants and a hospital to reduce the concentration of micropollutants. The focus was especially in the pharmaceutical compounds, however the removal efficiency of nutrients and other organic compounds is also taken into account when evaluating the feasibility of the tested technologies.

Restoration of eutrophied lake by withdrawal of hypolimnetic water - sedimentary phosphorus recovered as a circular economical resource

POSTER #44

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Restoration of eutrophied lakes has often led only to temporary improvements in water quality. A major problem is that the largest internal storage of nutrients such as phosphorus (P) is in the bottom sediment, which cannot easily be removed. Therefore, many restoration methods aim to retain P in the sediment. This restoration strategy includes two main problems. By retaining P in the sediment, the long-term recovery of the lake may be delayed. Moreover, P in the sediments cannot be recovered for potential use as a circular economical resource. In Lake Kymijärvi (southern Finland), we are currently testing a restoration method that can overcome these problems. Nutrient-rich hypolimnetic water will be pumped through a calcium filter to trap P, and returned to the lake through a wetland. The pilot restoration project funded by the Finnish Ministry of Environment will start in summer 2018.

Sulfate- and metal-rich effluents of the Finnish Pyhäsalmi and Talvivaara mines affect microbial communities of the nearby lakes

POSTER #2

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Finnish Pyhäsalmi and Talvivaara mines produce sulfate- and metal-rich wastewaters. Here we studied the effect of the mining effluents on the nearby lakes' microbiomes in epilimnion, hypolimnion and sediment samples collected from 9 mining-affected and 4 reference lakes. Based on the specific conductivity (SC) of the hypolimnion during winter stratification, mining-affected sampling sites were divided into three groups: "low" (SC 70-80 µS/cm), "medium" (SC 220-1400 µS/cm) and "high" (SC 6700-8800 µS/cm) contamination sites. Diversity of the bacterial communities was characterized using next-generation sequencing of 16S ribosomal RNA genes and ribosomal RNA. In most groups, *Proteobacteria* was the main phylum: therefore, its composition was studied further to the lowest identified taxonomical unit. In the hypolimnion and sediment samples, operational taxonomic units (OTUs) related e.g. to metal, sulfur and organic matter oxidation as well as sulfate and metal reduction were strikingly enriched in high and/or some of the medium contamination sites compared to the reference sites. Enriched OTUs represented e.g. the iron-oxidizing genus *Gallionella*, bioremediation-capable genus *Geobacter*, sulfur-oxidizing genus *Thiovirga* and the sulfate-reducing families *Desulfobacteraceae* and *Desulfobulbaceae*. Most probably, the selection pressure caused by the mining effluents resulted in the enrichment of the above-mentioned bacterial taxa capable of utilizing various chemical contaminants.

Human exposure to antibiotic resistant *Escherichia coli* through drinking, irrigation and recreational water

ORAL SESSION VII

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Scientific research shows the presence of antibiotic resistant bacteria (ARB) in rivers, lakes and beaches globally. When antibiotic resistant infections are contracted by humans they can lead to life threatening illnesses. This study examines the potential human exposure to antibiotic resistant *Escherichia coli* (AR *E. coli*) through drinking, irrigation and recreational water. Water samples were taken from European case study sites including a river located near a drinking water treatment plant (DWTP), a river used to irrigate local crops and a recreational water site. All water samples were tested and analysed for the presence of AR *E. coli*. Three human exposure assessment models were developed to characterise potential ARB transfer. Probability distributions were used to characterise uncertainty and variability in the model input data and Monte Carlo simulation was performed to generate exposure outputs. The drinking water model provides important information on the maximum acceptable levels of AR *E. coli* in source water used for DWTP. The irrigation model provides guidelines on maximum acceptable AR *E. coli* levels for irrigation water. The results from the recreational model quantify the amount of AR *E. coli* humans are exposed to though recreational

water use. The information generated by the human exposure assessment models are critical in gaining a clearer understanding of the levels of ARB humans are exposed to through surface water ecosystems.

Performance of POCIS passive samplers to estimate PFAS concentrations in fish

POSTER #35

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Passive samplers are discussed as a tool for monitoring priority contaminants of e.g. the EU's Water Framework Directive. They can concentrate compounds for which the conventional analysis of grab samples cannot achieve the environmental quality limits, or they could replace biota samples. We evaluated the performance of a Polar Organic Chemical Integrative Sampler (POCIS) for per- and polyfluoroalkyl substances (PFAS). POCIS samplers are designed to estimate the exposure of aquatic organisms to dissolved polar organic contaminants. They can mimic the accumulation of PFAS into fish, and estimate the time-weighted average concentrations in water. This study was part of the PFARA project, which examined the occurrence, fate and transport of PFAS at firefighting training sites. POCIS samplers were deployed in surface waters for two weeks and grab samples were collected in the beginning and at the end of the deployment. The PFAS uptake rates of the samplers were determined in a laboratory trial which enabled the calculation of time-weighted average concentrations. Fish were hooked from a lake downstream of a training site along with grab samples. POCIS samplers and fish effectively accumulate the long-chained PFAS, which were detected more often in samplers and fish than in grab samples. The suitability of POCIS samplers to estimate PFAS concentrations in fish and their potential to replace the laborious fish sampling were assessed.

Platform scheme of generic approach for the Soil Aquifer Treatment in Indirect Potable Reuse practice

POSTER #25

Picot-Colbeaux G, Hertout A, Akrour R, Aurouet A, Pettenati M, Devau N, Blanc P, Thiéry D, Loïc T, Hermes N, Dietrich C, Kunkel U, Müller J, Valsecchi S, Mascolo G, Murgolo S, Thomas K, Macken A, Hübner U, Jewell K, Pierre D, Carere M, Polesello S, Kloppmann W, Drewes J E, Ternes T*
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Recycling treated wastewater effluents to increase drinking water supplies defined as indirect potable reuse (IPR) practices is worldwide frequently happening. However, unknowns remained concerning emerging contaminants and pathogens transfer to surface waters and groundwater that adversely affect aquatic life as well as human health. The project FRAME funded by the Water JPI program has been done to develop global evaluation scheme allowing a comprehensive assessment of efficient and cost-effective IPR measures to minimize risks associated with emerging contaminants and pathogens, while closing local and regional water cycles. Focused on groundwater recharge by infiltration of recycled water by using surface spreading, the fate and transport of emerging contaminants in the unsaturated-saturated continuum are simulated during soil-aquifer treatment (SAT) through a series of hydrodynamic transport models by using the MARTHE code. Based on known IPR study sites, several models have been pre-processed considering different hydrogeological conditions to simulate the mean residence time in the groundwater from the infiltration basin and the associated fate and removal of chemicals of emerging concern. This SAT virtual assessment tool is included in the FRAME Decision Support Framework and can be used by stakeholders in conducting feasibility studies for the application of IPR considering their specific field site conditions.

Water quality forecasts to support adaptive water management. Progress on the modelling methods used by the JPI Water PROGNOS project

POSTER #11

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In the JPI Water PROGNOS project, we are developing an integrated approach that couples high frequency (HF) lake monitoring data to dynamic water quality models to forecast short-term changes in two specific water quality threats: algal blooms and increased dissolved organic carbon concentration. PROGNOS forecasts will support adaptive water management, by providing a greater window of opportunity for making water management decisions. They will help mitigate oncoming water quality issues, and will provide predictions of the length and severity of water quality problems that cannot be avoided. These forecasts are highly innovative and require the coupling of monitoring and modeling technologies in ways that are rarely achieved in the context of applied management. In PROGNOS we have worked to improve and standardize our collection of HF data from a number

of sites across Europe: have identified events in these data that are typical of ones that would need to be simulated by the modeling system: and are developing the modeling workflows to produce water quality forecasts. Here we present our progress on developing long-term hydrothermal and water quality calibrations that will form the model foundation of the forecast system, and also present the model workflows that will allow model simulations and HF data collection to be dynamically linked.

Determination of precursors of perfluoroalkyl acids in surface and wastewaters: application to some case studies

ORAL SESSION V

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The identification and the quantification of PFAA precursors is a key issue in their risk assessment but it is difficult and problematic for the lack of analytical standards or the challenges associated with available analytical techniques. In order to assess the total amount of PFAA precursors in natural waters, a method which used a persulphate oxidation of the sample has been tested and validated. The method has been applied on surface waters and treated wastewaters both in field and pilot scale tests to estimate the effect of the passage through the soil of wastewaters in managed aquifer practices including indirect potable reuse with the augmentation of natural resource (i.e. surface water and groundwater). By our method the evolution of PFAA concentrations has been followed during all treatments steps, including the presence of potential precursors which can generate PFAA after end-of-pipe oxidative treatment before the distribution as potable water. The results showed that the soil infiltration is able to generate PFAA from precursors already present in influent waters. The method for the estimation of PFAA precursors was also applied to the discharges of two factories that produce or used fluorochemicals, which represent the most significant sources of PFAS for the Italian river basins. The method demonstrated to be very effective also in assessing the actual risk for the ecosystem caused by discharges of fluorochemical plants.

Technology of treating the organic part of mud from wastewater treatment plants in a soil fertilizer

POSTER #41

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A novel technology of the aerobic meso-thermophilic fermentation process for the optimal separation of sludge at WWTP, in terms of energy, has been developed. During the thermal sedimentation, viscosity of colloidal micelles is reduced, allowing the sludge to be separated from an amount (about 60-65%) of free water. As a result of using this technology, the sludge water (50% or more of the

sediment volume) is fed to the dilution of incoming wastewater to the head of the treatment plant, while the organic part (30-35% of the volume of sediment) is sent to microbiological processing either into biofertilizers or into microbial biomass used, for example, as enzyme feed additives, and the mineral part is removed to sand or silt areas. As a result of implementing the developed technology, the following social and economic benefits have been attained: 1. Reduction of the nuisance generated by the sludge: elimination of the odor, improving air quality: 2. Sludge reduction in volume (by 1/3) for storage: 3. Processing organic sediment (where heavy metal concentrations do not exceed MAC) in microbial biomass for the production of bio-fertilizer (an organic product for agriculture): 4. Decrease in energy consumption: by 12% in average. 5. The use of vegetal and mineral waste has been improved the efficiency of the purification process and the efficiency of sewage sludge separation in the sludge.

Optimized risk assessment of hazardous chemicals typically present in Finnish municipal wastewaters

ORAL SESSION III

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Many emerging contaminants have been measured levels above the environmental quality standards (EQS) in the municipal wastewater effluents in Finland. Some of those are endocrine disrupters, such as brominated flame retardant hexabromocyclododecane (HBCD) and perfluorooctane sulfonate (PFOS), which has been widely used in various industrial products such as coating additives and firefighting foams. Both compounds are potentially dangerous in the environment and use of those has been recently restricted under the Stockholm Convention on POPs. In this study we modified standardized toxicity tests for boreal species to enable more reliable risk assessment of hazardous chemicals in boreal environmental conditions. Methods are alternative to the animal tests: OECD 210 standard for fish embryos of rainbow trout (*Onchorhynchus mykiss*) and in vitro cytotoxicity Neutral Red retention (NRR) assay with liver cell line of rainbow trout. Measured endpoints were cell death in the NRR assay, and mortality, abnormalities and embryo and yolk size in the fish experiment. In addition, lipidomics and body burden of HBCD and PFOS were measured from fish. Results indicated that HBCD and PFOS were not cytotoxic at the concentrations measured from Finnish wastewaters. HBCD and PFOS had an effect on fish embryo size. Results of alternative toxicity tests can be applied in environmental risk assessment of wastewaters to provide more information for stakeholders from industry to policy-makers.

Nanocomposite water filter applied to heavy metal ions and radioactive elements extraction

POSTER #52

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Metallic nanoparticles (MNP) have received extensive attention during the past decades due to their high potential applications such as catalysis, biomedical and water remediation. This work presents nanomaterials and nanocomposite based water filter that was developed for heavy metal ions and radioactive elements extraction from contaminated water. This sand based nanocomposite water filter enables the complete extraction of metallic pollutant like Pb, Cu, Zn, Mn, Fe among others by a simple passage of contaminated water through it. The extraction of radioactive elements such as U has been also successfully tested with this filter. The filter is made of 99% natural element which is sand and can be recycled at the end of its life respecting a circular economy. The active nanomaterials are also superparamagnetic, which enables their utilization for magnetic extraction from liquid solution if they are used as free-standing nanomaterials. In addition, the biocidal properties of these nanoparticles were studied against bacteria and fungi. Along with anti-microbial effects, the filter also is capable of degrading organics in industrially contaminated water and will be presented. Financial support from Estonian Research Council (PUT431) and the European Regional Development Fund project TK134 (TAR16019) is acknowledged.

Persistent, mobile and now partially known. The potential threat to drinking water resources by persistent, mobile organic compounds (PMOCs)

ORAL SESSION V

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Chemicals that are environmentally stable and highly polar have the potential to break through natural and technical barriers in the aquatic environment and to threaten the quality of raw water resources. Moreover, such persistent (P) and mobile (M) organic chemicals (PMOCs) are often not detectable by analytical methods used for the monitoring of water quality. Because a protection gap (for drinking water resources) coincided with an analytical gap, the potential threat to drinking water quality by PMOCs was unknown. This was especially critical with respect to industrial chemicals, as their number is very large and knowledge on environmental properties limited. A suite of LC-MS methods for PMOCs was developed to narrow the analytical gap, involving MMC-MS, HILIC-MS and SFC-MS. PMOC candidates were selected based on the data provided in the REACH registration process. The application of these methods to European water samples, from surface waters to drinking water provided a first view on the nature and concentrations of PMOCs in the water cycle and clearly illustrated that the number of environmentally relevant PMOCs is much larger than

anticipated. Future research efforts should be directed towards extending the analytical methods to an even larger number of PMOCs and investigating the sources, fate and effects of those PMOCs that have now been shown to occur in water cycles. Changes in chemical use and regulation may support protection of drinking water from PMOCs.

Technical solutions and strategies to monitor and reduce pollutants

KEYNOTE SESSION V

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Every drop of water counts: The availability of affordable, clean water represents the greatest global challenge of our time. Throughout the journey from source to sea water management meets many challenges such as infrastructure failures, the need for treatment innovations etc. where WaterIoT decision support tools could provide real value to the stakeholder. The aim is to address challenges in the catchment, city/town, wastewater treatment plant, etc. all of which can be met by distributed sensor networks and better information. Continual measurement is key to understanding sudden and gradual changes in chemical and biological quality of water, and for taking reactive remedial action in the case of contamination. The potential for innovative technology development for water monitoring and knowledge generation is huge and recent years have seen leaps forward in the development of sensor technology. This paper looks at innovative technologies from materials, sensors, data analytics and decision support tools as a continuum to meet the needs of a growing water challenge relating to emerging contaminants of concern. Up to now in-situ monitoring of specific target chemicals has not been possible due to lack of sensors. Some target analytes provide the basis for the development of novel biosensors, opening opportunities for monitoring at source in the future. We propose passive sampling and biosensors as tools for water quality monitoring. Drawing from research done in Ireland, examples of where sensor technologies, innovative sampling and monitoring tools were used, will be discussed and some new perspectives on monitoring needs and opportunities in the future will be presented.

Herbicide exposure on freshwater natural phytoplankton communities: effects on Adaptation vs. Acclimation

POSTER #5

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Herbicides are extensively used to optimize crops production. Chronic background contamination caused by herbicides run-off from fields can pose a selective pressure on natural freshwater phytoplankton communities favoring more tolerant species or even leading to selection of more resistant genotypes. Ecological theory and the existence of functional trade-offs in biological systems, suggest that adapted communities arising from a historical exposure to a specific stressor can exploit resources in a suboptimal way in non-disturbed conditions. Our aim was to assess the effect of long-term adaptation vs. short-term acclimation in a 2-phase community level experiment with natural phytoplankton communities obtained from germinating sediment seed banks from two lakes: a near-pristine forested catchment and an agricultural catchment. Using a controlled laboratory setup, phytoplankton communities from the 2 lakes were germinated in presence and absence of a sub-lethal level of an herbicide (Isoproturon, 12 µg/L). In the 2nd phase of the experiment, we exposed the germinated communities to 4 Isoproturon concentrations (7, 12, 61, 92 µg/L) following biomass development. Results indicate non-significant differences between biomass development when communities were germinated and incubated in absence of Isoproturon. However, when germination occurred in presence of herbicide, agricultural lake displayed lower sensitivity to the stressor compared to the one from the pristine lake.

Intensification of UV-C tertiary treatment: disinfection and removal of micropollutants by sulfate radical based Advanced Oxidation Processes

ORAL SESSION V

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This study explores the enhancement of UV-C tertiary treatment by sulfate radical based Advanced Oxidation Processes (SR-AOPs), including photolytic activation of peroxymonosulfate (PMS) and persulfate (PS) and their photocatalytic activation using Fe(II). Their efficiency was assessed both for the inactivation of microorganisms and the removal or micropollutants (MPs) in real wastewater treatment plant effluents. Under the studied experimental range (UV-C dose 5.7 to 57 J/L: UV-C contact time 3 to 28 s), the photolysis of PMS and PS (0.01 mM) resulted in a clear enhancement of UV-C efficiency, increasing up to 25% the bacteria removal. The photolytic activation of PMS led to the total inactivation of bacteria (˜ 5.70 log) with the highest UV-C dose (57 J/L). However, these conditions were insufficient to remove the MPs, being required oxidant's dosages of 5 mM to remove above 90% of carbamazepine, diclofenac, atenolol and triclosan. The best efficiencies were achieved by the combination of PMS or PS with Fe(II), leading to the total removal of the MPs using a low UV-C dosage (19 J/L), UV-C contact time (9 s) and reagent's dosages (0.5 mM). Finally, high

mineralization was reached (50%) with photocatalytic activation of PMS and PS even with low reagent's dosages.

Micropollutants removal by UV-C/sulfate radical based Advanced Oxidation Processes at full scale

POSTER #37

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This work reports the application of three different AOPs based on the addition of homogeneous oxidants (hydrogen peroxide, peroxymonosulfate and persulfate anions), in the UV-C tertiary treatment of Estiviel WWTP (Toledo, Spain) previously designed and installed in the facility for disinfection. AOPs based on the photolytic decomposition of oxidants have been demonstrated as more efficient than UV-C radiation alone on the removal of 25 different MPS using low dosages (0.05-0.5 mM) and very low UV-C contact time (4 – 18 seconds). Photolysis of PMS and H_2O_2 reached similar average MPs removal in all the range of oxidant dosages, obtaining the highest efficiency with 0.5 mM and 18 seconds of contact time (48 and 55% respectively). Nevertheless, PMS/UV-C reached slightly higher removal than H_2O_2/UV-C at low dosages. So, these treatments are selective to degrade the target compounds, obtaining different removal efficiencies for each compound regarding the oxidizing agent, dosages and UV-C contact time. In all the cases, H_2O_2/UV-C is more efficient than PMS/UV-C, comparing the ratio cost:efficiency (€/m^3·order). Even H_2O_2/UV-C treatments are more efficient than UV-C alone. The addition of 0.5 mM of H_2O_2 compensates the increase of UV-C contact time and electricity consumption, which would be necessary to improve the removal of MPs by UV-C treatments alone.

Assessment of full-scale tertiary wastewater treatment by AOPs: Removal or persistence of antibiotics and antibiotic resistance genes?

POSTER #36

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This research reports for the first time the full-scale application of different homogeneous Advanced Oxidation Processes (AOPs) (H_2O_2/UV-C, PMS/UV-C and PMS/Fe(II)/UV-C) in the removal of different antibiotics (ABs) and antibiotic resistance genes (ARGs). Treatments were performed in the UV-C tertiary treatment of Estiviel wastewater treatment plant (WWTP) (Toledo, Spain), in the frame of a collaboration between MOTREM and STARE Water JPI Pilot Call projects. AOPs based on the

photolytic decomposition of oxidants showed a higher efficiency than UV-C radiation alone on the removal of the antibiotics using low dosages (0.05-0.5 mM) and very low UV-C contact time (4-18 s). With 0.5 mM of oxidant and 7 s of UV-C contact time, a significant amount of ABs are removed more efficiently using PMS than H_2O_2. In terms of ARGs removal efficiency, H_2O_2/UV-C seems to be the most efficient treatment, even though PMS/UV-C and PMS/Fe(II)/UV-C were supposed to generate higher concentrations of free radicals. These results suggest that conditions leading to a higher removal of antibiotic compounds could correspond to a lower removal of ARGs. The main hypothesis to explain this behaviour is the competition for the absorption of UV photons between the oxidant species and the DNA molecules, leading to a reduction in the direct photolysis of the DNA without being compensated by the less effective damages produced by the radicals produced from the oxidant species.

Peshmelba: a spatialized model of water circulation and pesticide fate at the catchment scale coupling the landscape elements

POSTER #12

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Pesticide transfers are influenced by discontinuities that can accelerate or slow down and dissipate water and contaminant flows, such as grass strips, ditches, hedgerows or roads. Those landscape features must thus be integrated into watershed management plans which implies to take them into account when modeling water and contaminant at the small catchment scale. PESHMELBA aims at developing a modeling tool of water and contaminants circulation and fate at the scale of small catchments. The model explicitly takes into account spatial organization of landscapes by representing the existing features. Dominating processes ruling water and contaminants circulation for each element type are mainly represented by existing models. Those are used as modeling units ensuring a modular structure. The different units are connected in the OpenPALM coupler to implement the spatial and temporal couplings. This approach allows to obtain a spatialized model of the whole catchment. A special attention is paid to design a mesh representative of the landscape configuration. In addition to shaping the area of application of each modeling unit, this step aims to define connectivity between landscape elements. Preliminary results showed this method is promising to represent pesticides fate in complex landscapes and to test development scenarios in order to assess the influence of agricultural/landscape management practices on water quality. It could be extended to other reactive pollutants.

Emerging viruses in irrigation waters

ORAL SESSION I

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Recycled water is becoming an important source of irrigation. The use of molecular techniques and metagenomics to study the viruses circulating in a population gives a promising information for identification of reference and emerging pathogens and for public health surveillance. The Metawater project evaluated the presence of viruses in different sources of irrigation water and sewage. Over 1-year, 72 samples were collected and concentrated using a concentration method based on organic flocculation (SMF). Samples were analyzed using qPCR for different human and animal viral pathogens and indicators (HAdV, JCPyV, MCPyV, NoV GGI and GGII, HEV, PAdV). A metagenomics protocol to study virome of irrigation water was developed. In general, NoVGGII values were higher in all sewage (1,62E+05 GC/100ml) and tertiary effluents (2,35E+02 GC/100ml) but prevalences were lower than HAdV. Both HAdV and JCPyV, used as human fecal markers, were detected in all raw sewage (4,23E+04 and 2,49E+04 GC/100ml). Occasionally, HEV was found in groundwater extracted from a pig farming area, where porcine markers were also detected (PAdV 2,97E+02 GC/100ml). Most of the viral reads derived from bacteriophages and plant viruses, only 1% were related to human pathogenic viruses. The NGS allowed the identification of important pathogens such as NoV GGII and HEV. These results provide important public health information enabling stakeholders to adapt their managing strategies to pathogen dissemination.

Master's thesis: Risk mitigation options of plant protection products

POSTER #7

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The regulation of plant protection products (PPP) has been under major modifications during past years. In Finland, this is done towards more liberal recommendations, rather than strict regulations. However, farmers are obligated to follow restrictions given in the labels of products. The aim of the study is to assess the effectiveness of risk mitigation options in reducing the amounts of pesticides in rivers of Finland. To clear out this problem there were taken water samples from three rivers near fields and done interviews regarding the use of herbicides in agriculture for farmers and authorities of PPPs. The materials were collected during summer 2017. The water sample data was compared to the previous results from the past years done by SYKE. 10 farmers took part in to the interview. The questions were about their usage of PPPs, opinions considering the management and risk mitigation measures regarding PPPs. Afterwards, three of the farmers also took part in a longer interview. Possible misuses of pesticides were also determined from law cases and authorities. From the water samples there were found 23 different active substances. Compared to the previous years, the number of PPPs is not decreasing. According to the interviews farmers find the restrictions

perplexing. More detailed and unambiguous guidelines and monitoring are needed to reduce the amounts of PPP residues in water systems.

Machine learning combined with non-target analysis for an early warning system of chemical hazards in drinking water

POSTER #30

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Little is known about the vast majority of the manmade substances released into the environment. There are about 8,400,000 compounds commercially available globally. Of these, the EC Inventory has identified around 100,000 chemicals with an annual volume of production greater than one ton. These chemicals may go through chemical transformation processes during their release into the environment, which drastically increases their number. As a consequence, comprehensive monitoring the drinking water and drinking water sources becomes a challenging task. Non-target screening combined with LC-HRMS has been proposed as a more comprehensive approach for monitoring environmental samples, particularly water related ones (e.g. drinking water, surface waters). However, the conventional non-target screening is time consuming and requires multiple levels of post processing in order to produce confident identification of the detected chemical species. In this study, we report an innovative non-targeted approach for fast and reliable screening of drinking water. This method takes advantage of advanced statistical tools such as machine learning to capture any type of abnormalities in the analyzed samples. Our approach was applied to 48 drinking water samples collected from South-East Queensland, Australia in a real case study. In order to validate our approach, 23 of these samples were used as the training set for statistical modeling while the remaining samples were spiked randomly with five different analytes at three concentration levels (i.e. test set). Our method was able to capture “ng” levels of spiked analytes in those samples. Additionally, our approach demonstrated a higher degree of sensitivity when compared to conventional non-targeted approaches. Finally, the limitations of all the tested methods including our approach are discussed.

Development of an efficient and sustainable methodology for emerging pollutants removal in WWTPs (EMPORE-LIFE15 ENV/ES/000598)

ORAL SESSION V

Santos J M, Martínez F, González R, Lasheras C, Garcia H, Prats D, Bernal M A, Oyonarte S, Bosch F, Company M, Andreu J*
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The project aims to demonstrate an innovative, cost-efficient and highly replicable technology for the removal of Emerging Pollutants (EPs) from European Waste Water Treatment Plants (WWTPs). A pilot plant will be designed and integrated into the WWTP of Benidorm (Spain). The prototype will have a treatment capacity up to 5 m^3/h. It will consist of four principal processing units: filtration/adsorption by columns, filtration by membrane technology, Electrochemical Advanced Oxidation Processes (EAOPs) and Advanced Oxidation Processes (AOPs). The methodology will be demonstrated for three pre-selected groups of EPs: Group 1- Priority Substances regulated by the Directive 2013/39/UE (Chlorpyrifos, Trifluralin, DEHP, 4-t-OctylPhenol): Group 2- EPs listed in the "watch list" of article 8 b of Directive 2013/39/UE (Diclofenac, 7-alfa-Estradiol and 17-Beta-Estradiol): Group 3-EPs not regulated yet (Chloramphenicol, Carbamazepine, 2-(p-isobutylphenyl) propionic acid, Fluoxetine and Estrone). The project is due to last three years (Sep 16-Aug 19). For now, an extensive literature evaluation was conducted analysing the occurrence of these compounds in European WWTP and in natural water bodies. A one-year analytical campaign was carried out and the list of targeted pollutants is to be increased. A set of indicators was used to monitor the environmental and socio-economic impact. The pilot plant is designed and built up and the demonstration action is due to start in March 2018.

Assessing the role of the draw solution on the transport of trace organic contaminants through novel forward osmosis membranes

POSTER #47

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Forward osmosis (FO) has gained popularity as an alternative technology to pressure-driven processes for wastewater treatment and reuse. This study provides for the first time an extensive comparison of transport of trace organic compounds (TrOCs) through FO membranes that show exceptionally high water permeability and selectivity. A series of TrOCs diffusion experiments were performed in order to understand the influence of the draw solute on the permeability of TrOCs in FO. In the absence of any draw solute, steric hindrance was the main rejection mechanism unless the membrane had a strong negative surface charge, in which case electrostatic interactions between cationic compounds and the membrane dominated. At increasing membrane ionic strength, lower permeability of TrOCs was attributed to a de-swelling effect as the salt solution saturated the membrane. Otherwise, shielding of the negative surface charge was also observed as electrostatic interactions between solutes and the membrane reduced. Lastly, during FO operation, increased permeation of TrOCs could be partly explained by the convective transport of the water flux. On the

other hand, it seemed that RSF did not impact the transport of organic solutes. In conclusion, the role of the draw solution in forward osmosis was found to extend to the membrane's rejection capability by altering the membrane's physico-chemical character such as the surface charge and the hydrated pore sizes.

Contaminant traffic in Ergene Watershed: Paddy soil serves as source and sink for emerging contaminants in Ergene River

POSTER #29

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Ergene River is the most polluted surface water in Turkey. Pollution is mainly industrial at the source of the river located in the northeastern Thrace, whereas agricultural runoff transports pesticides to the river at the southwestern region, where rice cultivation is the major activity accounting for 55% of total rice production of Turkey. In this study, 170 organic emerging contaminants were searched with LC-MS/MS analysis in composite soil samples collected from 11 different paddy fields, where the surface water is consumed for the irrigated agriculture. The results were compared and associated with the analysis of water samples taken from the main river and its tributaries surrounding the agricultural area targeting the same analytes. From the analyzed micropollutants, 50 pesticides and 32 emerging contaminants were detected in soil samples. Among these hexa(methoxymethyl) melamine, benzododecinium and tris(2-butoxyethyl) phosphate were found frequently both in river and soil samples, whereas several industrial contaminants e.g. galaxolide and ethylhexylmethoxycinnamate were only detected in soil. Within the targeted pesticides, acetamiprid, azoxystrobin, carbendazim, prochloraz, molinate, oxadiazon were identified prevalently in a large concentration range of 0.01-1400 µg/kg. Since soil acts both as a continuous source of agrochemicals and sink for other persistent contaminants, understanding the contaminant footprint is crucial for the risk assessment of crop health.

Reducing the amount of asthma drug Salbutamol in water with wood cellulose nanofibrils

POSTER #40

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Amongst emerging pollutants, ionizable molecules such as salbutamol are often considered the hardest to remove. The reason for this is their pH dependent nature, which hinders their removal in conventional wastewater treatment processes and facilitates their transport to the environment. The usage of cellulose-based adsorbents in the removal of pollutants from water has gained increasing

attention during recent years due to their wide availability, affordability, high adsorption capacity, regenerability, and lower sludge generation compared with many other processes. By disintegrating cellulose fibers into cellulose nanomaterials like cellulose nanofibrils (CNFs), new areas are opened for the utilization of wood biomass in high-added-value applications such as bionanochemicals for the removal of emerging pollutants. The chemical modification of cellulose fiber surfaces, such as benign succinylation in deep eutectic solvent, improved the adsorption capacity of resulting CNFs. Our results showed that CNFs were rapidly adsorbing salbutamol already at low doses. The removal through adsorption can be explained by the opposite charges of CNFs and salbutamol. Furthermore, the removal efficiency is mostly dependent on the charge of the adsorbent nanomaterial. These results highlight the prospect of using cellulose nanomaterials for emerging pollutant removal.

A catchment based pesticide risk indicator

POSTER #4

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A small proportion, typically 1%, of used crop protection chemicals (later pesticides) ends to surface water via spray drift, surface runoff and drainage water. Even small amounts may pose risk for aquatic biota depending on the compound ecotoxicity. The daughter directives of Water Framework Directive (WFD) and The Finnish National Action Plans on the Sustainable Use of Plant Protection Products (NAP) require pesticide monitoring in water. Site selection is a crucial part of monitoring design. Site representativeness in relation to loadings is important information for correct interpretation of monitoring results. However, catchment based pesticide usage information is not available. We developed a catchment based pesticide loading risk indicator to facilitate the selection of sampling sites. The indicator is based on geographically distributed data of cultivated crops, catchment borders and area, estimated typical crop and compound specific pesticide usage and the aquatic ecotoxicity of each pesticide compound. The current version of the indicator is used in the WFD work (inventory of certain priority substances) and to demonstrate the areas of expected “high-risk” catchments in maps together with the location of previous pesticide surface water sampling sites (2007–2017). It will be utilized in the more detailed evaluation of the representativeness of the previous pesticide monitoring sites in Finland and in the selection of new sampling sites.

Fate of pharmacologically active compounds in pilot scale high rate algae ponds

POSTER #17

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Pharmacologically active compounds (PACs) are contaminants and can accumulate in aquatic organisms. PACs enter the environment via incomplete removal in wastewater treatment, a possible solution is to use high rate algal ponds (HRAPs).[1] HRAPs used as a final polishing for water

treatment also allow resource recovery of algae. However little is known about their removal in HRAPs and whether algal PAC contamination occurs. In this study, the fate of 80 diverse PACs in pilot scale HRAPs was investigated. The algae species within ponds was known as AV-12 (*Scenedesmus obliquus*). To ensure algae dominance throughout sampling, cell counts were done with a Nikon eclipse microscope. Using solid phase extraction and published methods, analysis was done using ultra-high performance liquid chromatography coupled to a Xevo TQD triple quadruple mass spectrometer. Grab samples were collected morning and afternoon for 5 days. Out of the 80 PACs, 52 were successfully detected. Concentration changes between influent and effluent samples have been calculated, with varying degrees of PAC reduction observed. PACs were categorised into high reduction (75% e.g. ibuprofen and clarithromycin), moderate reduction (40-74% e.g. codeine and venlafaxine) and little/no reduction (0-39% e.g. carbamazepine and sulfasalazine). Solid analysis demonstrated sorption for a number of PACs (e.g. carbamazepine and clarithromycin). [1] J. B. K. Park and R. J. Craggs, Water Sci. Technol., 2011, 63, 1758–1764.

Antibiotic resistance in European wastewaters mirrors the situation in clinical settings

POSTER #15

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Antibiotic resistant bacteria (ARB) and genes (ARGs) gained the statute of environmental contaminants, whose important reservoirs include urban wastewater treatment plants (UWTPs). The hypothesis of this study was that countries with higher rates of clinical use of antibiotics would have higher loads and diversity of ARGs and of genetic recombination elements (GREs) associated with ARGs acquisition, reaching UWTP. The consequent question was if, irrespective of the input, wastewater treatment would attenuate ARGs and GREs impacts to a baseline level. Twelve 12 UWTPs, from countries with high and low rates of antibiotic consumption (Cyprus, Ireland, Portugal and Spain, H_{AC}) and (Finland, Germany and Norway, L_{AC}), respectively were samples in three consecutive days, in early Autumn 2015 and early Spring and early Autumn of 2016. A total of 258 ARGs and GREs was analysed using a qPCR array approach. As hypothesized, countries with higher use of antibiotics in clinical settings had higher prevalence and diversity of ARGs, but not of RGEs. These values of ARGs and RGEs were not led to baseline levels after treatment. The importance of UWTPs as reservoirs of ARGs and RGEs claims for urgent implementation of surveillance and policy measures.

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Occurrence of pharmaceuticals residues and endocrine disruptors in a waste water treatment plant-impacted rivers of Krakow agglomeration in South Poland

ORAL SESSION VII

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The main aim of the paper is to present an occurrence of broad range of chemical classes (UV filters, parabens, plasticizer, steroid estragons, antibacterials/antibiotics, hypertension drugs, non-steroidal anti-inflammatory drugs (NSAIDs), lipid regulator, anti-histamines) in two main Krakow Wastewater Treatment Plants (WWTPs) and in the receiving rivers. Waste and rivers waters up and downstream of two major WWTP were monitored. The study was conducted in a section of the Drwina and Wisla Rivers in Krakow agglomeration (South Poland) affected by the discharge of a WWTP effluent. Solid phase extraction (SPE) was used for separation of analytes from the aqueous phase. Analysis were carried out with the usage of Waters Accquity UPLC system (Waters) coupled to a Xevo TQD Triple Quadrupole Mass Spectrometer (Waters, Manchester, UK), equipped with an electrospray ionisation source. The highest concentrations in rivers were observed for valsartan, irbesartan, diclofenac and 4-benzophenone, up to 6558.82 ng/L. The lowest concentrations were noted for ethyl- and propylparabens. In effluents of both WWTPs, valsartan, diclofenac and 4-benzophenone were detected at the highest concentrations, from 292.92 ng/L to 6464.71 ng/L.

Climate change effect on Algal Organic Matter characteristics and cyanotoxins produce in eutrophic pond: lab culture experiments and on-field monitoring

POSTER #1

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Excessive inputs of nutrients cause eutrophication, whose symptoms are magnifying by climate. In eutrophic pond, the phytoplankton is not limited by N and P and proliferate, which affect the aquatic life and the drinking water treatment process. It increases Organic Matter quantity and modify its characteristics: Algal OM (AOM) has a different hydrophobicity and SUVA than Natural OM. The water treatment process must face toxins, which are produced by cyanobacteria. To adapt the treatment, it is crucial to characterize the AOM and the toxins. In this context, the impact of climate on OM and toxins is studied in lab and on-site. 3 rainfall patterns are simulated under 3 T°C: 23, 15 and 5°C. The culture are *C. vulgaris* (CV) and *M. aeruginosa* (MA), which produces MC-LR. During their growth, the OM and MC-LR are quantified and characterized. Water quality of Kara (TG), Pigeard (FR) and Vombsjön (SE) is monitored: occasionally in TG and SE but monthly in FR. On-site, the physico-chemical and climate parameters are measured and correlated with the characterization of nutrients, phytoplankton and OM. Unlike rainfall, temperature rise affects significantly the growth of MA, the OM content and its characteristics. There is no effect of temperature (15-23°C) and rainfall on CV culture. In Pigeard, in summer, cyanobacteria are developing, increasing the DOC and hydrophilic fraction but decreasing the SUVA. No toxins are measured. Samples from Togo and Sweden will be analyzed for comparison.

Tackling emissions of micropollutants via municipal WWTPs – is it worthwhile to invest in advanced treatment technologies?

POSTER #8

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Many synthetic chemicals used in everyday life are found in effluents of municipal wastewater treatment plants (MWWTPs). Slow processes, questionable risk criteria/prioritization schemes and implementation challenges impede efficient regulation of hazardous chemicals. This has raised the question if implementation of more advanced wastewater treatment technologies should be used as a precautionary measure to reduce emissions of chemical contaminants to the aquatic system. The ambition to view wastewater as a resource (e.g. for irrigation and aquifer recharge) rather than waste makes questions about the quality of wastewater even more vital. What is currently missing is a comprehensive picture of which micropollutants are present in wastewater, the associated environmental effects and potential to reduce emissions using advanced treatments. In this case study, we review the current knowledge about micropollutants in wastewater discharged in the Baltic Sea catchment and environmental effects. Based on data compiled from the literature, we estimate and discuss total loads and what a realistic implementation scheme for advanced treatment could mean for this region in terms of reduced environmental risks.

Microplastic concentrations in surface water at Lake Kallavesi

ORAL SESSION I

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Microplastic concentrations in the freshwater environments are not yet widely studied. However, the freshwater ecosystems of shallow lakes may be vulnerable to harmful effects of the microplastic burden. In this study, we analyzed the microplastic concentration of the surface water at Lake Kallavesi located in Eastern Finland. Two sampling methods, a pump collecting different size fractions of 20 µm, 100 µm and 300 µm and the common manta trawl (333 µm), were used to collect surface water microparticles from 8 sampling sites in autumn 2016 and in spring 2017 at Lake Kallavesi surrounding the city of Kuopio. The number of synthetic polymer particles and fibres were analyzed and their materials characterized. The sampling sites represented various potential sources of microplastics, such as the city harbor, highway, discharge pipe of a waste water treatment plant and heavily trafficked urban environment. The total average concentration of microplastic particles at the sampling sites was 0.27 particles/m^3. This is in agreement with previous findings of the microplastic concentrations in the Baltic Sea. However, majority (62%) of the identified microplastics were fibres. All identified microplastics were common polymers, such as PP, PE and PET, but there was no clear correlation between the material type and the sampling site. The variation of particle concentrations between the sampling sites was high, and the city harbor site had the highest concentration.

Removal of arsenic from natural waters by low-pressure reverse osmosis

POSTER #39

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Arsenic (As) causes a considerable threat to human health through exposures by contaminated drinking water and agricultural products. As contaminated areas (ground and surface water, soil) affect a major part of the world's population and thus As is a serious global problem that needs to be solved. This work concentrates on As removal from contaminated surface waters. Among technologies for As removal from contaminated waters, reverse osmosis is one of the promising methods due to its selectivity and the high quality of the product water. The aim of this research was to efficiently remove As and other contaminants from water by low pressure reverse osmosis. The ultimate aim is to create a sustainable As removal process taking into account environmental, economic and social aspects. As removal was first studied using model water mimicking contaminated natural waters in France and Germany. The model water contained both As(III) and As(V). In addition, the combined effect of other compounds, such as sulphate, phosphate, iron, calcium and bicarbonate, were studied. As rejections of two flat sheet membranes were tested in a cross-flow membrane unit with the effective membrane area of 0.014 m^2. The effect of pressure and flow velocity were studied to determine optimal conditions for As removal. In the next steps, real water samples will be tested and the purification process will be optimized. Further, RO will be combined with adsorption and photocatalysis as a hybrid process.

Target Analysis of a large number of mineralocorticoids, glucocorticoids and progestogens in wastewater and receiving surface waters

ORAL SESSION VII

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Recent studies demonstrated the occurrence of steroid hormones such as mineralocorticoids (MC), glucocorticoids (GR) and progestogens (PG) in various water bodies. However, for their determination in environmental waters ultra-sensitive analytical methods are required, since steroidal pollutants impact the endocrine system of aquatic organisms and are known to trigger adverse effects at very low concentrations down to the ng/L range. Steroid hormones are widely used in medicinal therapy. As a consequence, the number of approved synthetic hormones is still increasing and thus, the loads entering the wastewater treatment plants are appreciable. Therefore, comprehensive and sensitive analytical methods are crucial for the determination of these classes of micropollutants. In a current study, a sensitive and robust LC-MS/MS method for the trace determination of 60 commonly used MC, GR, PG and their metabolites was developed and optimized. Using this method, numerous steroids have been detected in wastewater and receiving surface waters during a monitoring campaign. Their prevalent representatives and concentration patterns were determined in different water systems. In this study, the occurrence of dienogest,

mometasone furoate, betamethasone valerate and several active metabolites such as betamethasone propionate, 6a-methylprednisolone propionate, 6ß-hydroxy triamcinolone acetonide and canrenone is reported for the first time.

PAHs in freshwater mussels in Finland

POSTER #3

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The water framework directive sets environmental quality standards (EQS) for hazardous priority substances. The EQS for PAH compounds is set for benzo[a]pyrene (BaP) and fluoranthene in crustaceans and molluscs (Dir 2013/39/EU). We chose duck mussel (*Anodonta anatina*) as an example species in Finnish freshwaters. Mussels were collected from 12 sites with anthropogenic impact and one reference site. Altogether 15 different PAH compounds were found out of the 21 analyzed. BaP was found in only one sample, while plenty of those other high molecular weight (HMW) PAHs it should indicate were. This suggests that BaP might not be the best indicator to evaluate HMW PAH concentration in mussels. Fluoranthene was detected in every site, but the concentrations were clearly below the EQS. Most PAHs and highest concentrations were found in Vanhankaupunginlahti in Helsinki urban area, near the outlet of river Vantaanjoki. Almost as high PAH concentrations were found from urbanized southern bay in lake Vesijärvi in Lahti. Three PAH compounds were found from the mussels in the reference site. To our knowledge there are hardly any published studies available of PAH concentrations in freshwater mussels in Europe. This study shows that duck mussel might be considered as a suitable indicator species of PAH pollution in freshwaters due to its large area of distribution and ability to accumulate PAHs.

Grey Water Footprint for human and veterinary pharmaceuticals – case study of the Vecht river catchment

POSTER #21

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Water pollution by pharmaceuticals has emerged as an urgent topic globally and regionally as it relates to a variety of concerns such as ecological effects, antimicrobial resistances or drinking water supply. Several emission pathways for human as well as veterinary pharmaceuticals have been identified. Yet what are the dominant emission pathways on a catchment scale? And what could be promising reduction measures having identified these pathways? The paper aims to gain a better insight about the pollution with pharmaceuticals in the transboundary Vecht catchment (Germany and Netherlands) by estimating and mapping the grey water footprint (GWF) as an indicator of polluted water volumes. For this research, a variety of reference compounds was selected. The GWF

will be estimated for each of these substances and spatially mapped, distinguishing between GWFs related to wastewater from households, hospitals and to various types of livestock farming. GWFs will thereby also be expressed as polluted water volumes per community, per patient, and per unit of animal product, like meat, milk or eggs. The results of this work will provide an understanding about water pollution through pharmaceuticals from different sources on catchment scale. These deliver a basis to explore possible future pathways considering alternative developments for reducing pharmaceutical emissions which is of relevance for future research as well as for decision making among policy makers and other stakeholders.

Monitoring strategy, annual fluxes and risk assessment of emerging contaminants in a catchment scale

ORAL SESSION I

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Emerging contaminants (ECs) such as endocrine disrupting chemicals (EDCs) and pharmaceuticals and personal care products (PPCPs) attracted growing global concern due to their potential adverse effects on ecosystem and human health. In this work spot and passive sampling were undertaken to understand spatiotemporal occurrence, mass loads and ecological risks of ECs in a priority catchment (River Ugie, Scotland). Totally 11 ECs including 5 EDCs and 6 PPCPs were monitored over 1 year (monthly) and all ECs were detected in water by both sampling strategies. The total concentration ranged from 0.40 to 60.96 ng/L (mean: 9.90 ng/L) and 0.24 to 361.2 ng/L (mean: 51.16 ng/L) for EDCs and PPCPs, respectively. Ibuprofen and Carbamazepine were observed to be the dominant contaminants. The total annual fluxes to the Ugie estuary and North Sea were estimated to be 873 g and 646 g of 5 EDCs while 4636 g and 4517 g of 6 PPCPs, by spot and passive sampling, respectively. Overall the results of two samplings are in agreement and passive sampling tends to integrate the contaminants over a period of exposure and allows quantification of contamination at low concentration. The spatiotemporal trend suggested that living beings activities and medication usages were the primary source of the contaminants. The risk assessment results (e.g. of E1, E2, BPA and Triclosan) suggest that mitigation measures might need to be taken to reduce the input of ECs into the river and its adjacent estuary and sea.

Pharmaceutical load to municipal waste water treatment plants and their primary emission sources

POSTER #19

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Pharmaceutically active ingredients (APIs) have been detected in environmental samples on every inhabited continent. APIs are often discharged into the environment through municipal waste water treatment plants (MWWTPs), but those facilities are not the primary emission sources. APIs are emitted to the municipal sewer network from several sources, such as households, production facilities and health institutions (HI), but their respective significance as emission sources has not been previously estimated in Finland. In this case study waste water samples were taken from influent and effluent at the local MWWTPs and raw waste water discharged from local HIs in three Finnish cities. Samples from MWWTPs were taken as 24-h composite samples and from HIs as manual composite samples consisting of four subsamples taken at regular intervals during the workday. The concentrations of 151 contaminants (incl. 57 APIs) were determined and contaminant loads to and from WWTPs were calculated based on wastewater discharge. In this poster estimations of total flows of selected contaminant to WWTPs as well as the importance of selected primary emission sources will be presented and discussed.

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