



2015

FINNISH CONFERENCE OF
ENVIRONMENTAL SCIENCES
12TH MAY 2015, JYVÄSKYLÄ

PROCEEDINGS

<http://fses.fi/congress/>



JYVÄSKYLÄN YLIOPISTO
UNIVERSITY OF JYVÄSKYLÄ

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- Tuula Tuhkanen, professor, University of Jyväskylä, Jyväskylä (Chair),
- Elijah Ngumba, M.Sc., University of Jyväskylä, Jyväskylä (Secretary)
- Leppänen, Matti, PhD., Finnish Environment Institute (SYKE) (Treasurer)
- Sanna Pynnönen, M.Sc., Tampere University of Technology, Tampere,
- Jaakko Mannio, PhD, Finnish Environment Institute (SYKE), Contaminants Unit

This Conference has been financially supported by the following organizations

- (i) Federation of Finnish Learned Societies
- (ii) Maj and Tor Nessling Foundation

Finnish Society for Environmental Science greatly appreciate the support

PREFACE

The Finnish Society for Environmental Science and the University of Jyväskylä, Department of Biological and Environmental Sciences welcomes you to the 12th Finnish Conference of Environmental Sciences in Jyväskylä.

The Finnish Society for Environmental Science promotes the scientific research of the environment, and acts as a link between members as well as disseminates research based knowledge for the management and protection of the environment. Since 1993, the Society has every second year arranged this Conference, which has come to be the main activity of the Society. The Conference offers the opportunity for students, doctoral students and for more advanced researchers and other actors in the area of environmental sector, to present new research findings and to discuss current environmental issues. The Conference also invites plenary speakers from abroad and from our country to give presentations addressing with top level environmental research.

The main theme of the 12th Conference will relate to topics “Who needs Environmental Sciences?” and “What is the role of environmental science in the changing world?” One of the objectives is to update the situation of emerging pollutants and their prioritization. A new concept will be introduced – chemical planetary boundaries, where chemical pollution could potentially disrupt a vital earth system process. The interpretation of scientific discoveries is challenging as well as the decision-making after proper but fast risk characterization. The decisions should be implemented by communication both within experts and through the media. The organizers have considered these topics current issues of great importance that it earns to be discussed in keynote lectures.

However, the organizers have not forgotten the multidisciplinary nature of environmental science and we are looking forward to the keynote lectures covering environmental technology and the emerging pollutants, in this case, metals in the environment, as well as the platform and poster sessions within these fields.

The following pages provide an overview of the conference program, abstracts and the list of authors. The program contains 5 invited keynote lectures, 8 platform presentations and 22 poster presentations.

I hope that the Conference venue and the facilities the building at the Ylistönrinne Campus will turn out to be an inspiring and pleasant atmosphere for discussions and for learning of recent progress in environment sciences. The discussion can continue during the conference dinner at Hotel Alba, which is located in the vicinity of our campus, on the other side of Lake Jyväsjärvi.

As the chair of the organizing committee, I would like to thank the organizers for their efforts and special thanks belong to the Conference Secretary Elijah Ngumba. The financial support from Maj and Tor Nessling Foundation and Federation of the Finnish Learned Societies is gratefully acknowledged.

I wish you all welcome to Jyväskylä and pleasant and memorable scientific stay.

Tuula Tuhkanen

Chair

Finnish Society for Environmental Science

VENUE

Auditorium FYS1, Physics Department Building, Ylistönrinne campus, University of Jyväskylä

Street Address: Survontie 9, 40500 Jyväskylä, Finland

Registration Desk located at FYS1 lobby shall be open Tuesday 12th May 2015 from 8.30-10.00



Keynote lectures, platform sessions and posters

The lunch shall be served in Ylistö restaurant adjacent to FYS1

Conference Dinner

The conference dinner shall be held in Hotel Alba Located near the conference venue
(Ahlmaninkatu 4 40100 Jyväskylä) www.hotellialba.fi

Conference Program

TUESDAY 12th MAY 2015

FYS1 Lobby

09:30 Registration and welcoming coffee

FYS1 Auditorium

10.00 Opening: Tuula Tuhkanen, Chair of the Finnish Society For Environmental Science

10.15 **Key-note**
Kimmo Peltonen (Finnish Chemicals and Safety Agency): 1
Acetaldehyde, a challenging paradigm for regulatory toxicology

Session I: Fate and behavior of organic chemicals in environment
Chair: Tuula Tuhkanen

10:45-11:15 **Key-note**
Michael McLachlan (Stockholm University) 3
Which chemicals are global threats? Exploring the planetary boundaries concept

Platform presentations (3×20 min)

11:15-12:15 1. Hartikainen, S., Rönkkö, M. Hyttinen, M. and Pasanen, P. 8
Systematic risk modeling in plastic recycling processes: a future tool for process control, occupational safety, environmental risk management and consumer safety

2. Väliälö, P.A. and Perkola, N.P., Potential estrogenicity of Finnish wastewater effluents 20

3. Sainio, P., Meriläinen, P. and Rosendahl, K. Environmental risk assessments of selected active pharmaceutical ingredients in the Kokemäenjoki water system 11

Ylistö Restaurant

12:15-13:15 LUNCH

FYS1 Auditorium: Chair: Paula Jantunen

13:15-13:45 **Key-note**
Stephen McDow (US EPA)
Airborne organic particulate matter near roads

TUESDAY 12th MAY 2015

FYS1 Auditorium: Chair: Paula Jantunen

Platform presentations (2×20 min)

13:45-14:30	1. Räsänen, K., Mattila T., Porvari P., Kurppa S., Tiilikkala K. Ecotoxicity impact assessment as a tool to study impacts of hazardous substances – a case study for ecotoxicity impacts of pesticide usage in Finland	10
	2. Yi-Hua Xiao, Antti Räike A., Hartikainen, H., Vähätalo, A., Iron as a source of color in river water	21

FL 226 Lecture Room 5

14:30-15:30 Posters, exhibition and coffee

SESSION II: Behavior and effects of metals in environment

FYS1 Auditorium: Chair: Leppänen Matti

15:30-16:00	Key-note Mikael Motelica-Heino (University of Orleans) <i>Trace metals in the environment: from microscale biogeochemical processes to global cycling</i>	5
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Platform presentations (3×20 min)

16:00-17:00	1. Karjalainen, A.K., Karjalainen, J., Tuhkanen, T. and Kukkonen J.V.K., Assessing ecotoxicological effects of mine effluents on aquatic systems	9
	2. Salmelin, J., Pölönen, I, Puupponen, H-H., Hämäläinen, H., Karjalainen, A.K., Väisänen, A. and Vuori, K-M, Hyperspectral imaging in detecting metal contamination of aquatic insects: A pilot study	15
	3. Selonen, S., Liiri, M., Strömmer, R. and Setälä, H. The fate and effects of lead (Pb) at active and abandoned shooting ranges in a boreal forest ecosystem	19
17:00-17:30	Key-note Jaakko Mannio (Finnish Environment Institute) <i>Challenge in the rapid risk assessment and risk communication of accidental metal spills in Finland</i>	7

17:30-18:00 Closing and awards

Break

19:30-22:30 Conference Dinner at Hotel Alba

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6	Gu, Y.	Iron and pH regulating photochemical reactivity of dissolved organic matter in lake water	26
7	Haaranen, I.	Characterisation of leachates from torrefied wood	27
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POSTER PRESENTATIONS

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17	Rantanen, P.	Nitrification in drinking water distribution network in Helsinki and Vantaa	43
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20	Vähätalo, A.V	Photochemical decomposition of iron-binding ligands in large rivers	48
21	Väänänen, K.	Sediment Cu bioavailability – the use of diffusive gradient thin films (DGT) and the effects of chitosan amendment	49
22	Waissi-Leinonen, G.C	FullereneC ₆₀ loading interferes of the growth and emergence rate of the Midge <i>Chironomus riparius</i>	50

Invited Speakers

Kimmo Peltonen, Director General of TUKES, Finnish Safety and Chemicals Agency
“Who needs environmental sciences - case acetaldehyde?”

Stephen McDow, PhD. US-EPA
“Airborne organic particulate Matter near roads”

Mikael Motelica-Heino, Professor at the University of Orléans (France)
“Trace metals in the environment: from microscale biogeochemical processes to global cycling”

Michael McLachlan, Professor, Stockholm University
“Which chemicals are global threats? Exploring the planetary boundaries concept”

Jaakko Mannio, PhD, Finnish Environmental Institute (SYKE)
“Challenge in the rapid risk assessment and risk communication of accidental metal spills in Finland”

Who needs environmental sciences - case acetaldehyde?

Peltonen, K.

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How do we understand environmental sciences? How do we set a price for a wide and cross sectional knowledge on environmental issues? How do we ascertain competent authorities in administration and risk management operations and to take care of questions getting more and more complex on every day? Are societies feeling that environmental sciences/issues are old fashion or outdate? How environmental scientists can give understandable answers to public - what is our capability to share concerns with parents who for example feel unsecure about safety of food of their children?

Those of us who have environmental science background certainly have at least an opinion. Naturally the answers are high quality science and innovative and interesting way of teaching. Unfortunately the research funding is getting worse in every day and it seems that the universities do not consider environmental sciences sexy enough to get fully supported. A tendency seems to be that universities favor molecules, bioresources and clean tech over environmental sciences.

Today I am giving an example on a multidisciplinary case I have worked for some time - it challenges both research and risk analysis and the case is called acetaldehyde.

Acetaldehyde is a ubiquitous environmental contaminant, present in tobacco smoke and is a natural flavoring compound in almost all fruits and vegetables. It is a low boiling liquid and a major metabolite of ethanol. International Research on Cancer (IARC) recently (2009) upgraded acetaldehyde to group 1 in other words a human carcinogen (Group 1 Carcinogenic to humans).

Early on (2006) IARC concluded that alcoholic beverages are also Group 1 substances, exposure resulted typically to increased incidence of malignant tumors on upper digestive track, colon, and liver and female breast cancer.

Acetaldehyde was mainly upgraded to Group1 carcinogen because of increased risk to esophagus, head and neck cancers among heavy drinkers in East-Asian populations. The molecular reasoning to this finding lies in our genes. Two enzymes have a key role in ethanol metabolism namely alcohol dehydrogenase and aldehyde dehydrogenase, which both are detoxenzymes. Aldehyde dehydrogenase is polymorphic in Asian populations with a prevalence of 30%. A mutation to the gene encoding this enzyme leads to acetaldehyde accumulation in body. In Caucasian populations this mutation is rare and it is not considered as a polymorphic gene.

For the risk managers point of view acetaldehyde is challenging. Acetaldehyde is present in almost all fruits and vegetables because it is a natural flavoring compound formed during a ripening process. It is also formed during some fermentation processes and therefore present in some milk products like yoghurt. It is also a common constituent in urban air - all humans exposed to acetaldehyde daily also because it is formed endogenously in our metabolic processes.

Personally I believe that from the mechanistic point of view acetaldehyde is a genotoxic carcinogen with a relative high threshold value. This threshold is quite high even in subpopulations with mutated enzymes and lower the activity in detoxprocesses, however the threshold is lower than among in Caucasian populations.

Risk communication is one of the difficulties in acetaldehyde case. It is difficult to deliver a message about uncertainties in scientific observations and relate findings to a personal risk taken by eating healthy fruits and vegetables. It is even more difficult if commercial activity is involved. A key factor to success is open and understandable risk communication to public.

**Which chemicals are global threats?
Exploring the planetary boundaries concept**

**McLachlan, M.S.^{1*}, MacLeod, M.¹, Breitholtz, M.¹, Cousins, I.T.¹, de Wit, C.A.¹,
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Humankind must manage the planet such that vital earth system processes are not seriously disrupted, as otherwise the basis for our continued existence is threatened. Rockström et al. have coined the term planetary boundary to describe the safe operating space that humans have within which they must stay. Vital earth system processes can be disrupted by chemicals. Stratospheric ozone depletion by chlorofluorohydrocarbons is an example of how chemicals can disrupt a vital earth system processes to such an extent that the state of the planet is dramatically altered. Society has taken rigorous action to ensure that we do not exceed this planetary boundary by vastly reducing emissions of chlorofluorohydrocarbons. Past experience tells us that there are likely other – unknown – chemical planetary boundaries, where chemical pollution could potentially disrupt a vital earth system process. If such a chemical would do this on a global scale, and if the impact of this chemical on the vital earth system process would not be readily reversible, the consequences for the planet could be disastrous. We have a responsibility to make sure that such chemicals are not released to the environment. The challenge to environmental scientists is to identify these chemicals so that action can be taken to prevent their release to the environment. This presentation will specify three conditions for a chemical to be such a threat, explore different scenarios in which these conditions could be fulfilled, and develop chemical property profiles that could lead to those scenarios.

Airborne organic particulate matter near roads

McDow, S.

United States Environmental Protection Agency (US EPA)

There are now numerous observations that asthma, lung function, chronic respiratory symptoms, and other health problems are worse near highways and roads with heavy traffic. There is also a growing number of reports of steep concentration gradients for nitrogen oxides, carbon monoxide, volatile organic compounds, black carbon, and ultrafine particle number with increasing distance from roads. More recently, concentrations polycyclic aromatic hydrocarbons and other organic compounds associated with motor vehicle exhaust have also been observed to decrease with distance from roads. This presentation explores the relationship between ultrafine particles, black carbon, metals, and particulate organic species in particulate matter near major roads.

Trace metals in the environment: from microscale biogeochemical processes to global cycling

Motelica-Heino, M.

University of Orleans, France

Trace metals are important elements in the biogeochemistry of continental ecosystems. Several trace metals are micronutrients for plants and animals (Bohn et al., 1979). Anthropogenic activities have significantly altered metals natural cycles and modified their bioavailability (Garrels et al., 1975). Measurements of trace metals in sediments, soils and water columns of lakes and rivers soils have shown that they are involved in dynamic geochemical transformations that are often driven by biologically controlled processes. While changes in redox state offer general mechanisms for supply and removal of metals from solution, there may be specific linkages of particular elements. Almost all of the redox transformations are microbially mediated. The concentration of metals in particular organisms to different extents is consistent with them performing a wide variety of physiological roles. Identification of precise mechanistic linkages between the geochemistry and biota will be best achieved if measurements are made at a scale that relates directly to the individual organism or its species-specific grouping. The key is to identify the reactional mechanisms related to biogeochemical processes that control their bioavailability and global cycling at the relevant spatial scale.

Surface environments are made of a tridimensional mosaic of micro-habitats with various oxygenation gradients and redox conditions that alter the diagenetic processes (Kristensen 2000). The role of biota in controlling the removal and release of trace metals in natural waters through the processes of biological uptake and decomposition is well established. Changes in concentrations with depth and time in seasonally and more permanently anoxic basins have demonstrated the importance of direct redox controls for Fe Mn, As, Cr and Co and more indirect redox controls of other metals usually by (de)sorption to/from oxyhydroxides. Sediments are heterogeneous mixtures of mineral phases and organic matter. Systematic recruitment and accumulation gives rise to a layered structure of decomposition and redox gradients, as shown by measurements of solutes in pore water (Boudreau 1996). The zonations can occur on a very small scale, as shown by measurements of O₂, pH, nutrients and major components with microelectrodes (Jorgensen 1994, Glud et al., 2000; Werhli et al., 1994). When the technique of diffusive equilibration in thin films (DET) was

used to measure Fe and Mn in the pore waters of sediments in two dimensions, locally elevated zones of Fe and Mn were found, which were attributed to production within microniches (Shuttleworth et al., 1999). Similarly Taillefert et al., (2000) reported sharp features in Fe and Mn gradients measured by a voltammetric electrode. These observations are consistent with a general theory of microniches as outlined by Jorgensen (1977) and Brandes and Devol (1995) and modelled by Jahnke (1985) and Harper et al (1998). The idea is that the transformation of elements within sediments from one chemical form to another (solid phase/solution, redox state) occurs locally at the cluster of mineral or organic particles involved. Evidence that microniche mobilisation of trace metals might be occurring in sediments has been provided in a lake (Motelica-Heino et al., 2000a), a stream (Davison et al., 1997) and the Black Sea (Fones et al., 2001).

We present in-situ investigations of the microdynamics of trace metals in natural environmental systems with in-situ sensors such as DGT (diffusive gradients in thin-films). While deployed in situ, DGT probes bind metals to a chelating resin embedded in a gel (resin-gel) after their diffusive transport through a well-defined layer of hydrogel (Zhang and Davison, 1995). Measurement of the accumulated mass of metal in the resin-gel enables calculation of the concentration in the pore waters at the probe's surface. This reflects the bulk pore water concentration and the supply from solid phase to solution, as shown by numerical modelling of the DGT-sediment/soil system (Harper et al., 1998). Sharp features that have been observed in DGT profiles therefore reflect local mobilisation of metals.

Our work is contributing to the emergence of a new paradigm for the behaviour of trace metals. In sediments small-scale remobilisation within a 3-dimensional framework ("microniches" as localized hot-spots of reduced organic matter) appears to be superimposed on the relatively macro features of systematic vertical changes associated with redox zones. Correspondence between fine structure observed for the different trace metals and fine structure in sulfide, iron, manganese and nutrients, has provided insight into the linkages of the supply/removal processes of metals at a small scale, particularly the role of Fe, Mn and S(-II) phases and microorganisms.

Challenge in the rapid risk assessment and risk communication of accidental metal spills in Finland

Mannio, J.

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Scientist working in governmental institutes or as regional/local authority may face an environmental accident involving both rapid risk characterization, and rapid communication both within experts and to the media. These situations can turn even more challenging, if both organizations and individuals are not well prepared, or at least organized in a way to allow fast reactions. To determine and understand the role of each “team and player” is fundamental from the very beginning. Experts mainly give advice and options to authorities, but experts should avoid wild guesses even in media pressure.

This presentation illustrates some of the organizational key principles, main scientific/expert actions and calculations that SYKE focussed on Talvivaara gypsum pond leakage in November 2012 and some similarities and differences with the nickel discharge from Harjavalta in July 2014. In both cases, the main expertise SYKE could provide, was the modelling of the substance concentration and timing in the watercourses. Another issue was the effect assessment, which is in many ways more complicated with, e.g. mixture effects and time-lags involved.

Systematic risk modeling in plastic recycling processes: a future tool for process control, occupational safety, environmental risk management and consumer safety

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The social demands of the environmental safety and the needs of recycling business operations are increasing as a result of diminishing natural resources. Recycled waste materials can contain hazardous additives and biological or chemical contaminants which may affect the safe use of these materials. This can cause a variety of negative human health effects if hazardous substances enter into the recycling processes and accumulate in the products. Waste and recycling workers may also be exposed to hazardous substances when sorting and processing unsafe plastic waste materials. Unsafe recycled products containing harmful additives and contaminants may cause consumer exposure.

Chemical complexity of emissions during the recycling processes was confirmed in collaboration with industrial partners by on-site measurements. Occupational hygiene measurements and exposure assessments of the volatile organic compounds (VOC), semi-volatile organic compounds (SVOC), dusts, microbes, metals and bioaerosols were performed during sorting, washing, extrusion, injection molding and product manufacturing in plastic recycling processes.

There is an international need for systematic health, safety and environmental risk modeling and assessment in plastic recycling processes. Based on scientific literature review there is a lack of basic research. Collaboration with industrial partners also revealed that applicable risk assessment tools are inadequate for plastic recycling processes. In our ongoing research we have discovered that this systematic risk modeling has to cover all phases in plastic recycling processes from waste sorting to product manufacturing.

Assessing ecotoxicological effects of mine effluents on aquatic systems

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Metal mining industry in Finland has expanded in recent decades. Metal-containing mining effluents can have adverse effects on aquatic systems that can impair the usability of ecosystem services for the next generations. Direct threats include toxicity of metals and salting, as well as changes in species composition. Indirect effects include inter alia changes in lake hydrological dynamics, in sorption dynamics of metal-organic complexes, and in natural organic material itself.

MineView - project was initiated to assess the ecotoxicological and human health risks and public perception arising from mine effluents causing salting, acidity changes, and multi-metal stress on aquatic systems. We will focus on both laboratory and *in situ* scale research activities in the ecotoxicological subproject of the MineView. The aim is to fulfill some of the current knowledge gaps and to yield detailed information on the short- and long-term multistress effects in the typical Finnish river-lake systems. Piloting and implementing novel cost-effective tools for precise and fast ecotoxicological risk assessments will be touched on.

Ecotoxicity impact assessment as a tool to study impacts of hazardous substances – a case study for ecotoxicity impacts of pesticide usage in Finland

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Pesticide usage induces chemical pollution that is a serious problem, globally. In Finland, the most sold agricultural pesticides, of the total 1707.5 tonnes in 2011, are herbicides. The large variability in the response of the environment to pesticide application is a big challenge for general risk assessment. Traditionally, the risks of pesticides have been estimated in model environments by risk assessment processes. Should there also be more tools for steering environmental management for minimising impacts of pesticides? LCIA (=Life Cycle Impact Assessment) of ecotoxic impact proceeds from chemical use to estimated emissions (modelling of fate), and finally to exposure and effects on organisms. By this approach comparison of impacts and, thus, ranking chemicals are enabled. In addition, the (eco)toxicity impact of different chemicals in the production allows to compare alternative food production chains for chemical risk management. In this study, potential environmental impacts of agricultural pesticides were studied, in Finland, using previously described method. Potential impacts of pesticides (sales data of active ingredients, kg/year, obtained from the Finnish Chemical and Safety Agency) were studied between 2000-2011. Pesticide emissions were modelled on the average Finnish agriculture circumstances with PestLCI. The emissions were converted into impacts using characterisation factors from USEtox™. According to the results, ecotoxic pressure decreased over the period, mainly because of the decreased sales of the main hazardous fungicide fluazinam. Single very hazardous substances had a strong contribution to the total impact. No correlation between the sales amount and ecotoxic pressure was found, thus pesticide impacts cannot be indicated by their sale amounts, only. In conclusion, the first priority in the implementation of this LCA approach is to identify environmental impacts of single hazardous pesticides and according to that to develop environmental management of plant protection and, build up restrictions which are specifically directed to causes of impacts.

Environmental risk assessments of selected active pharmaceutical ingredients in the Kokemäenjoki water system

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1 Introduction

Active pharmaceutical ingredients (APIs) and their metabolites have been found in different environment compartments (e.g. Hernando et al 2006). APIs are shown to have adverse effects in the environment, e.g. various physiological effects on aquatic animals (Fent et al. 2006). APIs' ability to accumulate from soils to plant species has demonstrated (Carter et al. 2014). The effects of APIs in different environmental compartments and their influence in water use can become more serious since the consumption of pharmaceuticals is still growing.

In Finland, the overall sales of pharmaceuticals (3250 M€) increased over 2% in 2013 from previous year. The most sold pharmaceutical groups were cardiovascular drugs, drugs affecting the alimentary tract and metabolism, drugs affecting the nervous system and drugs affecting the respiratory system.

In this study, we studied occurrence of APIs in the Kokemäenjoki water system. Surface water was sampled 3 times during a year sampling campaign. The studied APIs belong in six anatomical therapeutic chemical classification groups and were selected among the most sold ones in each selected classification group (Table 1). Over twenty APIs were analysed, their predicted environmental concentrations and risk quotient were calculated.

2 Materials and Methods

Samples were taken from four different surface sampling sites along the Kokemäenjoki water system. Surface and waste waters were taken as grab sample. Samples were taken into the plastic bottles. Samples were stored in -18 °C until analyses. Sample pre-treatment was done with HLB-M disks with SPE-DEX 4790 extraction system (Horizon Technology; Salem, NH, USA) and sample extracts were analysed with ultra-performance liquid chromatography – tandem mass spectrometry (UPLC®–MS/MS). Analytes were separated by Acquity UPLC (Waters; Milford, MA, USA) with an Acquity UPLC BEH C18 (1.7 µm, 2.1 x 50.0 mm) analytical column.

The predicted environmental concentrations (PEC) in surface water calculations were based on EMEA guidelines (EMEA 2006). PEC was calculated using the amount of sold pharmaceuticals, the number of inhabitants in Finland, the volume of waste water per day per capita (155 l), dilution factor in the environment (10), degree of metabolism (or excretion) and removal efficiency of pharmaceuticals in activated sludge treatment found in literature. If degree of metabolism or removal efficiency was not in use, the worst case scenario where pharmaceuticals do not metabolize and /or remove in waste water treatment was used. The amount of sold pharmaceuticals was calculated based on consumption and standard dose of each pharmaceutical (Fimea 2013).

3 Results and Discussion

Measured concentrations are generally lower than calculated predicted environmental concentrations (Table 1) which may be due to the lack of information in PEC calculation.

However, for enalapril maximum measured concentration (3.7 ng/l) are close to PEC (6 ng/l), which indicates that excretion and removal efficiency in activated sludge treatment used in PEC calculation are realistic.

Table 1. Predicted no effect concentrations (PNEC), calculated PECs, measured concentrations for river water and calculated risk quotient (RQ) based on PEC and maximum of measured environmental concentrations for studied APIs.

	PNEC	PEC ₂₀₁₃	river min - max	RQ (PEC)	RQ (MEC)
	µg/l	ng/l	ng/l		
B BLOOD AND BLOOD FORMING ORGANS					
Warfarin	89 ¹	79	0.15 - 1.6	0.00	0.00
Dipyridamole	na	268	nd - 1.3	-	-
C CARDIOVASCULAR SYSTEM					
Bisoprolol	35.6 ²	231	9.2 - 28	0.01	0.00
Metoprolol	7.3 ²	306	11 - 35	0.04	0.00
Atenolol	30 ³	136	0.85 - 2.0	0.00	0.00
Ramipril	na	27	0.12 - 0.30	-	-
Enalapril	na	6	nd - 3.7	-	-
Losartan	245 ⁴	917	6.2 - 30	0.00	0.00
Telmisartan	na	189	18 - 58	-	-
Simvastatin	9.6 ³	149	nd - 0.36	0.02	0.00
Atorvastatin	0.13 ⁵	383	nd - 0.50	2.95	0.00
Amlodipine	na	148	nd - 1.1	-	-
J ANTIINFECTIVES FOR SYSTEMIC USE					
Doxycycline	0.3 ⁶	174	0.75 - 3.8	0.58	0.01
Fluconazole	na	48	0.37 - 1.8	-	-
M MUSCULO-SKELETAL SYSTEM					
Naproxen	0.630 ⁵	27	nd - 7.8	0.04	0.01
N NERVOUS SYSTEM					
Tramadol	2.56 ⁷	196	19 - 55	0.08	0.02
Quetiapine	7.98 ⁸	1326	0.16 - 1.5	0.17	0.00
Risperidone	6.0 ⁴	8	nd	0.00	0.00
Citalopram & Escitalopram	1.6 ⁹	272	0.31 - 4.1	0.04	0.00
Venlafaxine	0.888 ⁵	298	12 - 29	0.34	0.03
R RESPIRATORY SYSTEM					
Fexofenadine	na	150	2.5 - 14	-	-

¹ Liliás et al 1994, ² www.FASS.nu, ³ Boillot 2008, ⁴ FDA-CDER 1996, ⁵ Grung et al 2008, ⁶ Kümmerer & Henninger 2003, ⁷ Bergheim et al 2012, ⁸ Escher et al 2011, ⁹ Christensen et al 2007
na not available, nd not detected

RQ screening is often based on worst-case assumptions on sensitivity and exposure. According to the European Guideline (EMA 2006), the risk assessment is based on a binary ecological classification suggesting that there is potential risk to the environment when the RQ is >1. RQ results (PEC) indicate that all APIs but atorvastatin have no potential risk to

the environment. Atorvastatin is a cholesterol-lowering pharmaceutical that has been shown to up-regulate toxicologically relevant genes in rainbow trout gills (Ellesat et al. 2012). The high RQ of atorvastatin in this assessment may be due high consumption levels in Finland combined with unrealistic PEC due to the lack of excretion and removal efficient data, which is often the case for selected APIs. In many cases RQ based on measured environmental concentration is more realistic in local environmental risk assessments. In this assessment there is no risk for environment based on the current knowledge of APIs adverse effects. However, more information on chronic effects and mixture toxicity are needed for complete risk assessments to cover the data gaps in mechanism of toxicological action of APIs.

The results from this study indicate the information needs for completing APIs environmental risk assessment. Especially more information on metabolism, removal efficiency and toxicological actions of APIs is needed and research should be focused on them in the future.

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Acknowledgements This study was partially funded by the Ministry of the Environment. We would also like to thank Conpat project for providing samples.

Hyperspectral imaging in detecting metal contamination of aquatic insects: A pilot study

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1 Introduction

Hyperspectral imaging, HSI, is spectroscopy coupled with imaging. The basic principle in spectroscopy is that each substance reflects and absorbs different wavelengths of light. Consequently a given substance often has a unique spectral signature - a fingerprint. In spectral analysis the goal is to differentiate and recognize substances based on their spectral properties. Hyperspectral imaging diverges from conventional reflectance spectroscopy in that it produces an image of pixel spectra. The technique enables revealing changes, which might be unseen for human eye. HSI has many applications in geology, mineralogy, agriculture and steel industry including automated detection of metal content (e.g., Riaza et al. 2011).

Metal pollution threatens aquatic ecosystems worldwide. High metal concentrations are found especially in stream ecosystems contaminated by effluents from active or abandoned mines, industrial waste waters or drainage waters from acid sulfate soils (Ljung et al. 2008, Byrne et al. 2012). Metal exposure impairs growth and survival of aquatic organisms (Mebane et al. 2008), and causes adverse health effects in mammals (Järup 2003). Direct measurement of chemical concentrations in water is expensive as due to typically high spatial and temporal variation, extensive sampling would be required to reliably detect also critical peak concentrations. Moreover, and perhaps more importantly, metal concentrations in the water do not directly indicate the concentrations accumulated in organisms or in food webs. Larvae of caddis fly family Hydropsychidae are abundant and widespread benthic invertebrates in running waters. Metal exposure of Hydropsychidae spp. larvae can result in morphological damages such as anal papillae and tracheal gill darkening and reduction, the incidence of which can be used for indication of metal contamination (Vuori & Kukkonen 2002).

The aim of this study was to assess applicability of spectral analysis in detection of freshwater metal contamination by developing and testing a novel hyperspectral imaging application for aquatic insect larvae *Hydropsyche pellucidula* (Trichoptera: Hydropsychidae) with cadmium (Cd) as a representative model compound. The larvae were also screened microscopically to explore if they showed any visible morphological abnormalities in response to Cd exposure.

2 Materials and methods

Fifth instar larvae of *H. pellucidula* were collected from unpolluted River Siikakoski, Finland in November 2012. Larvae ($n=132$) were exposed to four different cadmium (Cd) concentrations: 0, 1, 10 and 100 $\mu\text{g L}^{-1}$ for 96 h. Individual larvae were then preserved in ethanol, inspected with microscopy for the number of anomalies in larval gills, and imaged by hyperspectral camera. The number of abnormal gills was calculated as hydropsychid gill abnormality index $\text{HYI} = \sum \text{NAG}/n$, where *NAG* is the number of abnormal gills, and *n* is the number of individuals (Vuori & Kukkonen 2002). Three additional larvae from each exposure were analyzed for tissue Cd concentration. The ICP-OES measurements (larval Cd body burden and Cd in water samples of 10 and 100 $\mu\text{g L}^{-1}$) were performed with a Perkin-Elmer (Norwalk, CT, USA) model Optima 8300 inductively coupled plasma optical emission spectrometry. A Perkin Elmer Model AAnalyst 800 atomic absorption spectrometer with an AS-800 autosampler was used for GFAAS measurements (water samples of 0 and 1 $\mu\text{g L}^{-1}$). The main instrument used in HSI was a compact and lightweight hyperspectral imager operating with wavebands between 500 and 850 nm, developed by VTT Technical Research Centre of Finland. Spectral separation in this device is based on the piezo-actuated Fabry-Perot interferometer. A workflow for HSI data processing included six steps: 1) data normalization to reflectance, 2) spectral unmixing to delineate specimen from image, 3) gathering of all spectra from specimen and selection of endmembers, 4) calculation of inversion for selected endmembers using filter vector algorithm and forming of abundance maps, 5) calculation of statistical features for abundance images, and 6) utilization of manifold learning approach to classify specimens to different groups.

3 Results and discussion

H. pellucidula larvae accumulated waterborne Cd into their tissues. Larval Cd concentration reflected the actual water Cd concentrations ($r_s=0.75$, $p=0.005$), but was on average highest at the second highest exposure concentration (Figure 1). There is evidence on active internal Cd concentration regulation and some physiological control seems to exist for protecting insects from excess uptake (Poteat et al. 2012). All exposure concentrations used in our study were acutely in a sublethal range for *H. pellucidula* as there was no mortality during this 96 h test. HY-index showing the average number of damaged gills per larvae in the exposed population was low and varied from 1.47 (SD \pm 0.42) in the control to 1.63 (\pm 0.25) in the exposure concentration of 10.0 $\mu\text{g L}^{-1}$ with no significant differences among exposure populations (1-way ANOVA, $F=0.077$, $df=3$, $p=0.971$) (Figure 1).

HSI data analysis indicated that larvae exposed to high Cd concentrations may have different spectral properties than control larvae. First, we were able to separate different parts of the larvae based on spectral unmixing (endmembers B-D in Figure 2). These different endmembers seem to represent darkly pigmented parts of the thorax and abdomen (B), and soft non-pigmented tissue between abdominal segments on dorsal (C) and lateral (D) parts of the larvae. Classifier gave 32 % accuracy, which is better than guessing (25 %) but too weak for performing automatic distinction between the exposed and control larvae. The most promising individual set of features, more specifically the inverse of the variance of pixel intensities in a larvae, correlated with the Cd exposure ($r_s=0.29$) (Figure 3). These data were captured from the dorsal side of the larvae. This result can be interpreted as abundance image's pixel intensities having less difference between each other when Cd exposure concentration is higher, which indicates that soft parts of the larvae are darker in the higher exposure concentrations. Physiological explanation for the soft tissue darkening in the high Cd concentration indicated by HSI is unclear, but e.g., darkening of fish tail region has been reported as an effect of lead exposure (Mebane et al. 2008).

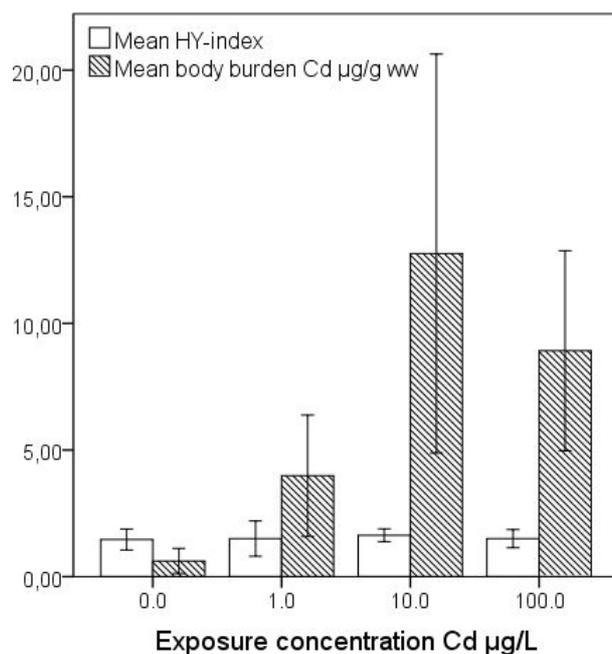


Figure 1. Mean HY-index ($\pm\text{SD}$) ($n=30$) describing the average number of damaged gill tufts of *H. pellucidula* larvae in the exposed population, and mean larval body burden Cd $\mu\text{g g}^{-1}$ ww ($\pm\text{SD}$) ($n=3$) in Cd-exposure concentrations of 0 (control), 1, 10, and 100 $\mu\text{g L}^{-1}$.

To conclude, larval mortality and the number of gill abnormalities did not differ among the Cd concentrations. In contrast, HSI data indicated a weak concentration-response relationship of larval spectral properties to the Cd exposure. We emphasize that this is a pilot study, and suggest some improvements for study procedure in future studies. The actual imaging process needs further development, especially concerning stabilization of larvae for spectral imaging in a standardized manner without damaging them. It is also important to acquire information of tissue Cd accumulation, gill damages, and specific spectral features from each larva. In the present study we were not able to get HSI data of larvae that were designated to tissue Cd analysis. Based on the results of this pilot study, we aim to optimize the workflow in imaging process, and reassess its potential for detecting metal contamination of aquatic environments.

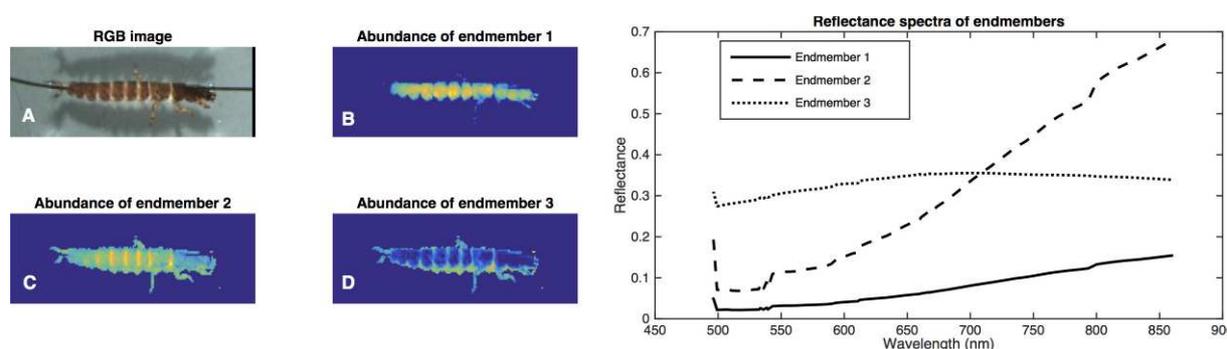


Figure 2. Separated parts of the specimen based on spectral unmixing. A larva as a RGB image (A), and abundances of the found endmembers (B-D), which represent dark pigmented parts of the thorax and abdomen (B), and soft non-pigmented tissue between abdominal segments on dorsal (C) and lateral (D) parts of the larvae. Extracted endmembers are on the right.

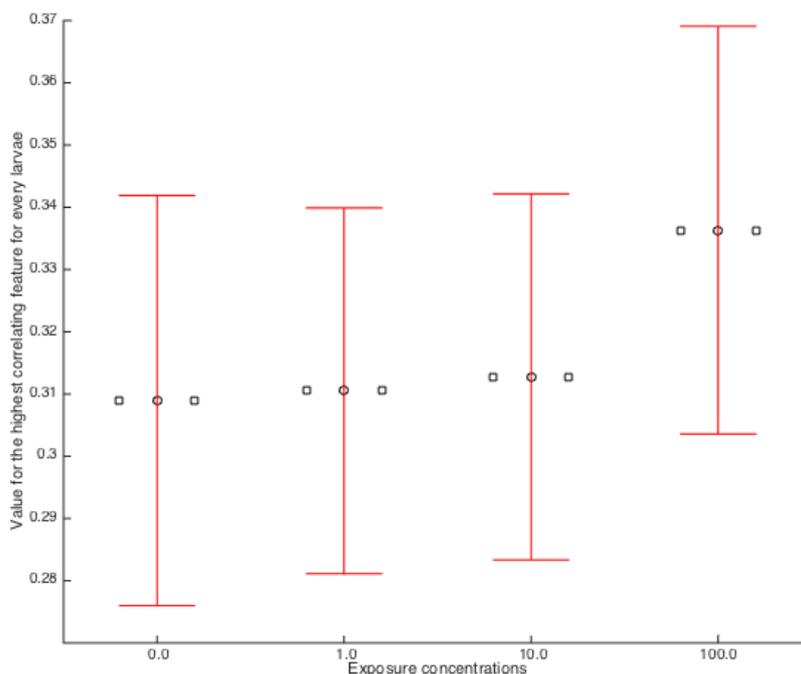


Figure 3. Values for the highest correlating spectral feature (mean \pm SD) for every larvae in Cd concentrations of 0 (control), 1, 10, and 100 $\mu\text{g L}^{-1}$. Spearman correlation between the calculated feature value and the exposure concentration is $r_s = 0.29$.

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The fate and effects of lead (Pb) at active and abandoned shooting ranges in a boreal forest ecosystem

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Lead (Pb) pellets are used at shotgun shooting ranges around the world, despite the known toxicity of Pb. Shotgun pellets spread in nearby ecosystems, which typically are forests in Finland. Here, an ecosystem-level research was conducted in a shotgun shooting range area to study the fate and effects of Pb in these ecosystems. In addition, by comparing an active and an abandoned shooting range site in the same pine forest, changes in the fate and effects of Pb twenty years after range abandonment could be evaluated.

The two shooting range sites were heavily contaminated by Pb, pellet burdens reaching up to 4 kg m⁻² and the average total Pb concentrations in organic soil horizon being more than 20 000 mg kg⁻¹ at both sites. Lead had also accumulated in biota and decreased fungal biomass and abundances of various soil fauna. However, although soil food web play a crucial role in decomposition processes, these functions were only slightly affected, indicating high resistance of boreal forest soil to this type of stress.

Lead also affected soil properties by decreasing phosphate and increasing nitrate concentration and soil pH. Increased soil pH may further affect the biota directly or indirectly by changing Pb availability.

In the entire organic soil horizon, the effects of Pb were less pronounced at abandoned than at active range. However, in the deepest organic soil layer (humus) the effects were stronger at abandoned range, the enchytraeid worms being completely absent. Furthermore, leaching of Pb through the organic soil horizon was twice as high at abandoned as at active range. These findings suggest that although less contaminated topmost soil layer is gradually formed due to litter accumulation after range abandonment, deeper in soil Pb is released from corroding pellets, increasing the toxicity of humus and risks for the groundwater quality.

Potential estrogenicity of Finnish wastewater effluents

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Wastewater effluent is considered to be one of the major sources of endocrine disrupting compounds (EDCs) to the aquatic environment. The primary reason for the presence of estrogenic compounds in wastewater effluent is natural and synthetic estrogens excreted by humans. However, traces of personal care products, pharmaceuticals, fire retardants and other household products are also sources of estrogenic effects in effluent. Some WWTPs also have loading from industrial and/or agricultural sources.

The objectives of this study were:

- a) To determine the estrogenic potencies of effluents in eight municipal WWTPs by combining analytical approaches (LC-MS/MS) with two *in vitro* bioassays (ER-CALUX and ELISA-E2), and to evaluate the contribution of the target compounds to the observed effects.
- b) To test the suitability of the ELISA-E2 test for wastewater analysis.

All of the analyzed samples showed estrogenic activity in both of the *in vitro* assays. The analyzed target EDCs contributed only partly to the observed effects and many compounds causing estrogenic effects were left unidentified. Two of the samples showed significantly higher estrogenic activities with all of the different analysis. ELISA E2 test was highly sensitive, quick and inexpensive. The concentrations were approximately 10 fold higher measured with ELISA than with chemical analysis. However, the results obtained from the ELISA E2 assay exhibited the same pattern as results from the ER-CALUX[®] and the chemical analysis.

Iron as a source of color in river waters

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Iron (Fe) is a source of the color of water (hereafter color), but its quantitative contribution is poorly understood. This study was undertaken to unravel the impact of Fe on the color of 6128 unfiltered water samples collected from 94 Finnish river sites discharging from contrasting watersheds. The contribution of Fe was examined by regression analyses and by using absorption coefficient at 490 nm as a proxy for color. According to the regression analyses, total organic carbon (TOC; mean 14.1 mg L⁻¹) consisted mostly (86%) of colored organic carbon (COC) but averagely 2.2 mg L⁻¹ of TOC was non-colored. The COC and Fe were much more important sources of color than phytoplankton (Chlorophyll a as a proxy) or non-algal particles (suspended solids as a proxy). When COC and Fe were considered as the only sources of color, COC explained from 19.0% to 99.5% (mean 71%) of the variation and the rest from 0.5% to 81.0% (mean 29%) being explained by Fe. When color was estimated as the sum of absorption coefficient of COC and Fe at 490 nm, Fe explained from 0.39% to 76.5% (mean 24.5%) of the variation, the rest being explained by COC. The contribution of Fe to color increased with increasing Fe concentration and was well predicted by TOC to Fe mass ratio (TOC/Fe). When TOC/Fe ratio < 4.5, detected in 61 out of 94 rivers sites, the contribution of Fe to color exceed 50%. Overall, our results indicate that Fe can be a quantitatively important and even the dominating source of color in river waters.

Biological removal of emerging micropollutants in nitrifying activated sludge under low temperature conditions

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Conventional wastewater treatment plants (WWTPs) are not designed for the removal of emerging micropollutants such as pharmaceuticals and thus, residues of them can be released in the aquatic environment with WWTPs effluents. Additionally in Nordic countries at least half of the year the average temperature of the process in WWTPs is at the maximum 12 °C which significantly decreases biological removal efficiency (compared to the summer season) and therefore increases the need for technological optimization of the conventional treatment processes.

This study focused on optimizing biological removal of six emerging micropollutants in existing WWTPs under low temperature conditions of Nordic countries. Removal rates of ibuprofen, diclofenac, carbamazepine and three estrogens were determined in four pilot-scale WWTPs: two Sequencing Batch Reactors (SBRs) and two Membrane Bioreactors (MBRs). Biodegradation rate constants (K_{biol}) were calculated in 24-hour experiments under 8 and 12 °C conditions for different activated sludge ages.

In the MBR process, a faster adaptation of activated sludge to the temperature decrease was observed. After start-up period, SBR process reached the same removal efficiency as 30 days old activated sludge in MBR. Activated sludge with sludge age of 60 days showed higher biodegradation rates comparing to 30 days. MBR process with 90 days sludge age was found to be the most efficient in removal of emerging micropollutants. Noticeable variety of removal rates observed during the experimental period both in SBR as well as in MBR processes was presumably caused by bacterial shift during the development of bacterial community.

The study showed that activated sludge performance in removal of certain pharmaceuticals can be enhanced under low temperature conditions by increasing activated sludge age. Modern membrane technologies improve biological removal by allowing new kind of bacterial communities to develop in the wastewater treatment processes.

Manganese sulfate decreases the survival of whitefish (*Coregonus lavaretus* L.) embryos and larvae

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Excessive concentrations of naturally occurring, and even essential, substances can have toxic effects on organisms. We studied the effects of manganese sulfate (MnSO₄) on whitefish (*Coregonus lavaretus* L.) embryos and larvae. Embryos and larvae were exposed to eight ecologically relevant MnSO₄ concentrations in geometric series from 0.007 to 568.4 mg L⁻¹ of SO₄ and 0.004 to 325.0 mg L⁻¹ of Mn under semi-static conditions. The continuous exposure was started from fertilization, and larvae were reared for three days after hatching. Embryonic mortality was observed 2 - 3 times per week and number of hatched and dead larvae were observed daily. Embryos and three days old larvae were sampled for metal uptake and gene expression analyses. Target genes for the gene expression analyses were metallothionein-A, metallothionein-B, catalase, superoxide dismutase-1 and glutathione S-transferase T, whereas beta-actin and ribosomal protein L2 were selected as reference genes.

The MnSO₄ exposure did not have clear effect on the fertilization success, but it decreased the total survival of the embryos and larvae and reduced hatching. According to the preliminary embryonic metal uptake results, embryonic Mn concentrations increased with increasing Mn exposure concentrations. However, according to the preliminary embryonic gene expression analyses, the MnSO₄ exposure did not cause any changes in the gene expressions. The messenger RNA levels may have been stable throughout the exposure, or then stress genes may have been activated in the beginning of the exposure but recovered after a while. Additionally, the embryo data does not define whether the Mn is accumulated in the chorion or in the embryo. If Mn was accumulated in the chorion, that might explain why none of the target genes were induced. The larval samples are under process and may reveal more about the metal uptake and gene expression dynamics.

Are flame retardants also growth retardants?

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To investigate the effects of two emerging polychlorinated flame retardants on hatching success and growth in birds, an *in ovo* exposure experiment on Japanese quail (*Coturnix coturnix japonica*) was performed. In total 392 eggs were injected with Dechlorane Plus (DP; syn- and anti-isomer), Tris(1,3-dichloro-2-propyl)phosphate (TDCIPP) and a mixture of both chemicals (MIX). Eggs were injected in the yolk sac, right before incubation (at embryonic day zero) and were administered a low (10 ng/g egg), medium (100 ng/g egg) or high (1000 ng/g egg) dose of the compound or mixture. Two control groups were also included: one group was only injected with a 'vehiculum' containing peanut oil and lecithin, while the other group did not receive any injection. Eggs were incubated for 17-18 days and chicks (n=101) were kept in cages per three individuals. Food and water was provided *ad libitum*. Everyday body weight, head length and tarsus length were measured to examine effects of the contaminants on growth. At day 14, the birds were killed by decapitation and samples were taken for analysis of the compounds in the tissues. It was hypothesized that growth would be negatively affected by the injected compounds and that there would be an effect of mixture toxicity. Also hatching success was expected to be lower in exposed eggs and behave in a dose-related manner. The overall hatching success of the birds in this experiment was 47.2%. Preliminary results indicate that hatchability was decreased in all exposed eggs compared to the control eggs (58.5%). Hatching success of the different exposure groups followed the decreasing order of TDCIPP (49.2%) > DP (46.0%) > MIX (41.5%). Interestingly, in contrast to DP and TDCIPP, hatching success in MIX increased with dose. Furthermore, the growth data are currently under investigation and these results will also be presented at the conference.

Neonicotinoid insecticides: environmental monitoring and toxic effects to *Lumbriculus variegatus*

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Neonicotinoid insecticides are the most widely used insecticides worldwide and have been on the spot recently due to the apparent toxic effects caused to bees. As a consequence, their use was restricted to a great extent in the EU for two years. The neonicotinoid insecticides that have been on the spot are clothianidin, imidacloprid and thiamethoxam. Although neonicotinoids are intended to treat crops from pests, a high proportion of the insecticide may leach to the surface waters after application as their solubility is high. They have been detected in environmental waters from around the World.

Although they allow a faster and healthier growth of crops by aiming at pests, neonicotinoids can be toxic also to non-target organisms, for example, the presence of imidacloprid has been related to a decrease in the population of aquatic invertebrates.

It is known that neonicotinoids may be toxic to non-target organisms, but information about the toxicity of these insecticides in combination with other compounds is scarce. The present study aims at discovering the toxicity caused by the common fungicide propiconazole and the neonicotinoid thiamethoxam, using *Lumbriculus variegatus* as a model organism. The worms were exposed in sediment for seven days to propiconazole in different concentrations with and without thiamethoxam. The results show that the addition of thiamethoxam has a negative effect in the reproduction of *L. variegatus*. However, no statistical decrease in biomass of worms were observed.

Additionally, the authors have studied the presence of neonicotinoids and other pesticides in three rivers of Southern Finland by the use of passive sampling. The results showed that besides neonicotinoids, other fungicides and herbicides were present in the three rivers, suggesting that passive sampling is a suitable method to assess the welfare of Finnish waters.

Iron and pH regulating photochemical reactivity of dissolved organic matter in lake water

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Lakes are active sites for considerable carbon transport, transformation and storage, that, may disproportionate their spatial extent. As part of global carbon cycle, 685×10^{15} g C dissolved organic matter (DOM) are found in ocean, affecting food web stability, transmission of solar radiation and trace metal availability. Photochemical mineralization of DOM influences aquatic carbon cycling as it recycles organic matter back to inorganic forms. This process depends on environmental conditions, for instance, solar irradiance, pH and concentration of DOM. Photochemical degradation of DOM to dissolved inorganic carbon (DIC) is influenced by concentration of iron and pH. Though DOM photochemical degradation is a functional property for ecological and geochemical activities in aquatic environment, its quantitative description under various iron-pH pair conditions is lacking. As iron can be found in high concentration and in association with DOM, it's important to understand the role of iron for DOM photodegradation process in lake water. This work focused on effects of ferric iron and pH on photochemical reactivity of DOM in lake water by establishing model for predicting dissolved organic carbon (DOC) photochemical reactivity, presented with apparent quantum yields (AQYs) as quantitative indicator, and to understand iron's role in photochemical degradation procedure with different pH conditions.

Characterisation of leachates from torrefied wood

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The use of biomass fuels is projected to increase dramatically in many EU member states in order to achieve EU energy policy objectives. Torrefaction, a partial pyrolysis of wood carried out under inert atmosphere, is an emerging technology with which a new generation of fuel pellets can be produced. The improved fuel properties of torrefied wood enable higher rates of co-firing in coal power plants thereby achieving larger net CO₂-equivalent emission reductions. However, studies on many issues related to wide-scale use of torrefied fuels have not been carried out. One such issue is the chemical stability of torrefied wood under storage conditions in the fuel yard.

This study aims to determine the leaching properties of torrefied wood through laboratory-scale experiments. The work characterises the solubility of torrefied wood in rain water, the persistence of leachates in the environment, CHN trace-element content of samples. In addition the DOC and COD values of leachate are measured. Parallel measurements on untreated wood and fossil coal are also carried out and results are compared. The results of this study are of use in assessing environmental impact of fuel-yard storage of torrefied wood fuels.

Context-Sensitive Vocalization among Brown Bears

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Bears have captured our imagination throughout centuries. Ancient Finnish and Lappish myths and legends are probably one reason why these powerful animals are still held in great respect today in these areas and referred to as the King of the Forests [1, 2]. Worldwide, according to our current knowledge based on DNA analysis, the bear taxonomy includes eight still living species: brown bears, polar bears, black bears, white-chested bears, sun bears, sloth bears, spectacled bears and pandas [3]. The focus of our study is on brown bears and their communication in certain contexts.

Bear behavior and communication research is very different from bear population research. Information and communication technology (ICT) provides us new research tools and methods in addition to radio signal tracking and Global Positioning System (GPS). Close monitoring and information collecting give more precise information on bears' behavior, and based on that information we can create new knowledge on bears' biology and their environmental state.

Bears are not only wandering by themselves around forests or glaciers but they are also communicating with each other and – when needed – for humans as well. The behavioral and communication schema of the bear seems to be very goal oriented and situation specific. If we can recognize context-dependent communication schemas, we will be able to create an ABC of a bear communication. The ABC can be used for example by scientists, authorities, teachers, students, hikers and especially citizens living in bear-rich areas.

In addition to biological research, bears are constantly contributing to our environmental research as well – if only we could understand their signals. It is important to increase the competence of modern humans – especially that of environmental researchers and decisions makers – to interpret weak signals from the nature early enough for environmental protection initiatives and programs to avoid for example the current predicament of polar bears and pandas. Ancient and aboriginal populations like Mayas and Indians, as well as nomads in many continents, have good skills for living in harmony with and as a part of the nature. It is important to understand bear communication in general because that will better enable us to interpret their weak signals when the living conditions in bears' natural environments change.

It is often believed that bears behave in an unpredictable way. However, as with all mammals, bears' behavior is governed by a combination of genetic programming and social and environmental factors. Once we understand bears' behavior and communication, it won't be random for us anymore.

The focus of our research is on context-based bear communication – especially on bear vocalization and body language in certain situations. We introduce a context-based schema for brown bear communication research, which is based on the sensing, processing and actuating (SPA) architecture (Figure 1) [4, 5, 6]. The system described here is in its early stage of implementation. The system is under construction in a Matlab environment with Signal Processing Toolbox [7, 8]. The tree main SPA phases and preliminary results are shortly described as follows.

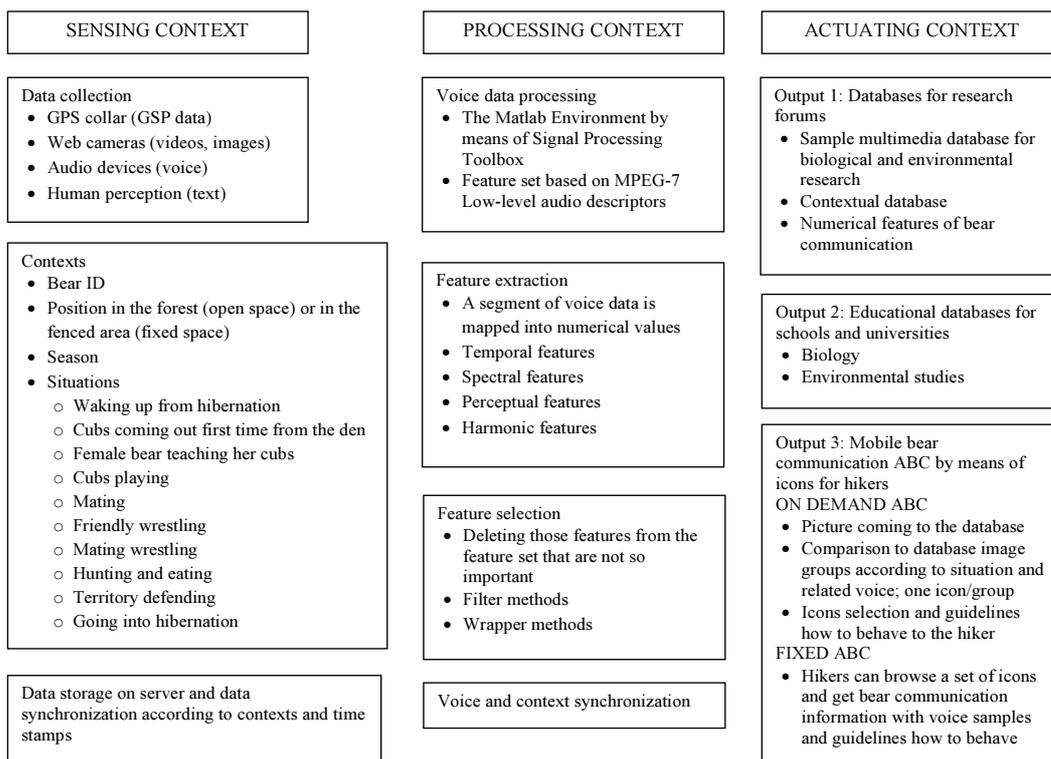


Figure 1. Context-based bear communication research schema

Sensing: In Finland, the Predator Center in Kuusamo (PCK) [9] offers unique opportunities to study contextual bear communication in a fixed, but quite wide space. At the moment, there are six bears in PCK. The space is divided into five sub-spaces: i.e. two bears are sharing one space, and the rest have a sub-space of their own. Each sub-space has a den, eating area, tree area, play area, grass area, pond area and wild nature. The movements and voices of individual bears are easy to follow by means of GSP collars, web cameras and human perception. The sub-areas are easy to divide into rectangles. By means of the sensing data, we can calculate how often the bear comes to a certain rectangle and for how long it stays there. By means of this information we can calculate weights for each rectangle as a function of time. For example, during hibernating the value of the den’s weight $W_{Den}(\text{October} - \text{March}) = 1$. With the weight values, we can create priority maps showing the locations in a bear’s fixed space with most activities during the bear’s annual timeline and also the kind of activities during that period.

In addition to PCK, there are two fixed space parks with bears in Finland: Ranua Zoo [10] near Oulu and Rovaniemi and Ähtäri Zoo [11] near Jyväskylä. Both of them also provide good opportunities to study bear communication. The forest would of course provide us an open space research environment. However it suits better for bear population studies carried out by the Natural Resources Institute Finland [12]. Population study has long been the main contribution to bear research in Finland. Now also bear behavior and bear communication studies have been taken up, for example at the University of Jyväskylä.

The main idea of our research is to identify groups of voice sequences typical for certain situations. The following context classes are used in the study: bear ID, which includes name, gender and age; GPS position, which includes the bear’s location in the forest (open space) or in a fenced area (fixed space – which applies to PCK); season, which includes spring,

summer, autumn and winter. Situations as a context class include: waking up from hibernation; cubs coming out first time from the den; female bear teaching her cubs; cubs playing; friendly wrestling between cubs or between adults; mating wrestle between two males; hunting and eating; defense of territory; and, finally, going into hibernation.

Processing: Voice signal classification consists of extracting and selecting physical and perceptual features from a voice signal. By using these features it is possible to identify into which context class the voice is most likely to fit. Feature extraction is a process where a segment of a voice signal is characterized with a compact numerical representation. If the features extracted are carefully chosen, it is expected that they contain relevant information from the input data. A desired task can then be performed using that reduced representation instead of the full size input. Feature selection is the process of removing features from the feature set which are less important with respect to the classification task to be performed. There are many features that can be used to characterize voice signals in the MPEG-7 format. We study the feature extraction of context-dependent vocalization of bears by means of temporal (features are calculated from the input waveform), spectral (features are computed from short-time Fourier transform of the input signal), perceptual (features are computed from the human perceptual model) and harmonic features (features are computed from the sinusoidal harmonic model of the signal).

Actuating: We describe here three examples of how the created multimedia bear database can be used in addition to our bear vocalization-context –analysis. The bear database includes voice and video sequences, still images and textual information, numerical features of bear communication together with contextual and temporal information. Firstly, the database provides valuable information for biological and environmental research forums and for authorities. Secondly, it can also be used for biological and environmental education in schools and universities. Thirdly, by means of the database and icons we can create a mobile bear communication ABC for hikers. In “On Demand ABC” the hiker can send a bear picture taken by her/his mobile phone to the server. The input picture is compared to database image groups according to situations and related voices. An icon representing the most similar image group will be selected. This icon with a voice sample will be sent to the hiker with some guidelines about how to behave. In “Fixed ABC” hikers can browse a set of icons by their phone and get bear communication information with voice samples and guidelines about how to behave.

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Assessing the role of passive sampler geometry

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Several passive sampling techniques have been developed for monitoring pollutants in aquatic environment for almost decades. Although it has been recognized that the prevailing conditions near the sampler body effect on its performance, the cross scientific approach has not been considered thoroughly. The environmental variables (such as pH, turbulence and temperature) have been observed to effect on the exchange kinetics of the sampling procedure. Still, the studies of the contribution of the sampler housing geometry on the accumulation have been very limited. However, this could be discovered based on existing physical or engineering literature and without extensive field measurements.

In physics the issues related to heat and mass transfer are extensively studied. With a literature review we can assess the best shape of the passive sampler housing that would minimize the effects of unwanted phenomena's and magnify the desired ones. For example geometry which includes pins on the surface of the sampler body generates flow environment that would smoother the rapid changes occurring in surrounding aquatic media. That creates more regular flows near the receiving phase of the sampler and thus makes the interpretation of passive sampling results more reliable.

Based on the literature it is evident that the shape of an item in which the receiving phase of the passive sampler is fixed can have significant effect on the exchange kinetics of sampling. Theoretically we can define the effect as an amount of material accumulated in the receiving phase which increases with the water flow. Thus when selecting sampler housing with suitable geometry the sampling period can be increased or decreased depending on the flux the item is creating with surrounding media. In this poster the fluxes created by selected shape of passive sampler housings and their effect on the sampling kinetics are discussed.

Proficiency test on field measurements of oxygen, temperature, pH and electrical conductivity in waters

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Profest SYKE organized the first intercomparison tests in Finland for field measurements of natural river water temperature, conductivity and dissolved oxygen concentration, oxygen saturation, and pH-value. The aim was to evaluate the quality of fields sensor used for natural water analysis, as well as the comparability of the results between different instruments in field conditions. Also overall quality assurance procedures were studied. In total, three proficiency test 27 participants and 42 field meters took part in this proficiency test that was arranged in River Kerava and in River Oulu during 2013-2014. For evaluations of performance of each participant, z-scores were calculated allowing 1.5 - 10 % deviation from the assigned value.

Most sensors used were less than five years old and all sensors were calibrated according to the manufacturer's instructions. In total, 70-100 % of the measurements were acceptable when 1.5-10 % deviation from the assigned values was allowed. Results obtained with electrochemical (amperometric) oxygen sensors were lower than results obtained with optical sensors in the river with low flow speed.

All sensors were less than five years old and they were calibrated according to the manufacturer's instructions. In many cases a person responsible for the sensor has been named, but more attention should be paid to training and handling of the equipment. In addition, several participants had some quality control procedures.

Field sensors are reliable and good tools if they are used by skilled personnel and quality assurance is sufficient. Therefore it is not excluded that they can be applied in environmental monitoring programmes after sufficient guidelines for quality control and quality assurance are taken into use.

Rare earth elements dysprosium and erbium nanoparticles and their effects to white-rot fungus *Cerrena unicolor* enzyme production profiles

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1 Introduction

Nanoscience has produced many new materials which exhibit improved properties developed into nanotechnology products. Rare earth metal dysprosium (Dy) and erbium (Er) have been used in laser products, electronics industry and sensing instruments. Er and Dy behave differently as nanoparticles since surface area to volume ratio increases and have prospects for new applications especially in nano-electronics and photonics. At the end of nanoproducts' life cycle nanomaterial can be released and spread into the environment. Wood, litter and soil colonizing basidiomycetous fungi produce oxidative extracellular ligninolytic enzymes, which are needed in biodegradation of manmade xenobiotic compounds and lignin containing plant detritus (Hatakka 1994). Previous studies of metal contamination indicated that nickel has harmful impacts to the growth and laccase enzyme production of basidiomycetous fungi (Lankinen et al. 2011). However, little is known about impacts of nano-dysprosium and nano-erbium on the growth of fungi, their oxidative enzyme production and ability to degrade harmful xenobiotics. Our aim was to reveal effects of nano-Er, nano-Dy, Er, Dy, Er salt and Dy salt to the oxidative ligninolytic enzyme production and degradation of azo violet textile dye by the white rot fungus *Cerrena unicolor*. Decolorization of this recalcitrant textile dye can be seen as indicator for the functionality of wood and litter decomposing fungi.

2 Materials and Methods

The white-rot fungus *Cerrena unicolor* FBCC 387 was cultivated in low nutrient nitrogen liquid medium in flasks (100 ml) with shaking in the presence of Er₂O₃, nanoparticle Er₂O₃, Dy₂O₃, nanoparticle Dy₂O₃, (0 – 200 mg/ l) as well as ErCl₃ and DyCl₃ (50 mg/ l). All cultivations were done as three replicates at 22 °C Laccase (EC 1.10.3.2) and versatile peroxidase (VP, EC 1.11.1.16) enzyme activities were measured spectrophotometrically on 96-well plates with plate reader (Infinite 200, Tecan, Switzerland) (Heinfling et al. 1997). Decolorization of azo dye Remazol Brilliant Violet 5R was followed with decrease of the absorbance at 556 nm on 96-well plates with the plate reader. Scanning electronic microscopic (SEM) pictures were taken to find out the effect of tested metals on the hyphal growth of *C. unicolor*.

3 Results and Discussion

Cerrena unicolor grew in the presence of all tested metals. Our results showed that *C. unicolor* produced laccases in the presence of nano-erbium, erbium, erbium salt, nano-dysprosium, dysprosium, and dysprosium salt in liquid cultivation (Figure 1.). Laccase activity was three times higher in the lowest (5 mg Dy/l) and middle nano-dysprosium (50 mg/ l) concentration than those in the highest concentration (200 mg Dy/l) at the day of 26. This indicates that nano-dysprosium (200 mg Dy/ l) was harmful to the production of laccase with *C. unicolor*. Similar reduction was not seen with dysprosium, where all activities was

similar in all concentrations tested (5-200 mg Dy/ l). *C. unicolor* laccase production was higher in the lowest (5 mg/ l) and middle (50 mg/l) nano-Er concentration than those in the highest nano-Er (200 mg Er/l) concentration indicating that nano-erbium (200 mg Dy/ l) was harmful to the production of laccase with *C. unicolor*. Laccase activity was higher in the lowest (5 mg Er/l) and middle erbium concentration (50 mg/l) than those in the highest (200 mg Er/l) concentration. The production of laccase was 4-7 times higher in the presence of dysprosium or erbium salt compared to those without added metal.

Versatile peroxidase (VP) activities of *C. unicolor* in the presence of nano-erbium, nano-dysprosium, erbium, dysprosium, erbium salt and dysprosium salt in liquid cultivation are shown in Figure 2. Our results showed that VP activity was similar with all three nano-erbium concentrations (5 – 200 mg Er/l). VP activity peaked at the day of 14 with the highest nano-dysprosium concentration (200 mg/l). All VP activities were similar between nano-Dy, Dy and Dy salt, and also nano-Er, Er and Er salt indicating that these metals were not toxic to the production of versatile peroxidase by *C. unicolor*.

Decolorization of recalcitrant azo violet textile dye with *C. unicolor* was tested in the presence of nano-erbium, erbium, erbium salt, nano-dysprosium, dysprosium, and dysprosium salt. Violet was decolorized almost completely within 7 days with tested erbium metals and within 14 days indicating that *C. unicolor* was able to degrade aromatic structure containing Remazol Brilliant Violet 5R azo dye. This dye was not decolorized without the presence of the fungus *C. unicolor*. Scanning electronic microscope (SEM) pictures showed that nano-erbium, nano-dysprosium, erbium, dysprosium, erbium salt and dysprosium salt were on both the surface and inside the hyphae of the fungus. Our results indicate that nano-Er, nano-Dy, Er and Dy cause harmful effects to fungal enzyme production profiles and therefore cause harmful effects to the fungal communities and therefore to the biodegradation of xenobiotics in the nano-metal contaminated environment. Decreased or altered activities of oxidative enzymes such as laccase and versatile peroxidase can be considered as early warning to indicate contamination in the environment.

Acknowledgements

This work was funded by Maj and Tor Nessling Foundation

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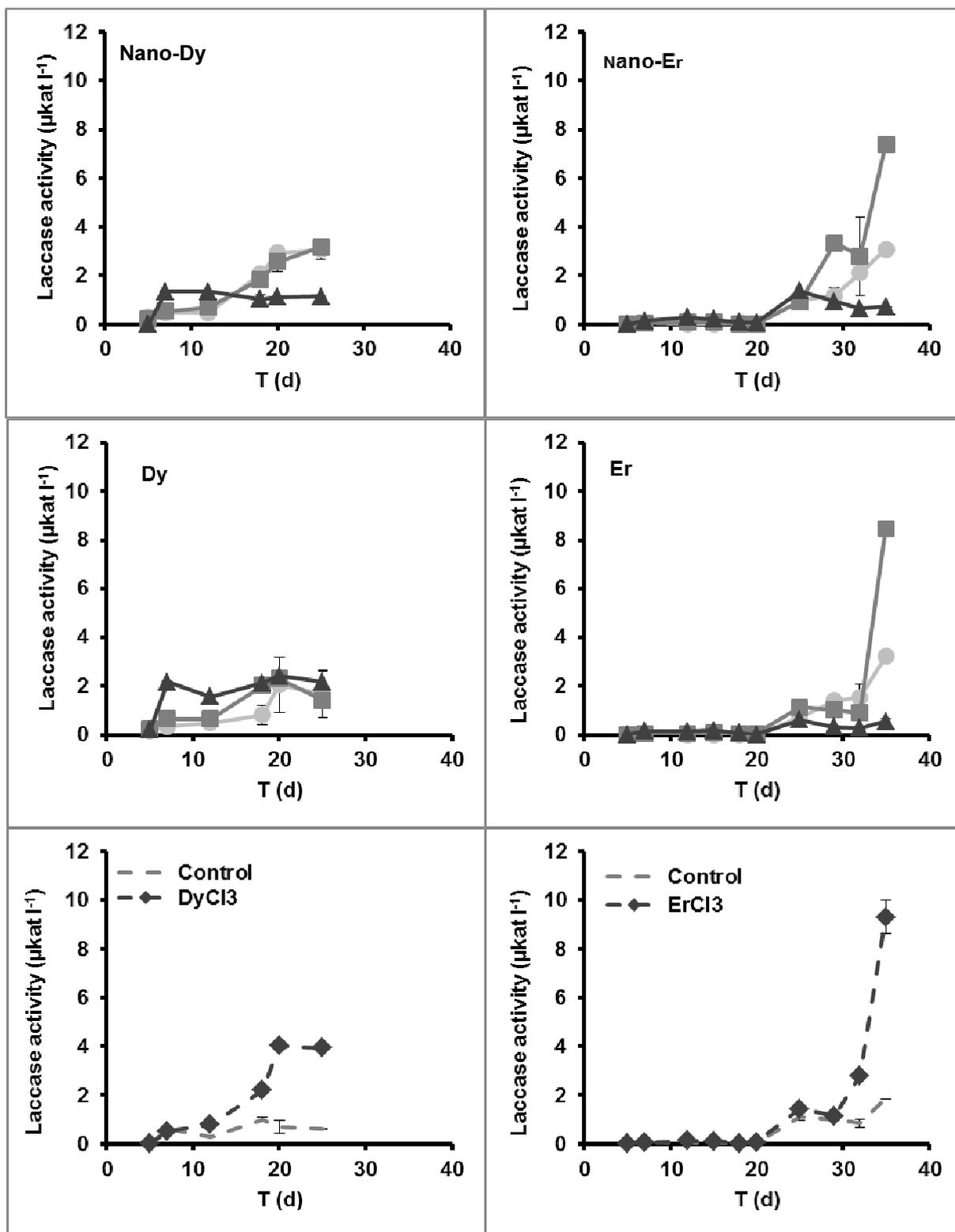


Figure 1. Laccase activity produced by *Cerrena unicolor* FBCC387 during cultivation on low nutrient nitrogen culture medium with ● 5 mg l⁻¹, ■ 50 mg l⁻¹ or ▲ 200 mg l⁻¹ nano-Dy, Dy (left panel) nano-Er, Er (right panel) or 0 mg l⁻¹ (dashed light grey) or 50 mg l⁻¹ DyCl₃ or ErCl₃ (dashed grey line).

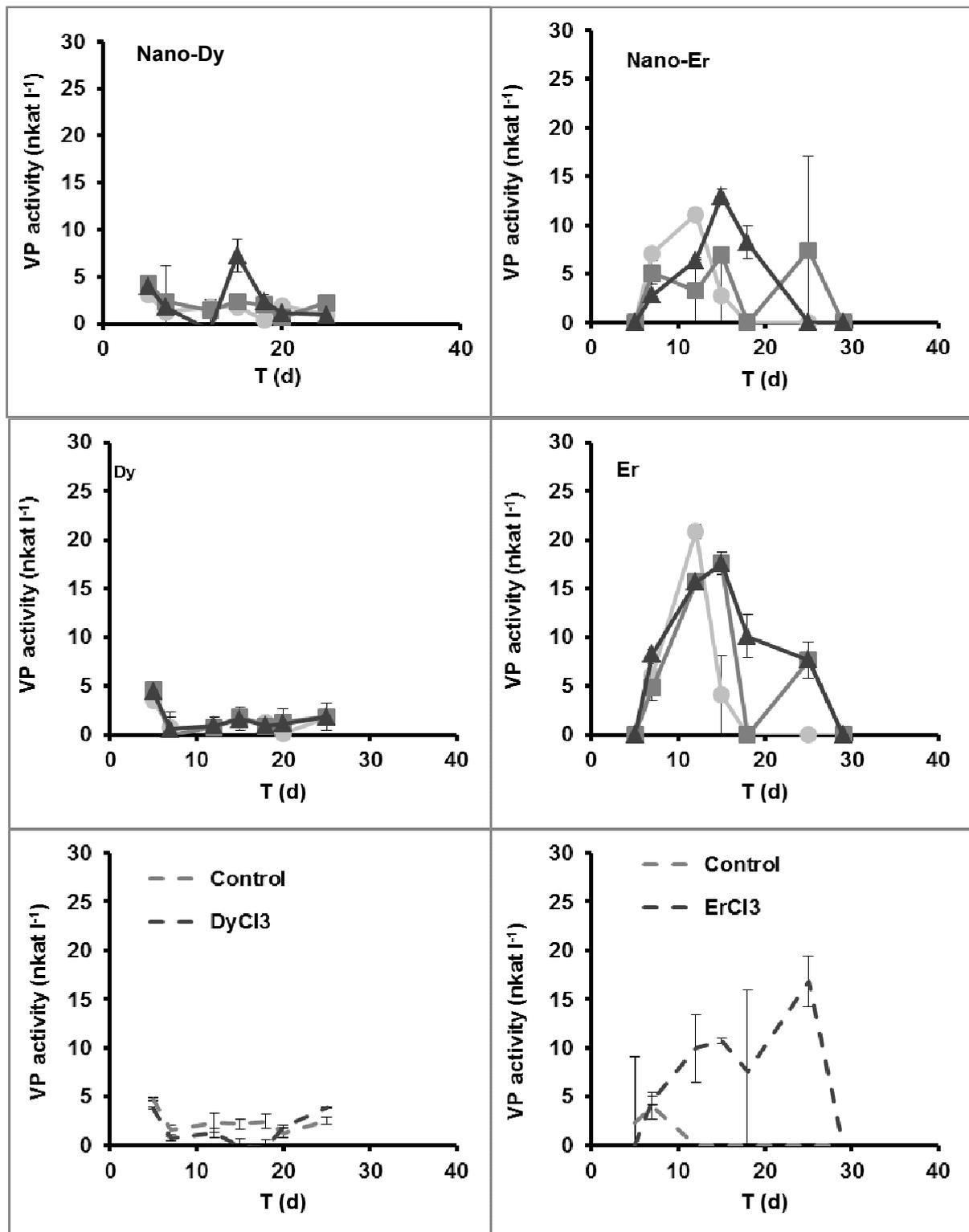


Figure 2. Figure 1. Laccase activity produced by *Cerrena unicolor* FBCC387 during cultivation on low nutrient nitrogen culture medium with \bullet 5 mg l⁻¹, \blacksquare 50 mg l⁻¹ or \blacktriangle 200 mg l⁻¹ nano-Dy, Dy (left panel) nano-Er, Er (right panel) or 0 mg l⁻¹ (dashed light grey) or 50 mg l⁻¹ DyCl₃ or ErCl₃ (dashed grey line).

Study of pharmaceuticals in municipal wastewater and in the recipient water of northern Lake Päijänne

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The occurrence of five pharmaceuticals, consisting of four anti-inflammatory and one antiepileptic drug, was determined in influent and effluent of a municipal WWTP near the city of Jyväskylä, Finland and in the receiving water, northern Lake Päijänne. In addition to water samples, the concentrations were studied in sedimented particle samples collected from the receiving water body. The solid phase extracted (SPE) water samples and the extracts of sedimented particles were analyzed by liquid chromatography coupled to tandem mass spectrometry (LC-MS/MS) in the multiple reaction monitoring (MRM) mode. The selected pharmaceuticals were detected in influent, effluent and lake water but also in the sedimented particles. The concentrations of selected pharmaceuticals in the effluent were at the $\mu\text{g L}^{-1}$ level. In the Lake Päijänne, it ranged from hundreds of ng L^{-1} (diclofenac, ibuprofen, ketoprofen and naproxen) to a few nanograms of carbamazepine, respectively. In the sedimented particles, approximately hundred ng g^{-1} of ketoprofen was detected while only trace amounts of other selected pharmaceuticals were found. The results show that the concentrations of pharmaceuticals are affected by the biological and chemical reactions occurring in the wastewater treatment processes but also by the UV light in the photic layer of Lake Päijänne. Based on the results of this study, further analysis of pharmaceuticals in the lake water but also in sediments can be recommended in order to receive valuable information about the condition of the Lake Päijänne, one of the most important fresh water sources in Finland.

Effects of metals on gene expression in an earthworm: from stress response to metabolism

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Metal contamination affects soil organisms in various ways. The effect of metals can be studied by focusing on proteins involved in metal homeostasis, e.g. metallothionein, or other stress-response proteins, e.g. heat-shock proteins. Because metals can affect metabolic processes of soil organisms, an alternative approach could be to examine the effects of metals on metabolism directly in addition to organism's stress responses. Earthworms are important decomposers in terrestrial ecosystems. We are interested in how metals affect the metabolism of an epigeic earthworm, *Dendrobaena octaedra*, and potentially its contribution to decomposition. We examined the expression of nine genes that produce enzymes and proteins related to decomposition: aldo/keto reductase, carbonyl reductase, chitinase, chymotrypsin inhibitor, dehydrogenase, fucosidase, leucine aminopeptidase, pyruvate dehydrogenase and xylulose reductase. Using qPCR, we compared gene expression of 20 individuals collected from a metal contaminated site and 20 individuals from an uncontaminated site. Expression differed significantly between earthworms from the two sites in three genes (chymotrypsin inhibitor, leucine aminopeptidase and xylulose reductase), being higher in earthworms from the contaminated site, indicating that exposure to metals can potentially affect metabolism of this species. We plan to study the effects of metal contamination on expression of these genes further with a long-term microcosm experiment (in progress), where respiration, growth and nutrient mineralization are also measured, in order to link the gene expression patterns and decomposition. Our microcosms include *D. octaedra* with either high or low genetic diversity (containing individuals with different or the same genotypes), in uncontaminated and in Cu contaminated soil, and with or without other species from the decomposer food web. Preliminary results will be presented.

Occurrence of selected antibiotics and antiretroviral drugs in Nairobi River Basin, Kenya

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The occurrence of Pharmaceuticals and Personal Care Products (PPCPs) in the environment has become the focus of worldwide attention in recent years as questions about their potential threats to the natural environment and human health have been raised. Discharges from wastewater treatment works have been identified as the primary point source of pharmaceuticals into the water systems. However, significant populations in cities within the developing countries such as Nairobi-Kenya reside within the informal settlements that are characterized by poor sanitation system high disease prevalence such as HIV/AIDS. Wastewater from these settlements is not subjected to treatment and ends up contaminating the rivers and other water sources within the locality.

The occurrence of three antibiotics (sulfamethoxazole, trimethoprim and ciprofloxacin) and three antiretroviral (lamivudine, nevirapine and zidovudine) drugs in Nairobi River Basin, Kenya was studied. All the studied compounds were detected with sulfamethoxazole having the highest detection frequency of 97.5% and ciprofloxacin had the lowest at 65% (n=40). The results showed that the concentration of the drugs was high especially in sections bordering informal settlements. The maximum (median) concentration in river waters for sulfamethoxazole, trimethoprim, ciprofloxacin, lamivudine, nevirapine and zidovudine were 13765 (1801), 2650 (327), 509 (129), 5428 (1004), 4859 (769), and 7684 (660) ng/L respectively. The environmental risk as a result of the occurrence of the analytes in Nairobi River Basin was evaluated by calculation of the risk quotients (RQs) for algae and daphnia and was expressed as the ratios of measured environmental concentrations (MEC) and the predicted no-effect concentrations (PNEC). Apart from Lamivudine that had low RQ, all the other studied compounds had high RQs with sulfamethoxazole having the highest RQ at 508.7 indicating possibility of adverse ecological risk and calling for corrective and mitigation strategies.

Effects of activated carbon amendment on *Lumbriculus variegatus* in PCB contaminated sediments in freshly amended and aged systems

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Activated carbon (AC) amendments have been studied as a new stabilizing method for contaminated sediments. The sorption efficiency of AC toward hydrophobic organic compounds (HOCs) has been shown in several studies. Recently the focus has been turned also to the possible secondary effects of AC amendments. The result relating to secondary effects has been somewhat contradictory and especially sediment dwelling organisms has been shown to be sensitive to AC amendments. The aim of this study was to investigate the efficiency of AC to reduce bioaccumulated concentrations of PCBs and possible adverse effects on benthic organisms, main focus being on how long contact time affected the effects of AC amendments. *Lumbriculus variegatus* was used as a test organisms. Coal based AC (ø 63-200 µm) was mixed in natural sediments from PCB contaminated areas and let to stabilize for two weeks or three years after amendment. AC amendments proved to be efficient in reducing PCB bioaccumulation and the sorption capacity remained strong even after three years of AC-sediment contact time. However, adverse effects were observed on *L. variegatus* biomass and egestion both with two weeks and three years AC-sediment contact times. Responses observed within this study emphasize the importance of site specific characterization when remediation measures are designed, by knowing the local conditions the applied doses may be adjusted to avoid secondary effects as far as possible. Sediment dwelling organisms may be sensitive to carbon amendment due to the exposure both internally and externally and thus they may also be suitable indicator species for the secondary effects of AC.

The association of silver nanoparticles and silver ions with sediment components

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The use of silver nanoparticles (AgNP's) in technology and industry is annually increasing. Extensive usage leads to release of AgNP's into the aquatic environment. Sediment is believed to be the final sink for the particles but only little is known about the environmental effects and behavior of AgNP's in sediments. To address the association of AgNP's with sediment components we spiked natural sediments from Lake Höytiäinen and Lake Kuorinka and one artificial sediment with uncoated (uc-AgNP) and polyvinylpyrrolidone coated AgNP's (PVP-AgNP). Silver nitrate (AgNO₃) was used as a reference substance. Spiked sediments were topped with artificial fresh water and three sediment dwelling oligochaete *Lumbriculus variegatus* were introduced into the test system to add bioturbation. Association of silver with different sediment components was studied by ultrasound assisted sequential extraction method. In all sediments over 90 % of AgNP's was tightly bound to the residual fraction and could not be extracted. Depending on sediment, iron- and manganese oxides or organic matter and sulfides were the secondary dominant silver binding components. In artificial sediment no AgNP's were found in bioavailable fractions of the sediment and in natural sediments this proportion was also low, less than 1 % of the total silver. In addition to the sediment properties, surface chemistry is important factor driving the association of the particles with different sediment fractions. PVP-AgNP's were found in the bioavailable fractions of natural sediments throughout the experiment, while uc-AgNP's were typically not. Our findings highlight the importance of the matrix and nanoparticle properties when modelling the environmental fate of AgNP's. In certain conditions AgNP's can be bioavailable in sediments and since their toxicity is poorly known they might disturb the benthic ecosystems.

Nitrification in drinking water distribution network in Helsinki and Vantaa

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Introduction

In 1998 it was noted in the Helsinki area that nitrite concentration started rising in the drinking water distribution network (DWDN). This was due to the new process unit in the water treatment plant (WTP) of Vanhakaupunki, namely granular activated carbon (GAC) filtration. The filtration decreased the organic matter and indirectly favored nitrification. (Vahala & Laukkanen 1998). This phenomenon was noted also in a research network test by Vahala *et al.* (1999). The phenomenon was further studied by Lipponen *et al.* (2002 and 2004) from the microbiological point of view. The existence of autotrophic nitrification bacteria in the biofilm of distribution pipes was confirmed, also the nitrification potential of the biofilm was proven. Since then nitrification in the DWDNs has not been studied in Finland.

Extensive studies of nitrification in DWDNs occur especially in the USA (*e.g.* Wilczak 1996, Zhang *et al.* 2010) but the conditions clearly differ from the Finnish conditions by the concentration of added chloramine. In the US the concentrations of chloramine, which is the source of ammonium and thus promotes nitrification, vary from 1 to 3 mg l⁻¹ as total Cl₂ (Wilczak *et al.*, 1996) as in the Helsinki area the respective concentration is 0.35-0.4 mg l⁻¹ as total Cl₂. Thus most of the experiences from the US based research can't be applied directly.

Materials and methods

In this study the extent of nitrification has been investigated in the light of obligatory monitoring data in Helsinki and Vantaa. The data was from 3,5 years, between January 2010 and July 2013. It consisted of 2000 samples analyzed for various compounds and physical properties, including ammonium and nitrite in most cases. The data was transferred from pdf files into a spreadsheet program and geocoded.

Results and discussion

It was noted that nitrification occurs in all the parts of the DWDN of Helsinki and Vantaa (Fig.1). The occurrence was determined according to the limit introduced by Kirmeyer *et al.* (1995); nitrite concentration above 0.05 mgN l⁻¹ as nitrogen shows nitrification and a concentration below it shows no nitrification. All in all nitrite exceeded 0.05 mgN l⁻¹ in 44% of the analyzed samples. Some farthest branches of the DWDN show low nitrite concentrations as if nitrification did not occur in those areas, *e.g.* north-west Vantaa (Fig. 1). On the other hand nitrite was occurring closer to the WTP of Pitkääkoski in the same branch, which does not receive waters from other branches. It seems more likely that nitrite had reacted further into nitrate in the second reaction of nitrification in the farthest part of the branch in north-west Vantaa. This conclusion was bolstered by the few nitrate analyses of the whole data (45 altogether); when the summed concentrations of the oxidized forms of nitrogen were plotted against the concentrations of ammonium nitrogen they had a negative linear correlation ($r = 0,57$, $p < 0.1\%$). On the other hand when the pairwise nitrate and ammonium nitrogen concentrations were compared against each other they did not correlate

linearly, but curvilinearly; low nitrite values occurring both on the highest and the lowest ammonium nitrogen concentrations and the highest nitrite concentrations occurring on middle concentrations of ammonium.

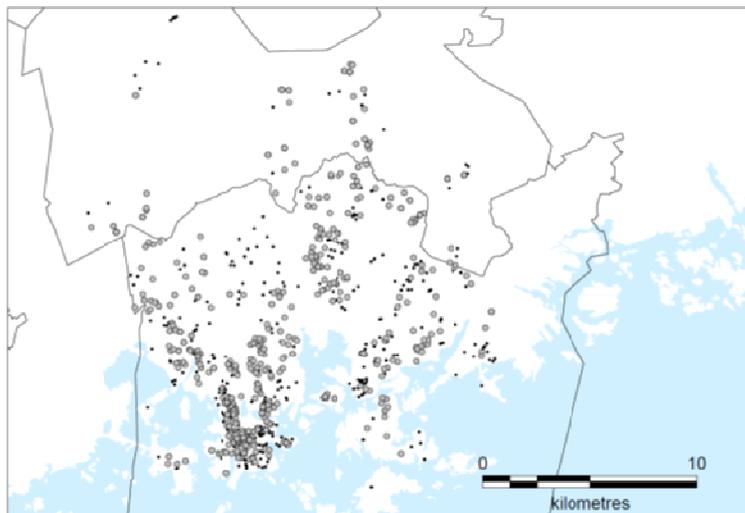


Figure 1. The extent of nitrification in the DWDNs of Helsinki and Vantaa. Grey dots show a nitrite concentration above $0,05 \text{ mgN l}^{-1}$ and black small dots concentration below 0.05 mgN l^{-1} .

The branch mentioned above was scrutinized further because it provided a rare area; the branch started at the Pitkälkoski WTP and led via Kaivoksela, Myyrmäki, Rajatorppa and Keimola to Seutula in a relatively simple form without receiving waters from other branches. The reactions of nitrogen fractions could be observed in a linear fashion and the changing of each nitrogen compound into other compounds could be seen clearly without interfering effects.

It was found out that nitrite concentrations peaked at the distance of 4-6 km from the WTP when the distance was measured via the DWDN. They started at low concentrations at the WTP and reached the maximum median of 0.073 mgN l^{-1} (5%-95% fractiles: $0.040\text{-}0.099 \text{ mgN l}^{-1}$) at the distance of 5.9 km from the WTP. Clearly the concentration of nitrite depended on the concentration of the substrate of its formation reaction; ammonium. When ammonium was substantial, it was available for the nitrite formation reaction and nitrite concentrations started to rise. On the other hand when ammonium concentrations were low, nitrite was not forming at the same rate as on the highest ammonium concentrations and the nitrate formation started to limit nitrite concentrations finally leading to nitrite concentrations below the detection limit at the distance of 17.0 km from the WTP.

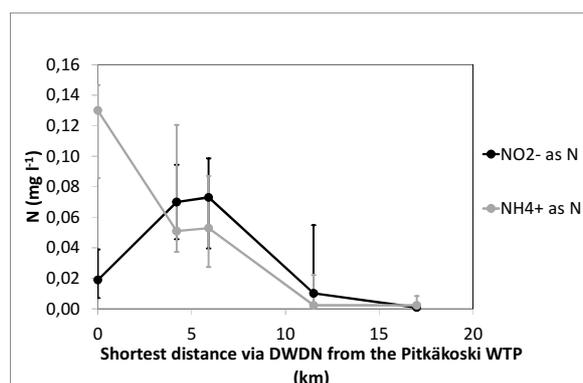


Figure 2. Ammonium and nitrogen concentrations as a function of the distance.

The choice of using low concentrations of chloramine in disinfection of the drinking water thus has led to relatively low nitrite concentration in Helsinki and Vantaa. Even the highest nitrite concentrations did not exceed the statutory limit, $0.5 \text{ mg l}^{-1} \text{ NO}_2^-$ ($0.15 \text{ mg l}^{-1} \text{ N}$, VVY, 2009) the average of NO_2^- concentrations being 0.15 mg l^{-1} and maximum 0.42 mg l^{-1} . On the other hand, the previous limit of nitrite concentrations in drinking water, $0.1 \text{ mg l}^{-1} \text{ NO}_2^-$, which is still in use in e.g. Denmark (Danish Environmental Ministry, 2014) was exceeded in 72 % of the analyzed samples.

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Microclimates Created by Two Different Solar Power Plant Technologies

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Solar power plants are known to be renewable energy and their environmental impact is considered to be minimal especially in dry deserts. We studied two power plants in the world's driest desert, Atacama Desert, in Chile. We compared two Photovoltaic technologies to know what kind of microclimate they create and which has a lower impact on ground moving arthropods composition. The study aims to investigate what kind of changes solar power plants cause in Atacama Desert environment.

Fixed solar power plant was in the valley of Copiapó (Atacama region) and solar tracking system was in Pozo Almonte (Tarapacá region). Fixed table creates more constant shadow below the panel unlike moving table where the shadow is moving both sides of the panel and only few hours during the midday the shadow is below the panel and so the microclimate that they create are very different. Some arthropod groups were affected by the change in microclimate in both solar power plants, but more groups were affected in fixed table system compared to their control areas. Therefore, we concluded that the solar tracking system might have a smaller impact on Atacama Desert arthropods than fixed tables, although future studies are necessary to confirm the preliminary results.

Multixenobiotic resistance efflux activity in *Daphnia magna* and *Lumbriculus variegatus*

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Multixenobiotic resistance (MXR) is a phenomenon in which membrane-bound ATP-binding cassette (ABC) family proteins transfer harmful compounds out of cells. The MXR activity works as a first line against xenobiotics by keeping the intracellular concentration of these compounds low. MXR activity affects both bioaccumulation and toxicity of chemicals, and therefore modulation of the activity may have ecotoxicological consequences. *Daphnia magna* and *Lumbriculus variegatus* are model species in aquatic ecotoxicology, but the presence and activity of the MXR system have not been well described in these species. The aim of this work was to study the presence, activity, and inhibition of ABC transport proteins in *D. magna* and *L. variegatus*. The presence of *abcb1* and *abcc* transcripts in 8 - 9-day-old *D. magna* was investigated by qRT-PCR. The activity of MXR in *D. magna* and *L. variegatus* was explored by influx of the fluorescent ABC protein substrates rhodamine B and calcein-AM, with and without the model inhibitors verapamil (unspecific ABC inhibitor), reversin 205 (ABCB1 inhibitor) and MK571 (ABCC inhibitor). Juvenile *D. magna* possessed all examined *abcb* and *abcc* transcripts, but only reversin 205 inhibited MXR activity. The MXR activity in *L. variegatus* was inhibited by MK571, and to a lesser extent by verapamil, whereas reversin 205 seemed to stimulate the transport activity. Calcein-AM worked better as an MXR substrate in *D. magna*, but rhodamine B was a better substrate for *L. variegatus* MXR activity measurements. As the substrate and inhibitor specificity seems to differ greatly between these species from different phyla, it is likely that also xenobiotics in nature will act differently as substrates and inhibitors of the MXR system in these species.

Photochemical decomposition of iron-binding ligands in large rivers

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This study examined solar radiation-induced photochemical decomposition of iron-binding ligands in water samples collected from ten large rivers. In order to quantify the amount of iron bound on DOM sensitive to photochemical decomposition, sterile-filtered river waters were irradiated with simulated solar radiation as long as chromophoric dissolved organic matter (CDOM) was photobleached completely. Following the photochemical destruction of CDOM, the concentration of dissolved (<0.2- μ m) iron associated to DOM decreased to less than half of the original concentration in most rivers when quantified as the concentration of iron passed through a cation exchange resin. Photochemical decomposition of CDOM influenced little the concentration of dissolved iron in samples collected from Ganges-Brahmaputra and Yangtze. In these rivers, both the concentration of iron and CDOM were the lowest among the river examined. The high concentrations of dissolved iron were related to high concentration of CDOM, but after the photochemical decomposition of CDOM, the concentrations of dissolved Fe decreased to low values similar to found in Ganges-Brahmaputra and Yangtze. The results indicate that photochemical decomposition of iron-binding CDOM results in the flocculation of iron in the coastal ocean.

Sediment Cu bioavailability – the use of diffusive gradient thin films (DGT) and the effects of chitosan amendment

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Metal bioavailability is a factor that is usually connected to metal toxicity in water environments. Bioavailability evaluation and the possibilities to reduce the bioavailability of metals are important in risk assessment and development of new remediation methods.

We used diffusive gradient thin films (DGT) a) to observe bioavailable fraction of Cu in sediment, b) to study metal bioavailability reducing effects of chitosan amendment in Cu-spiked natural sediment and c) evaluate the toxicity of copper and/or chitosan.

Natural lake sediment (Parkkimajärvi) in Finland was chosen for this study. ICP-MS was used for metal analysis. Possible toxicity was tested with 28-day reproduction and growth experiment using *L. variegatus*. Sediment was spiked with 25-410 mg/kg dw Cu and with 0; 0.5 and 5 % dw chitosan. In the first experiment, DGT concentrations correlated with total Cu concentrations. It indicates that in this sediment, DGT can be used for determining reactive concentrations of Cu. DGT showed that chitosan adsorbed bioavailable copper (410 mg/kg dw) in chitosan concentrations of 0.5 (32 % reduction) and 5 % (87 % reduction). Based on the DGT, chitosan was effective in binding copper in this slightly acid sediment (pH 5-6), but it did not reduce the bioavailability, which was shown in the accumulation of Cu into *L. variegatus*. Chitosan also had adverse effects on the biomass of *L. variegatus*.

FullereneC₆₀ loading interferes of the growth and emergence rate of the Midge *Chironomus riparius*

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The suitability of test methods for use with nanomaterials is a topic of significant research interest. There are several uncertainties when assessing nanomaterials, such as fullerene(nC₆₀), potential toxicity to aquatic invertebrates because of their unique chemical properties which substantially differ from those of hydrophobic organic chemicals and dissolved metals. Aims of this study were to investigate the method for measuring the body residues on *Chironomus riparius* and to study if sediment associated fullerene had an impact on larval development and emergence rate. A benthic invertebrate *C. riparius* larvae were exposed to nC₆₀ with two different exposure methods; 1) masses in the sediment top layer creating an environmentally realistic method and thus simulating a sensitive exposure route for *C. riparius* feeding habits and 2) using fullerene spiked sediment which is commonly used method in ecotoxicology. Body residues after acute and chronic exposures were analysed and larval growth and development rate assessed. Body residues were lower in the exposure method 1 after 15 d exposure than after 10 d which may stem for changing in behaviour of larval feeding habits during the development time or possibly after 10 d larvae have reached steady state. Using the exposure method 2, larval growth and emergence rate were affected by fullerenes. Findings indicated that presence of fullerene interferes organisms even at the lower end of tested concentrations (method 2, 0.5 mg/kg). Overall, these results pose that there is possible ecotoxicity towards benthic organisms that fullereneC₆₀ may cause leading changes in ecotoxic parameters used here.

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