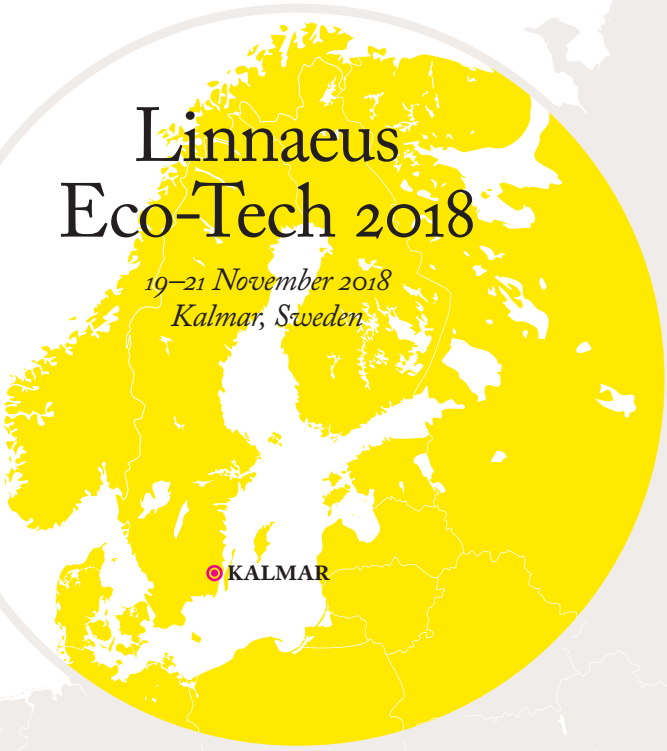
Linnaeus Eco-Tech 2018

19–21 November 2018
Kalmar, Sweden



Book of Abstracts

The 11th International Conference on
Establishment of Cooperation
between Companies and Institutions
in the Nordic Countries,
the Baltic Sea Region and the World.

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Linnæus University

BOOK OF ABSTRACTS

LINNAEUS ECO-TECH 2018

INTERNATIONAL CONFERENCE
ON
NATURAL SCIENCES AND TECHNOLOGIES
FOR

WASTE AND WASTEWATER TREATMENT
REMEDIATION
EMISSIONS RELATED TO CLIMATE
ENVIRONMENTAL AND ECONOMIC EFFECTS

The Eleventh International Conference on the Establishment of Cooperation between Companies and Institutions in the Nordic Countries, the Baltic Sea Region, and the World

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PREFACE

The Baltic Sea catchement area covers approximately 1.8 million km^2 and encompasses 14 countries of which nine borders the Baltic Sea. In the end of the 1990s, big gaps existed in terms of economic development among the countries in the region. Nevertheless, a strong sense of historical connection established during centuries demanded action to reduce this gap. 1997 to 2016, these differences have levelled, and the distances are shortened mainly thanks to the development of new communication systems. In 1997 the City of Kalmar celebrated the 600^{th} anniversary of the Union between the Nordic countries and the first Kalmar Eco-Tech Conference was organized. One of the main goals of the University of Kalmar (HiK) in Sweden was to promote research and education-cooperation towards sustainability among the countries around the Baltic Sea. The strategy established by HiK to reach this goal was through close cooperation with trade and industry. The Kalmar Eco-Tech conferences embraced both the goal and the strategy. Kalmar Eco-Tech was renamed Linnaeus Eco-Tech. The conference has been held every second year but for 2010 when Kalmar University and Växjö University were merged into the new Linnaeus University. 20 years have passed since the start and we might feel that we have not done enough for the environment and not met the goals for sustainability. Can we ensure that the pollution-load to air, soil and water is decreasing? If not, what can we do better in the future? How can we improve our message to the new generation and recruit youngsters to become environmental engineers and scientists that will do better in the future?

The main objective of Kalmar Eco-Tech through the years has been to promote cooperation between the academia, trade and industry in the Baltic region and expand clean technology by engaging companies, industries, city engineers and administrators. The most important goal has been to solve the existing environmental problems through technological solutions and new ways of thinking, producing, consuming and recycling/reuse. It has become evermore obvious that the environmental issues have rised from local through regional to global concern. Pollution has an evermore transboundary nature and affects everyone. Therefore, the Kalmar Eco-Tech themes changed by time (**Figure 1**). Particularly since 2005, the Conference has been open not only to the Baltic region but to the whole world. During the last decades the global warming and CO_2 emissions have been hot topics, not only among scientists but also among politicians and the society. During Eco-Tech' 07 special attention was devoted to gaseous emissions related to climate changes and renewable energy from waste. **Table 1** shows some events connected to Kalmar Eco-Tech with participation of Linnaeus University and the previous University of Kalmar. One activity to highlight is the Youth Environmental Conference Ecobaltica that has been held in Saint Petersburg every second year since 1996 in cooperation with the Assembly of Young Scientists of St. Petersburg, the State Committee on Higher Education of the Russian Federation, the City Administration of St. Petersburg, St. Petersburg State Technical University, Russia and 2016 in Moscow the Federal Agency for Scientific Organizations (FASO). During the years, this conference has been devoted to youngsters by opening possibilities for undergraduate and graduate students from the Baltic region countries to present their theses and academic projects, to meet senior researchers and representatives from trade and industry and develop business and academic skills.

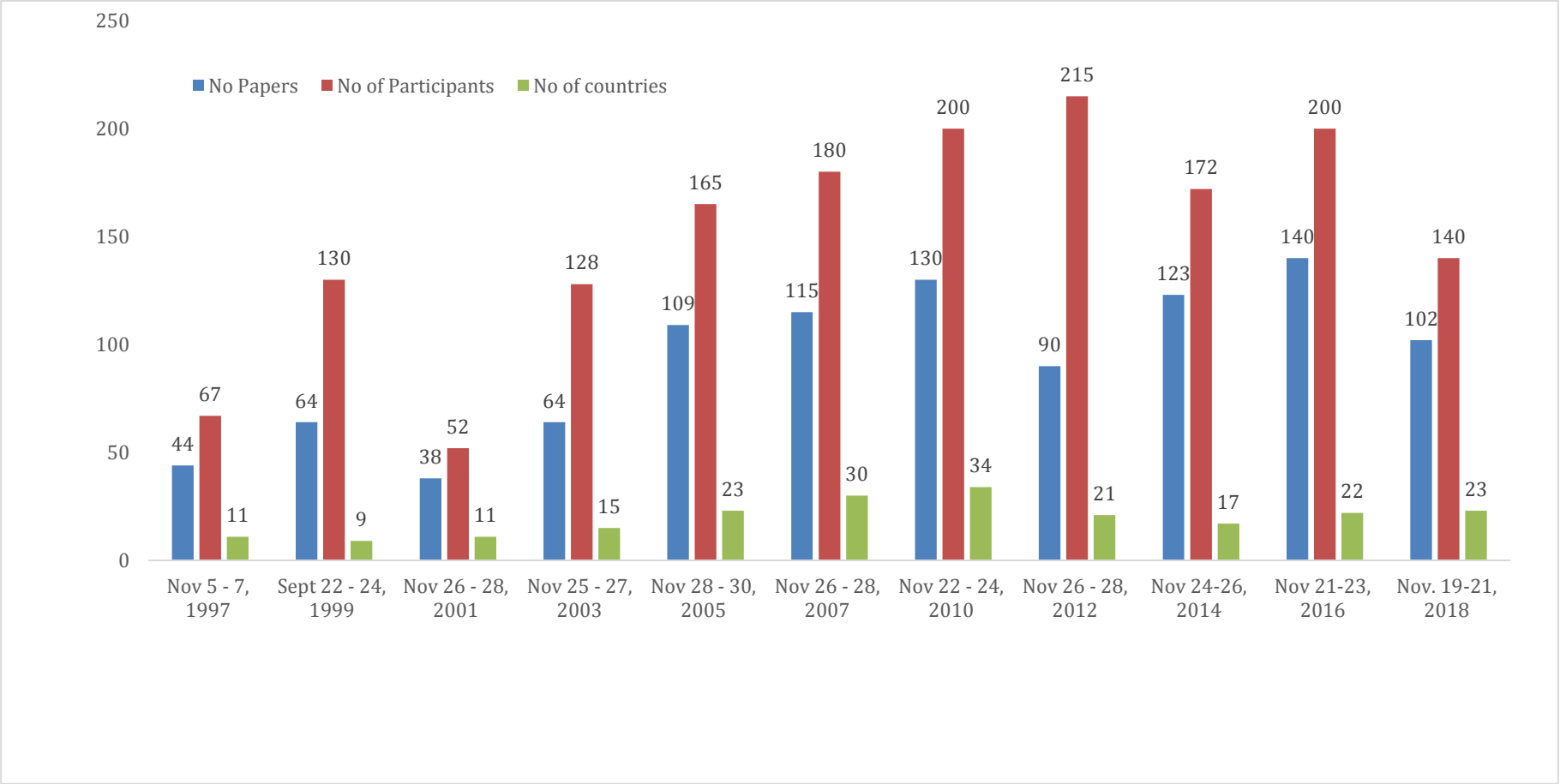

Figure 1. Kalmar ECO-TECH' 1997, 1999, 2001, 2003, 2005, 2007, 2010, 2012, 2014, 2016 and 21. The number of different papers, participants and countries are given.

Table 1. Events organized during 1996-2018 related to the sustainable development in the Baltic Sea Region, mostly in cooperation with Kalmar or Linnaeus University.

Year	Activity	Main institutions and persons involved
1996	The idea about Kalmar Eco-Tech arises	Åke Erlandsson AB Gustaf Kähr and William Hogland University of Kalmar
5-7 Nov. 1997	The 1st Kalmar Eco-Tech Seminar on Waste Management and the Environment was organized, to be held every second year in Kalmar	Head of Department of Technology, Göran Borgö and William Hogland, University of Kalmar
1998	Cooperation agreement on International Youth Environmental Conference Ecobaltica to be held every second year in St. Petersburg, Russia	William Hogland University of Kalmar and Vasilii Rud St. Petersburg State Technical University, Russia
5-7 Jun, 1998	The Ecological Symposium, Gdansk, Oruma, Poland	Piotr Kowalic, the Technical University of Gdansk, Poland
22-26 Jun, 1998	The Youth Environmental Conference Ecobaltica´98, 22-26 June 1998, St. Petersburg, Russia	Vaslii Rud and William Hogland. State Committee on Higher Education of the Russian Federation, the City Administration of St. Petersburg, St. Petersburg State Technical University, Russia
1998	Cooperation agreement between Kalmar University and St. Petersburg State Technical University (renewed since then)	Vice Chancellor Örn Taube, Professor William Hogland, Vaslii Rud St. Petersburg State Technical University
2-20 Nov 1998 11-17 Apr, 1999	Advanced International Training Programme, Sida Course in" Solid Waste Management in Eastern Europe": Part 1 in Stockholm, SWECO, Sweden; Part 2 in Yalta, Ukraine	SWECO, Stockholm
26-29 Nov, 1998	The 5th Danish-Polish Workshop on "Biofuels", Ecological Education Center, Starbienino, Poland	Poitr Kowalic the Technical University of Gdansk, Poland, Roskilde University Centre, Denmark and Free University of Berlin, Germany
2-27 Aug, 1999	International Course Agenda 21: Planning and Management for Sustainability in the Baltic Sea Region	University of Kalmar
22-24 Sept. 1999	Kalmar Eco-tech´99, The 2nd Seminar on Establishment of Cooperation between Companies/Institutions in the Nordic Countries and the Baltic Countries	Professor William Hogland and his Team at the University of Kalmar
2-5 Dec, 1999	The 6th Danish-Polish Workshop on "Biomass for Energy", Starbienino, Poland	Technical University of Gdansk, Poland, Roskilde University Centre, Denmark, Free University of Berlin, Germany, Poitr Kowalic, William Hogland
14-15 Dec, 1999	Seminar on "New Environmental Technology for Processing Landfill Leachate", Siauliai, Lithuania	Dr Lennart Mårtensson, University of Kristianstad, Sweden
25-29 Jun, 2000	The 1st International Workshop of the Baltic Test Team: Global International Waters Assessment-GIWA UNEP/GEF	GIWA UNEP/GEF, University of Kalmar, Marcia Marques and William Hogland
26-30 Jun, 2000	The Youth Environmental Conference Ecobaltica´00, St. Petersburg, Russia	Vaslii Rud, International Director and co-organizer William Hogland; State Committee on Higher Education of the Russian Federation, the City Administration of St. Petersburg, St. Petersburg State Technical University, St. Petersburg, Russia
12-16 Aug, 2000	The 2nd International Workshop of the Baltic Test Team: International Global International Waters Assessment-GIWA UNEP/GEF	GIWA UNEP/GEF, University of Kalmar, Marcia Marques and William Hogland
7-10 Dec, 2000	the 7th Danish-Polish Workshop on "Biomass for Energy", Starbienino, Poland	Technical University of Gdansk, Poland, Roskilde University Centre, Denmark and Free University of Berlin, Germany, Piotr Kowalic, William Hogland
18-20 Dec 2000	The 3rd International Workshop of the Baltic Test Team: Global International Waters Assessment-GIWA UNEP/GEF	GIWA UNEP/GEF together with Professor William Hogland and Marcia Marques
17-18 Sep, 2001	The First International Symposium: Environmental Problems in the Baltic Region States, Environmentally Friendly Treatment Technology for Waste Water in the Baltic Sea Region, Šiauliai, Lithuania	Dr Lennart Mårtensson University of Kristianstad, Sweden

26-29 Sep, 2001	The First Baltic Symposium on Environmental Chemistry	Professor Toomas Tenno, University of Tartu, Estonia
26-28 Nov. 2001	Kalmar Eco-tech´01 Leachate and Wastewater Treatment with High-tech and Natural Systems	Professor William Hogland and his Team at University of Kalmar
21-25 Oct, 2002	The Youth Environmental Conference Ecobaltica 02, St. Petersburg, Russia	Vaslii Rud, International Director and William Hogland; State Committee on Higher Education of the Russian Federation, the City Administration of St. Petersburg, St. Petersburg State Technical University, St. Petersburg, Russia
22 Oct, 2002	Sustainable Water Treatment and Water Quality Control Systems: Leachate Treatment from MSW and Industry Landfills; The 2nd Workshop "Sustainable Leachate and Waste Water Management using High-tech and Natural Systems"	William Hogland, Kalmar University and St. Petersburg State Polytechnical University (SPbSPU), St Petersburg, Russia
11-13 Apr, 2003	Decision Making in Water Management Network	Institute of Ecology, Tallinn, Estonia
12-15 Jun, 2003	The 8th Danish-Polish Workshop on Biomass for Energy, Starbienino, Poland	Professor Piotr Kowalic, the Technical University of Gdans, Poland, Roskilde University Centre, Denmark and Free University of Berlin, Germany
28 Nov, 2003	The gender perspective "Women in Technology with focus on Bioremediation and Leachate Treatment in the Baltic Region"	William Hogland, University of Kalmar
25-27 Nov. 2003	Kalmar Eco-tech´03 Bioremediation and Leachate Treatment – The 4 th International Conference on the Establishment of Cooperation Between Companies and Institutions in the Nordic Countries and the countries in the Baltic Sea Region	Professor William Hogland and his Team at University of Kalmar
16-18 Jun, 2004	The 5th Youth Environmental Forum Ecobaltica ´2004, St. Petersburg, Russia	Vaslii Rud, International Director and William Hogland; State Committee on Higher Education of the Russian Federation, the City Administration of St. Petersburg, St. Petersburg State Technical University, St. Petersburg, Russia.
2-24 Sep, 2004	International Conference "Strengthening Academic Cooperation in Environmental Issues in the Nordic and Baltic Sea Region", Uppsala, Sweden	St. Petersburg State University for Engineering and Economics (Engecon) and the Swedish University of Agricultural Sciences (SLU)
6-10 Oct, 2004	International PhD course Solid Waste Management in the Nordic Countries and St. Petersburg.	Esa Marttila and Mika Horttanianen, Lappeenranta University in Finland, Vadim Chekalin, St. Petersburg State University of Engineering and Economics, Russia and William Hogland, University of Kalmar
4-5 Oct, 2005	Seminar and Study Visit in Kalmar for the Young Scientist Delegation from St. Petersburg Polytechnic University, Russia	William Hogland for the Royal Swedish Academy of Engineering Sciences
2002-2004	The Baltic Sea Network for Leachate and Wastewater Treatment with emphasis on High-tech in Combination with Nature Based Systems	William Hogland, University of Kalmar and Felix Stolberg at the Kharkov State Academy of Municipal Economy, Ukraine
2004-2007	The Baltic Sea Region-Ukrainian Network on Bioremediation and Treatment of Leachate from Landfills with Emphasis on Persistent Organic Compounds	William Hogland, University of Kalmar and Felix Stolberg at the Kharkov State Academy of Municipal Economy, Ukraine
2004	Education cooperation on Master Course in Environmental Engineering with researchers and teachers at the Danish Technical University in Danmark, Telemark College in Norway; University of Kalmar	Rune Bakke, Telemark University College in Norway
28-30 Nov, 2005	Kalmar Eco-tech´05 Waste to Energy, Bioremediation and Leachate Treatment, The 2nd Baltic Symposium on Environmental Chemistry; the First Kalmar Nanotechnology Workshop	Professor William Hogland and his Team at University of Kalmar and The European Association for Chemical and Molecular Sciences, the Swedish Chemical Society and the Trans Regional Network NanoGrowth (together with Dr Bo Carlsson)
26-28 Jun, 2006	The 6th International Youth Environmental Forum of Baltic Region Countries Ecobaltica 2006, St. Petersburg, Russia.	Vaslii Rud, International Director, William Hogland, State Committee on Higher Education of the Russian Federation, the City Adm. of St. Petersburg, St. Petersburg State Technical University, Russia

28 Jun, 2006	Establishment of the "Baltic Scientific Ecological Centre"	Professor William Hogland, University of Kalmar
21-25 Aug, 2006	Susbus project Workshop: European Project _ JEP-23100-2002 “Developing Sustainable Business Patterns in Ukraine”	Felix Stolberg Kharkov State Academy of Municipal Economy, Ukraine; Pekka Peura, Levon Institute, Finland, William Hogland and Marcia Marques, University of Kalmar
26-28 Nov. 2007	Kalmar Eco-tech 2007, The 6 th International Conference on Technologies for Waste and Wastewater Treatment, Energy from Waste, Remediation of Contaminated Sites, Emissions Related to Climate	Professor William Hogland and his Team at University of Kalmar. 10 yr Anniversary of the conference.
26-28 June 2008	The International Youth Science Environmental Forum Ecobaltica 2008	Michael Fiodorov, Vaslii Rud, International Director, William Hogland; St. Petersburg State Polytechnic University (SPbSPU), Ecology Laboratory of Baltic Sea Region, Russia
2007-2009	Joccow – Joint capacity building concerning waste management,	Partners: The Municipality of Kalmar (Sweden), Kaliningrad City Hall, Municipal Institution Environmental Centre «ECAT-Kaliningrad», Kaliningrad State Technical University, Municipal enterprise «Chistota», University of Kalmar (Sweden), Association for Waste Management (Sweden)
7 Oct. 2008	Seminar within the Joccow Project, Kaliningrad, Russia. Speaker on “Perspective for improving the system of waste management”.	See above
2010-2012	Sustainable innovations and treatment in industrial wastewater clusters (STInno), 2010-2012, EU FPT- Regions 2009	Regional Council of Kalmar county – Linnaeus University (Prof William Hogland with a consortium research also from Finland, Greece, Italy, UK)
22-24 Nov. 2010	Linnaeus Eco-Tech 2010 – The 7th International Conference on Establishment of Cooperation between Companies and Institutions in the Nordic Countries and the World.	Professor William Hogland and his Team at the Linnaeus University
Sept 29 – Oct 1, 2011	The International Youth Science Environmental Forum Ecobaltica 2011	Michael Fiodorov, Vasiliy Rud, International Director, William Hogland; St. Petersburg State Polytechnic University (SPbSPU), Ecology Laboratory of Baltic Sea Region, Russia
2011-2012	Nova-FoU project – “Pre-study for Sediment Mining and Remediation in Oskarshamn Harbour”	Professor William Hogland and his team at the Linnaeus University. Partnership with the Municipality of Oskarshamn.
2011-2013	Strukturfonder - Regionförbundet –EU project – “Plattform for Triple Helix Cooperation on Industrial Water Handling in Småland Region and the Islands” based on the KK-Foundation project “Integrated Approach for Industrial Wastewatr and Stormwater Management in Wood-Industry sector”.	Environmental Science and Engineering Group under supervision of Prof William Hogland in cooperation with the business sector consisting of five companies. The project has been a cooperation also between Kalmar Municipality and Ann-Christin Bayard from Sustainable Southeast Sweden AB (network of 21 companies) that has been working as an intermediate between academia and the industries.
2011-2013	Sida – Project “The Triple Helix Concept applied in the Baltic Sea Region”.	Professor William Hogland with the Environmental Science and Engineering Group. The project aims to teach undergraduate students the Triple Helix concept in the Baltic region and to increase cooperation between countries, focusing on water treatment in wood industry.
2012-2015	Swedish Institute – Project “Closing the Life-cycle of Landfills – Landfill Mining in the Baltic Sea Region for Future”	Linnaeus University (Swe), Riga Technical University (Latvia), Estonian University of life Sciences (Est), University of Padova (Italy), St. Petersburg State Polytechical University (Rus), Waste Management Association of Latvia, Estonian Waste Management Association, RGS 90 (Swe), Saarema Landfill AB (Estonia), GLT Norway, Waste Management Association of Norway, LundaHydro AB (Swe), Avfall Norge (Norway).
2012	Linnaeus Eco-tech 12, – The 8th International Conference on Establishment of Cooperation between Companies and Institutions in the Nordic Countries and the World.	H.M. King Calr XVI Gustaf opens the conference and the participated the study trip. Professor William Hogland and his Team at the Linnaeus University organisers.

2012-2013	Vinnova – Project "Integrated Waste Management Technology for Effective Biogas Production". This project is a cooperation between the academic sector and industries from Sweden and Brazil.	Linnaeus University (Swe), Rio de Janeiro Federal University (Bra), Rio de Janeiro State University (Bra), Essencis (Bra), Institute of Water Problems and Land Reclamation NAAN (Ukr), SP Technical Research Institute of Sweden, Läckeby Water Group, JOAB, Wastec, Kalmar Sund Region Waste Management Company, Sustainable Sweden Southeast, Mindmancer AB, LundaHydro AB, Flexus Balasystem AB
2013	February 2013: International PhD course in Landfill Mining, in Estonia	Organisers: William Hogland, Linnaeus University; Mait Kriipsalu Estonian University of Life Sciences; Gintaras Denafas, Kaunas University of Technlogy
	Seminar and Closure ceremony of the Kudjape landfill, Estonia (2013-09-18)	Official persons from Swedish EPA, Swedish Institute; William Hogland Linnaeus University; Estonian Minister of Environment; Mait Kriipsalu Estonian Uni of Life Sciences; MoE, Estonia; Latvia Waste Mangement Association; Kyiv Nat. University the Federal Agency for Scientific Organizations (FASO)
	International seminar „Waste Dumpsite Recovery – Challenges for Latvia and Experiences of Europe Countries" Tuesday, 2013. 10th December, Riga, Latvia	Organizing: "Waste Management Association of Latvia" (LASA) in cooperation with Environment Protection Department, the Ministry of Regional Development and Tekniska Verken, Linnaeus University, RGS 90, LundaHydro AB
	Landfill Mining project Vika Landfill seminar, Katrineholm (2013-04-25)	Tekniska Verken, Linnaeus University, RGS 90, LundaHydro AB
24-26 Nov. 2014	Linnaeus Eco-tech 14, – The 9th International Conference on Establishment of Cooperation between Companies and Institutions in the Nordic Countries and the World.	Professor William Hogland and his Team at the Linnaeus University
2014	Erasmus visits and International seminar "Landfill mining in the context of global environmental mitigation" Department of Environmental Technology, Kaunas University of Technology, Kaunas, Lithuania 06-11.04.2014	Organisers: Gintaras Denafas, Kaunas University of Technlogy, William Hogland, Linnaeus University; Mait Kriipsalu, Estonian University of Life Sciences others were Kyiv National T. Shevchenko University and Lappeenranta University of Technology
	Seminar on Landfill mining, Sätra Gård, Sweden 23 april 2014	Ragnsells and Linnaeus University
	International PhD course in Landfill mining I (21-25/4) – II (24 July), Sätra gård, Sweden, 2014	Ragnsells, Linnaues University and Estonian University of Life Sciences
2015	The Elsevier Atlas Award was delivered 28 May 2015 in the Netherlands	The Elsevier Atlas Award for "Research for a better world" article "Solid waste management challenges for cities in developing countries" by Lilliana Abarca Guerreroa, Eindhoven University of Technology and Costa Rica Institute of Technology, Ger Maasa, Eindhoven University of Technology, and William Hogland, Linnaeus University, (doi: 10.1016/j.wasman.2012.09.008).
	International Summer School on Waste Management and Circular Economy, 9 June to 12 June 2015, Lappeenranta FINLAND	Organised by: Mika Horttanainen LUT Environmental Technology, Finland; William Hogland, Linnaeus University, Sweden; Mait Kriipsalu, Estonian University of Life Science, Estonia
	Mining in Sludge Landfill: characterization of sludge from drinking water treatment, and metal extraction (PhD Course). SWEDEN, June 12–18, 2015.	Organised by: William Hogland, Linnaeus Universtiy and Kenneth. M. Persson, Lund University, Sweden and Sydvatten; Mait Kriipsalu, Estonian University of Life Sciences (EMU); Estonia

	Landfill Mining and waste characterisation. Estonia (PhD course), June 18-22, 2015**.**	Organised by: Kaunas University of Technlogy; William Hogland, Linnaeus University; Mait Kriipsalu, Estonian University of Life Sciences
	The PhytoTech Park Project, 9th Ocotober 2015, the Glass Factory, Boda Glasbruk, Sweden	Kick off seminar for the international project: Phytoremediation park for treatment and recreation of glassworks contaminated sites, sponsored by the Swedish Institute
21-23 Nov. 2016	Linnaeus Eco-tech 16, – The 10th International Conference on Establishment of Cooperation between Companies and Institutions in the Nordic Countries and the World.	Professor William Hogland and his Team at the Linnaeus University
2016-2019	Interactive Water Management - IWAMA	Interreg Batlic Sea Region project
2016-2020	Life Sure- Sediment uptake and Remediation on Ecological Basis	Life Environment and Resource Efficiency project
2016	Bova Intensive Master Course Waste to Resource in Baltic States in 2020 24-29 April 2016, Estonia	Organised by ASU (Kaunas), LLU (Jelgava), EMU (Tartu) and Linnaeus University Sweden
	International Scientific-Practical Conference Modern Engagering Technologies and Environmental Protection 19-20 May 2016, Kutaisi, Georgia	Akaki Tsreteli State University, Kutaisi, Georgia
	International Science Environmental Conference Eco-Baltica, Moscow, Russia, 21 October 2016	Organised by Alexey Glynushkin, William Hogland, Vasiliy Rud at the Federal Agency for Scientific Organizations (FASO)
2017	Sweden Impact Award 2017 for the Triple Helix cooperation on industrial water handling in Småland and the Islands based on a KK-project.	The research project "Integrated approach for Industrial Wastewater and Stormwater Management in Wood-Industry Sector Phases I and II" got the **Sweden Impact Award 2017** in the category "Physical Sciences & Engineering" 12-13 June in Stockholm 2017 given by AESIS, Network for advancing & evaluating the societal impact of science.
2017-2020	RBR – Reviving Baltic Resilience	Interreg South Baltic project
	EcoBaltica August 2017. Grodno, Belarus.	Organisers: Vasilli Rud and William Hogland
	Phyteco 1. Glass Mining and Phytoremediation Baltic Sea Region. Swedish Institute funded course – Glass Mining in Practice (4 ECTS). April 6-13, 2017. Sweden, Orrefors.	Organizers and lecturers, supervisors from Lnu – William Hogland, Yahya Jani, Fabio Kaczala, Joacim Rosenlund, Juris Burlakovs
	Phyteco 2. Park design. Swedish Institute funded course. May 2017. Sweden, Orrefors.	Organizers and lecturers, supervisors from Lnu – William Hogland, Yahya Jani, Fabio Kaczala, Joacim Rosenlund, Juris Burlakovs.
	Sand and Glass Symposium 3-4 March 2017, Riga.	Juris Burlakovs. Lecturing and member of Scientific Board
	Pecec. Remediation in Mining Regions. Swedish Institute funded course. November 2017. Estonia, North-east.	Organizers and lecturers, supervisors from Lnu – William Hogland, Juris Burlakovs

19-21 Nov. 2018	Linnaeus Eco-Tech 18, – The 11th International Conference on Establishment of Cooperation between Companies and Institutions in the Nordic Countries and the World.	Professor William Hogland and his Team at the Linnaeus University
2018	Knowledge and Circular Economy. International Bova and Swedish Institute supported course, April 2018. Pärnu, Estonia. Clay and Ceramics conference 2018: Applications, Mineralogy and Geology. February 3-4, 2018, Riga. Bova Intensive MSc Course: Application of Circular Economy Principles in Landfills, 16-20 April 2018 IWAMA 5th International Capacity Development Workshop, 13-15 June 2018, Kalmar, Sweden Agenda 2030, 23 August 2018 IWAMA 6th Workshop, 20-21 September 2018, Gdansk. Poland PECEC Closing Workshop and Lasuwama Opening Workshop 22-26th September, 2018 Baltic Cleasn Technology Conference for Sustainable Solutions, 17-18 October 2018, Szczein, Poland	Co-organizers and lecturers, supervisors from Lnu – William Hogland, Juris Burlakovs Lecturing and Member of Scientific Board from Lnu J. Burlakovs Bova University Network, Estonian Univeristy of Life Sciences, Latvia University of Agriculture, Linnaeus University, RWTHAachen University IWAMA Interreg Baltic Sea Region in Cooperation with LNU and Kalmar Vatten. Topic workshop: Nutrient reduction and recovery Organiser Kalmar-Öland UN-association and the Environmental Political Party in Mörbylånga, Öland IWAMA Interreg Baltic Sea Region Organisation Lnu and Akaki Tseretal State University, Kutaisi, Gerogia. Swedish Institute project. Prof. William Hogland keynote speaker, www.baltic-clean-technology.com

During the Linnaeus Eco-Tech 2014 the Triple Helix concept became even stronger and the concept "Beyond the Zero Waste" was introduced which encourages recovery of all materials lost during the entire life cycles of different products manufactured, and which are still available in different sinks (landfills, sediments of rivers, ocean, etc.). All waste, materials and chemical compounds lost as sludge, slag, harbor sediments and others can, in principle, be returned to the anthropogenic loops and the toxics substances could be removed from the circuits and handled in an environmentally-friendly way. The long-term goal is to apply such innovative approaches in an environmentally and economically efficient way, making use of the accumulated knowledge, including reuse and/or recycling of materials bound in urban and rural structures. This time many thanks goes to the administrative secretary Jelena Lundström, the staff of the Envrionmental Science and Engineering Research Group: Fabio Kaczala, Joacim Rosenlund, Yahya Jani, Parisa Hassanzadeh and Ann-Christin Bayard from Sustainable Sweden South East making it possible to organise the workshop in Swedish "Remediation of Oskarshamn harbor – New knowledge and new possibilities.

During these years of Kalmar Eco-Tech, many influential persons have contributed to make the conference possible. I would like to acknowledge Prof. Vasiliy Rud, St. Petersburg State Polytechnical University that has cooperated organizing both Kalmar Eco-Tech in Kalmar and Ecobaltica in St Petersburg. The idea behind Kalmar Eco-Tech was originally formulated together with Åke Erlandsson, Environmental Manager at AB Gustaf Kähr in Nybro. The first Conference in 1997 was possible thanks to Göran Borgö and Göran Johansson, both former heads of the Department of Technology, University of Kalmar. The first conference also

received valuable support from the former Mayor of Kalmar Anders Engström and, during the latest conferences, by his successor, Mayor Kjell Henriksson.

The Region Council in the county of Kalmar, represented by Håkan Brynielsson and his colleagues has also embraced the idea behind the Conference, as well as Jan Hagel, Omvärldskommunikation and the Kalmar County Governor Sven Lindgren and later Stefan Carlsson. During the years, Hans Dahl, Kalmar Vatten och Renhållning and Lars Kylefors, Vatten och Samhällsteknik as well as Ragn-Sells plus the Swedish Association for Waste Management have all worked actively to support the Conference. Bernth Norén at the XL-laboratory, University of Kalmar has helped with ideas to improve the content of the program. Without the financial support of the following institutions, Linnaues Eco-Tech could not be possible: AB Gustaf Kähr, Brofästet Hotel & Conference, E.ON, Flexus Balasystem, IVA – The Royal Swedish Academy of Engineering Sciences, Kalmar Energi, Knowledge Foundation, KSRR, Linnaeus University, Länsstyrelsen Kalmar län, Ragn-Sells AB, Sida – Swedish International Development Cooperation Agency, STINT – The Swedish Foundation for International Cooperation in Research and Higher Education, Sustainable Sweden Southeast AB, Swedish Institute, The Regional Council in Kalmar County, Tillväxtverket – European Regional Development Fund, Vatten och Samhällsteknik, VINNOVA – The Swedish Governmental Agency for Innovation Systems and others.

In 2007, the memorable 10-year celebration, of what is now Linnaeus Eco-Tech, was held. This was the same year as the University of Kalmar celebrated its 30th year Anniversary. Kalmar Eco-Tech' 07 was our humble tribute to it. In the same way Linnaeus Eco-tech 10, 22-24 November 2010 was our tribute to the establishment of the Linnaeus University on 1st January 2010 as a fusion between the University of Kalmar and Växjö University. The Linnaeus Eco-Tech 2012 was an opportunity to strengthen Linnaeus University by moving towards the established goals of internationalization of the Småland Region. In this conference the Triple Helix concept was highlighted but also urban mining, landfill mining, glassmining and harbor mining. H.M King Carl XVI Gustaf was opening the the conference and he showed very big interested in solid waste and water managementand followed the conference participantson the study trip to Moskogens Landfill and to companies as Purac. On behalf of the Linnaeus University, all participants from different countries who during have contributed to this conference, by being active all these years, with new research ideas and willingness to share experience and knowledge with colleagues were acknowledged. In 2012 many thanks goes to H.M. King Carl XVI Gustaf and to Joacim Rosenlund, administrative secretary of the conference, colleagues from Lnu Malin Bolander and Anna Gustavsson and the Environmental Science and Engineering Research Group: Marcia Marques, Fabio Kaczala, Amit Bhatnagar, Eva Kumar, Henric Hansson, Henrik Svensson, Sawanya Laohaprapanon, Muhammad Assim, and in particular also the Local Programme Committee including among others Erik Ciardi, the Region Council in the County of Kalmar, Ann Christin Bayard from Sustainable Sweden South East, Kerstin Linsved, RagnSells and Lars Kylefors, Vatten och Samhällsteknik.

During the Linnaeus Eco-Tech 2014 the Triple Helix concept became even stronger and the concept "Beyond the Zero Waste" was introduced which encourages recovery of all materials lost during the entire life cycles of different products manufactured, and which are still available in different sinks (landfills, sediments of rivers, ocean, etc.). All waste, materials and chemical compounds lost as sludge, slag, harbor sediments and others can, in principle, be returned to the anthropogenic loops and the toxics substances could be removed from the circuits and handled in an environmentally friendly way. The long-term goal is to apply such innovative approaches in an environmentally and economically efficient way, making use of the

accumulated knowledge, including reuse and/or recycling of materials bound in urban and rural structures. This time many thanks were given to the administrative secretary Jelena Lundström, the staff of the Environmental Science and Engineering Research Group (ESEG): Fabio Kaczala, Joacim Rosenlund, Yahya Jani, Parisa Hassanzadeh and Ann-Christin Bayard from Sustainable Sweden South East making it possible to organise the workshop in Swedish "Remediation of Oskarshamn harbor – New knowledge and new possibilities".

Since the conference 2014 the activities in ESEG has been more and more directed into "the Beyond the zero waste" activities and both research and several international PhD courses has been carried out. During one of the PhD courses in Glass mining, 17 nations were represented. The co-operation with Ragnsells, Glafo and Gothenburg Univeristy has increased in the area of Glass mining and Ragnsells is now sponsoring a PhD candidate in glass mining for ESEG. The Glass mining project sponsored by the Swedish Institute Baltic Sea Unit has played an important role in this research area. Landfill mining activies have continued and then in particular in Sweden and Estonia. A new profile of landfill mining was entered in cooperation with Sydvatten for test excavations of landfilled drinking water sludge. An international PhD course was held on field sampling and extraction of Al and Fe from landfill drinking water sludge. The course was carried out in cooperation with Estonian University of Life Sciences, Lund University and Linnaeus University. The project Life Sure – "Sediment uptake and remediation on ecological basis" opened the area of harbor, bay and lagoon mining. The project is carried out in cooperation with Kalmar municipality and Techmarket Sweden AB (TechMarket). This has raised the question on construction of "Bank Account" landfill cell for sorting of fine material fractions as in ash, sludge, bottom sedeiments and polluted soils for later recovery when economic methods for extraction of for instant metals and nutrients will exist. The cooperation with the floor manaufacturer AB Gustaf Kähr is continued and very soon a Demo-plant for treatment of industrial process water and for upgrading of stromwater for industrial use will be implemented in the industry.

During 2016 Jelena Lundström continue to lead the administrative work as project assistant for the conference and the staff of the Environmental Science and Engineering Research Group: Fabio Kaczala, Joacim Rosenlund, Yahya Jani, Richard Mutafela, Juris Burlakovs, Charlotte Marchand, Marco Tadeu Gomes Vianna and also Ann-Christin Bayard at Linnaeus Unviersity as well as Jan Stenis, LundaHydro AB, have played an important role for the organisation of this 20 years Anniversery conference of Linnaeus Eco-tech. Many thanks go to Stina Alriksson editing the Book of abstracts and proceedings.

Phytroremediation projects in cooperation with the local waste management company KSRR were carried out and ended up in a doctoral thesis in beginning of 2017 by Charlotte Marchand. Another doctor degree thesis on the Triple concept was presented already in the beginning of 2017 by Joacim Rosendlund. The Orrefors Phytoremediation/tourist park was constructed with 12 000 visitors already the first summer. Co-operation increased with Jeanette Lennartsdotter, CEO at Orrefors Park, several international MSc/PhD courses were held in Orrefors, and the park was developed further. The international cooperation in the Baltic Sea region was strengthened as Ukraine and Georgia were more involved and Armenia participated.

Yahya Jani became double doctor and now with the thesis "Landfills and Glass Dumpsites as future bank accounts of resources – waste characterization and trace elements extraction" defended on 2 February 2018 at Lnu. Also 2018 Jelena Lundström took the lead of the hard

administrative och organisative work of Linnaeus Eco-tech 18 for the third time since 2014. Yahya was responsible for the editing work of the abstracts and the full papers. Furthermore, Ecobaltica XV-th International Youth Scientific and Environmental Forum of Baltic Region Countries will be held November 29 to December 1, 2018 in Copenhagen.

Thanks to everyone who contributed to making all the events come true!
Thank You Sponsors!

William Hogland

Chairman of Linnaeus Eco-Tech Conference since the auguration
Professor in Environmental Engineering and Recovery (PhD)
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INVITED SPEAKERS AT OPENING CEREMONY

BALTIC SEA UNDERGROUND INNOVATION NETWORK (BSUIN): DEVELOPING THE CAPACITY FOR INNOVATION FOR THE REGION'S UNDERGROUND LABORATORIES

BSUIN team (http://bsuin.eu/)
Presented by Marcus Laaksoharju, for SKB
(Swedish Nuclear Fuel and Waste Management Co.)

Abstract

Six underground laboratories around the Baltic Sea have establish a new 3,3 milj. € EU INTERREG, Baltic Sea Region cooperation project called BSUIN (Baltic Sea Underground Innovation Network). The project is lead from the Oulu University in Finland. The following underground laboratories participate:
• Callio Lab, Pyhäsalmi mine, Finland
• Äspö Hard Rock Laboratory, Sweden
• Research and education mine Reiche Zeche, Freiberg, Germany
• Ruskeala marble quarry and geopark, Karelia, Russia
• Underground Laboratory of Khlopin Institute, St Petersburg, Russia
• Conceptual Lab Development Cuprum, Poland

The aim of the project is to make the underground laboratories in the Baltic Sea region more accessible for innovation, business development and science by improving information, operation, user experiences and safety. The project is operated for a period of three years.

The project and network will especially focus on widening the use of the laboratories for companies and institutions and improving the innovation handling i.e. from idea to market. The method for this is to gather and map detailed information from the local businesses, owners and users. The outcome will be used to improve e.g. the accessibility, information, user experiences, cooperation possibilities, business development possibilities and innovation support functions such as prototype realisation, testing, demonstration, financial support and market analysis. The information, network and support systems will be of great value for the future expansion of the laboratories towards the European market and the financial system.

Keywords: Underground Laboratories, Baltic Sea region, Baltic Sea Underground Innovation Network (BSUIN)

WATER RESOURCES: QUANTITY & QUALITY ISSUES

WATER REUSE IN KALMAR

Qing Zhao
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Sweden

Abstract

Conventional water and drainage system provide people with clean water and sewer, and protect surface water against eutrophication. Today, essentially all of the water used in Swedish society is water of drinking water quality according to the Swedish Food Administration's regulations. As the water and drainage system works today, it consumes energy, chemicals and other resources at a level that hardly can be considered sustainable. Water of drinking water quality is used as flushing water in our toilets, for washing cars, facades, workshop floors, patios, lawn irrigation and many other uses. Drought in the Kalmar / Öland region in 2016, and even declining groundwater levels in 2017, has put the development of a sustainable water and drainage system in Kalmar on the agenda. A sustainable water and drainage system is not just about how drinking water is produced and how wastewater and storm water are treated, but also about how water resources are used in a cost-effective and environmentally sustainable manner. This project will contribute to the development of a more sustainable water and drainage system in Sweden.

The purpose of the project is to investigate legal, economic, technical, environmental and health conditions for water reuse in Sweden with a big focus on end-users' needs. The following reuse areas will be explored: potable reuse, non-potable urban reuse, industrial reuse, and reuse in irrigation for agriculture and landscapes. The project will show the best reuse areas in Kalmar from an environmental and cost-effective perspective.

Keywords: drinking water, drainage system, wastewater

AN ECONOMIC WATER SUPPLY INSTRUMENT APPLIED ON DISTRIBUTION OF WATER RESOURCES

Jan Stenis
LundaHydro AB, Sweden
William Hogland
Linnaeus University, Sweden

Abstract

This paper presents a cost structure for improving distribution options of fresh, used and recycled water resources. The previously introduced equality principle and the model for Efficient Use of Resources for Optimal Production Economy (EUROPE) allocate shadow costs to losses that reduce the efficiency of the distribution of water resources. It is found that long-distance transportation of fresh and used water by channels, basins, pipes and tunnels is approximately 4 times cheaper than desalinating the same amount of water in plants at the coast. The introduced methodology improves the usage of remote and rigid areas by enabling efficient irrigation and improving the access to fresh water. Profitability increases, the technology is advanced and environmental conditions improve when the EUROPE model is applied on water issues at various higher policy analysis levels. The developed methods constitute support tools for management. The results show utility for long-distance water resources transportation.

Keywords: Water Transport, Losses, Efficiency, Equality Principle.

IMMOBILIZED TIO_2 ON GLASS SPHERES APPLIED TO HETEROGENEOUS PHOTOCATALYSIS TO REMOVE BENZODIAZEPINE DRUGS FROM WATER

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***Rodrigo Coutinho da Silva*[1]**
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ABSTRACT

Benzodiazepine drugs are considered as potential emerging contaminants found in different aqueous matrices at concentration ranges including surface water and drinking water, with reported ecotoxicity. However, there are very few studies about their removal from water using photocatalysis as the treatment method. Currently, there is a growing interest in new materials, which can be applied in sustainable technologies for water purification and wastewater treatment. Heterogeneous photocatalysis (HP) is an attractive treatment method based on semiconductor catalysts, such as titanium dioxide (TiO_2) which is capable of partially absorbing sunlight photons to degrade a great variety of organic substances. When immobilized in a supporting material, additional benefits are achieved. The aim of this study was to apply a simple protocol for impregnation of commercial TiO_2 (P25) on borosilicate glass spheres and evaluate its efficiency in photocatalytic degradation in water of three benzodiazepine drugs widely used in the modern society: bromazepam, clonazepam and diazepam. The assays were conducted in a lab-scale Compound Parabolic Concentrator (CPC) reactor using radiation from a lamp simulating the solar spectrum. Scanning electron microscopy (SEM) images were collected before and after the photocatalytic treatment. The immobilized TiO_2 catalyst showed very stable coating and remained mostly unchanged after the treatment. Under simulated solar radiation at 45 W/m^2 (within the UVA range), after 180 min of light exposure, immobilized TiO_2 was able to degrade 98, 76 and 88% of bromazepam, clonazepam and diazepam, respectively. The efficiency of the immobilized TiO_2 on glass spheres was higher than the photolysis (photodegradation) with the same exposure time. Immobilized TiO_2 obtained through the procedure here described has an excellent potential to be used in water/wastewater treatment and HP-based remediation of contaminated sites.

KEYWORDS:
Benzodiazepine drugs; Aqueous matrices; Immobilized TiO_2; Heterogeneous photocatalysis.

BIOENERGY AND PLANT NUTRIENTS IN WASTE AND SEWAGE SYSTEMS

Ruzena Svedelius,
Sweden

Abstract

Human existence is dependent on renewable organic matter (ROM) in products derived from plant and animal kingdom. Food, feed and fibers contain the solar radiation energy that has been converted into bioenergy in the biomass of the plants during photosynthesis. At least 16 essential chemical elements must be available for plants during this process. Bioenergy and the chemical elements are during harvest transported from cultivated fields to human settlements. Long-term survival is about balance between production on cultivated fields and sustainable return of well treated residues of ROM from all human activities back to cultivated fields. Using sustainable management of material originating from ROMs in waste and sewage system will have significant positive effects on biodiversity, health, environment, climate, circular bioeconomy. The most up to date is the utilization of bioenergy and plant nutrients in the food waste. The content of bioenergy and plant nutrients in human waste, it means urine and faeces without dilution with water, begins to be discussed. Here proposed system for treatment of food and human waste will positively affect directly 9 of the 17 Sustainable Development Goals (SDG 2030) and the others indirectly.

Keywords: bioenergy, plant nutrients, renewable organic matter (ROM), food waste, human waste, wastewater, sustainable management, SDG 2030

MONITORING OF THE STATE OF FLOWING WATER IN THE PIPELINE TO SOLVE ENVIRONMENTAL MONITORING PROBLEMS IN THE ENVIRONMENT

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Abstract

Water is life! A person consists out of the water by 80%. The water surface is more than 71% of the Earth's area. These are oceans, seas, rivers and lakes. Water is a means of quenching thirst, irrigation of soil, vehicle and so on. People activities have strong man-made impacts on water resources. This leads to the depletion of fresh water resources. In addition, there is a strong pollution, both freshwater sources and marine. All living organisms suffer from this.

Ecological monitoring of water resources makes it possible to reduce the impact of harmful influences. Monitoring the state of flowing water in the pipeline is the most difficult. Water for consumption comes to a person through pipelines. For methods of monitoring the state of water, especially drinking water, high demands are made. The most important of them: the methods of control shouldn't introduce changes in the structure of water, don't degrade biological properties.

To solve the problems of monitoring the state of flowing water in the pipeline, we propose to use a refractometer. This device allows you to measure the refractive index of water $n_в$. $n_в$ depends on the presence in the medium of dissolved or undissolved substances. The refractive index changes if the state of the medium changes. Our device registers this.

Water is differs in different regions and sources. On the basis of this we concluded: by refractometry, the state of water should be controlled not by measuring the value of $n_в$, but by changing the light-shadow boundary. The position of the boundary is determined by the value of the refractive index of water. Position of the border light shadow changes if changes $n_в$.

This optical method of control does not the change in investigated medium. This allowed us are making to refractometer a more universal in comparison with other models for monitoring of liquid medium. The device can be used for turbid media with large insoluble particles.

Keywords: ecological monitoring, refraction, refractive index, flowing water.

MOSS BASED CONSTRUCTED WETLAND SYSTEM: IS IT POSSIBLE TO USE AQUATIC MOSS (*Warnstorfia fluitans*) FOR REMOVAL OF AS IN AN ECO-FRIENDLY APPROACH?

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Abstract

The heavy metal and metalloid contaminated groundwater is considered as one of the major global environmental disasters that need sustainable solutions. One sustainable environment-friendly solution is using plant-based remediation, or phytoremediation. For contaminated water aquatic plant based phytofiltration could be applied. A Swedish aquatic moss species (*Warnstorfia fluitans*) have been discovered to accumulate high levels of As (arsenic) from the water. In a number of areas in Sweden, the As content in the groundwater is high due to mining activities and geochemical conditions. Our hypothesis was that since this moss species could accumulate As from contaminated water it would be possible to apply in constructed wetland system for removal of As from water. The aim of this study was to investigate the removal of As from the outlet water by using *W. fluitans* in constructed mesocosm type wetland systems with various water flow speeds under greenhouse conditions. Besides these, As content in the vegetables (lettuce, *Latuca sativa*) grown in this outlet water was also analysed. The total As concentration was analysed with hydride generated atomic absorption spectrophotometry (HG-AAS). Results showed that *W. fluitans* could reduce the As concentration in the water with 36 and 56% from initial As concentration at high (5 mL/min) and low (1.5 mL/min) water flow rate, respectively. The As concentration in the vegetables was also lower when low flow outlet has been applied as irrigation water. In conclusion, the result fits our hypothesis that aquatic moss could be used in the constructed wetland system to reduce As content in irrigation water and by that also in the irrigated vegetables.

Keywords: Arsenic, Accumulation, Irrigation, Phytofiltration, Phytoremediation, Vegetables, Wetland

CAN WETLANDS REDUCE HUMIC SUBSTANCES IN FORESTED STREAMS - COMBINING TWO APPROACHES TO CHARACTERIZE EFFICIENCY

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Abstract

Establishing statistical significance in assessing wetland performance can be quite challenging when reduction in the monitored substance is very small and temporarily variable. Assessing colour changes associated with humic substances is such a situation. One of the most important parameters of any evaluation of wetland treatment performances is the retention time of the water before it exit the wetland. This can be theoretically estimated, but even better measured directly with the help of a tracing agent. In this research, the approach is based on the simultaneously assessment of hydraulic retention time using conservative tracing (Rhodamine WT) and a mass balance based removal efficiency assessment (regression slope of the summation mass-in vs. summation mass-out).

Keywords: Trace, retention time, wetland

ENVIRONMENT AND SOCIETY

SETTING PRIORITIES FOR THE CIRCULAR ECONOMY: ENABLING LONG-TERM SOCIETAL VALUE

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Abstract

Currently there are strong efforts worldwide in developing the circular economy as a part of societies' work toward the global sustainable development goals. However, moving toward the a more circular economy without the guiding support of priorities in resource management, while paved with good intentions, can be inherently risky. We argue that the current split between the governance and priority orders for primary resources and secondary resources needs to be reassessed for an effective (from a SDG perspective) circular economy development. For example, while primary resources are governed by e.g. primary market mechanisms and product standards, the prevalent governance of secondary resources is that of a priority order exemplified by the waste hierarchy.

In this article, we elaborate on a proposal for broadening our focus from end of pipe priorities to general resource priorities. Such priorities need to assess our resource management strategies from generational time perspectives – focusing on the long term functionality of both our general resources stocks (capital) and our resource flows. The proposed broader resource principles are exemplified and evaluated through a few case studies of major impact areas.

In conclusion, we argue that impacts such as toxicity in the anthroposphere, resource criticality, and greenhouse gas emissions can be addressed in a more effective manner via an evaluation of resource priorities through a systems perspective.

Keywords: Circular Economy, Waste Hierarchy, Priority Order, Sustainable Development, Resource Management

THE CIRCULAR ECONOMY BUSINESS MODEL OF ALGOLAND

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Abstract

In the Algoland project, microalgae are used to clean water and air from industry. This is built on a long standing collaboration between research, industry and society. In this way Algoland supports the transition to a circular economy by turning pollution into biomass and potential products. This paper evaluates the potential for microalgae in industries from a circular economy perspective. The economic aspects are highlighted using a triple layered business model canvas using data from interviews and a business model workshop. Results show that the triple layered business model canvas can be used as a framework for a circular economy model. In this model industry and ecology works jointly to create value and provide ecosystem services for society. Further, the paper discusses the challenge of deciding on the value proposition in form of products and ways to extract value from these on a competitive market.

Keywords: Circular economy, Microalgae, Business model

HIGHER EDUCATION CHALLENGES IN TRANSITION TO CIRCULAR ECONOMY

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Abstract

In the EU, the paradigm is shifting from "take-make-consume and dispose" lifestyle to the full-use of each natural resource. Many companies have taken circular economy thinking into their strategies The transition is complex and requires a whole new way of re-design, new skills and a change in mindsets of people, especially coming specialists making eco-effective decisions.

This Practical Approach for Teaching Circular Economy is based on the results of the couple of NordPlus projects from Latvia and Lithuania.

The aims of this research are to develop a joint curriculum for teaching in transition to circular economy, find out best pedagogical practices and connect to labor market in order to ensure an economic activity that promotes overall system health.

The study method is based on application of the different size of circular economy modules and best pedagogical solutions gathered into a common toolbox. Modules and didactic solutions can thereby be used in appropriate combinations for specific purposes.

The analysis of the existing curriculum in Environmental Sciences shows the weak relationship between scientific ideas and their commercialization as well as insufficient insight of profitable development of new business models. Despite the notion of sustainability has been incorporated into the study courses, there is still a lot to be done in putting this kind of wide and systemic thinking into practice. The innovative feature of this Joined Curriculum and Toolbox for Circular Economy is that high level of political and social ambitions will be put into practice in bachelor and master level education.

K**eywords:** T*eachin*g, circular economy, tool box, labor market

PHYTOREMEDIATION A STEP TO CIRCULAR ECONOMY IN BALTIC SEA REGION

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Abstract

One of key activity in the Baltic Sea Region strategy is in transition from linear economy to circular economy. The one of the first step to circular economy is to reduce flow of potentially recyclable material and substance flow to waste pool. The one of possible solution is phytoremediation. The aim of this study is to highlight phytoremediation advantages and limitations in circular economy context at Baltic Sea Region. The first task is to identify phytoremediation technologies for soil and groundwater remediation, second task is to evaluate phytoremediation technologies in Baltic Sea Region context, third task is to give recommendation for land owners, municipalities and governments for phytoremediation technologies application. The results show high potential of phytoremediation technologies in non-point source pollution reduction in agricultural sector. The high potential of phytoremediation technologies application is in decentralized sewage water management systems. The circular economy approach can be applied to digester, wood ash and sewage sludge phytoremediation integration in renewable energy sector by wood chips production. The phytoremediation show high potential as circular economy driving force in Baltic Sea Region.

Keywords: Triple Helix, nitrogen reduction, phytoaccumulation.

CHALLENGES AND NEEDS OF SMALL AND MEDIUM ENTERPRISES OF RECYCLING IN GEORGIA – THE CASE STUDY BASED ON QUADRUPLE HELIX COLLABORATION

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Abstract

The presented study describes the challenges that is performed on the basis of the EU-Georgia Association Agreement in the waste management sector of Georgia.

Georgia set ambitious targets for waste recycling. The Vision of the Waste Management in Georgia is: "Georgia to become a preventing and recycling society". It would be necessary to establish waste separation systems in immediate proximity to paper, plastic, glass and metal waste sources. So, the enterprises must be to be able to do more recycling as much as possible. Waste recycling is that sector of business, which must be developed rapidly, in order to cover at least those minimal needs, which the country's waste management sector is being faced today.

The planned measures will result in significant challenges of the country's local authorities, universities, business and the whole society in the near future.

With the aim of supporting and studying the current situation in waste separation and recycling within the framework of the project "Supporting Small and Medium Enterprises", Imereti Scientists Union SPECTRI try to collaborating all stakeholders based on the Quadruple Helix Model.

For identifying the problems and needs of the recycling was performed a survey of business entrepreneurs involved in this field, to study the prospects of development of recycling and demonstrate effective mechanisms for promoting mutual cooperation with governmental and non-governmental sectors.

Keywords: waste management, recycling, survey, small and medium enterprises.

APPLICATION OF THERMOELECTRIC ENERGY CONVERTERS IN LINE WITH «GREEN ECONOMY» PRINCIPLES

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Abstract

The principles of "green economy", developed in the framework of sustainable development more than 20 years ago, as was noted at the conference of the "Rio +20", despite many failures and crises, continue to develop and move around the world. The importance of this issue to the international community and Russia is confirmed by the adoption of the Paris Agreement within the "Framework Convention on Climate Change" in December 2015 and Sustainable Development Goals 2030 set by the United Nations, in which the need for the intensification of efforts for preventing climate change (including the development and spread of social and environmentally optimal energy technologies) is emphasized. In accordance with the "Climate Doctrine of the Russian Federation", the application of new non-carbon energy sources and their fabrication technologies is an urgent problem of the third stage of Russian energy-sector development, which consists in a gradual transition to power engineering of the future with radically new technological possibilities for further development based on the highly efficient use of traditional energy resources.
The aim of the paper is to present the results of GalTEC project, which deals with electricity generation by means of waste heat recovery on a river boat. The project investigates the use of heat pipe to increase thermal energy extraction from the exhaust gases. Exhaust pipe of diesel generator is equipped with 138 thermoelectric generator (TEG) modules. It aims at generating 4.5 kWh from exhaust gases with the temperature range between 200^0C and 380^0C and decreasing of the carbon footprint of the river boat by 10.86 t (CO_2-eq) per one navigation. The study shows economic and environmental profitability of TEC application.

Keywords: thermoelectric energy converters, circular economy, energy efficiency, Paris Agreement, Sustainable Development Goals.

CREATING NEW SERVICES FOR UNDERGROUND LABS VIA SERVICE DESIGN

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Abstract

The Baltic Sea Innovation Network (BSUIN Project) is developing the Baltic Sea region by finding new uses for underground spaces and laboratories. This involves creating an innovation platform based on the facilities and research equipment in the Underground Labs (ULs) of the universities and research institutes in the region. The platform will be jointly operated by the BSUIN network in order to offer innovative services for companies and research institutes in these unique ULs. The objective of the paper is to describe the process and the challenges of developing such jointly offered services.
Service design is chosen as an approach for developing ULs, as its visual tools and customer orientation are believed to benefit also industrial service development. Furthermore, service design emphasises the importance of the lucrativeness of the services being developed for the service provider. Service design has not been applied previously in a similar industrial context. The work involves organising workshops in order to gain understanding of customers' needs in relation to service providers' activities and resources. Data from the workshops and the whole service design process will be analysed qualitatively for research purposes.
Firstly, in the exploration phase of service design, the current business models of the ULs were described and analysed, and critical aspects identified. Secondly, in the creation phase of service design, new services and their business models will be co-created in collaboration with relevant stakeholders of each UL. In addition, customer profiles, customer journeys, service blueprints and value propositions will be created for the chosen service ideas. Finally, decisions will be made about the service offering of the joint network.
Further research will be conducted through applying the case study approach to gain more theoretical and practical understanding of the use of service design in industrial contexts.

Keywords: Service design, service offering, business model, value proposition

CARPATHIAN SCHOOL AS A TOOL FOR ACHIEVING SUSTAINABLE DEVELOPMENT GOALS-2030 IN MOUNTAIN REGIONS OF EASTERN EUROPE COUNTRIES

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Abstract

Newly established project entitled “Strengthening BSR Universities Network on Landscape Sustainability and Waste Management” (LASUWAMA) supported by The Swedish Institute, has been launched in September 2018 in Kutaisi, Georgia. It aimed at strengthening the networking abilities of nine participating universities in research on landscape sustainability, waste management and transferring of modern landscape remedial technologies to vulnerable mountain regions of West-NIS Countries. There are six educational entities from Baltic Sea Region (BSR) representing Sweden, Estonia, Lithuania, Latvia, Finland and Germany plus three Eastern European universities from Ukraine, Georgia and Armenia. The overall goal of cooperating universities is working towards the UN’s Sustainable Development Goals 2015 – 2030. The universities are involved in generating educational curricula and delivering practical skills on their best experience in waste management and mountains’ landscape safeguarding.

Special emphasis will be focused on Quadruple Helix Cooperation that considering universities as a driving force of sustainable society and dissemination of information concerning the quality of landscapes and human needs in environmental services. The project encasing social activities of Master and PhD students involved in schooling together with local authorities and business entities.

ENVIRONMENTAL ISSUES: LOCAL & GLOBAL SCALE

MURUJUGA: WHERE A 50,000 YEAR CULTURAL LANDSCAPE MEETS THE INDUSTRIAL AGE

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Abstract

Murujuga, with a cultural occupancy spanning some 50,000 years, has for the past 50 years been exposed to the destructive force of the resource industry. Back in 1964, with no legal authority, the Aboriginal custodians of this place could not prevent the development of a port to export iron ore from the inland mines of this remote part of north-western Australia. Some 50 years later, the estimated one million images that are engraved into the rock surface of this landscape are exposed to the changing conditions brought on by the industrial expansion of petroleum and allied chemical processing plants.

The footprint of industry had removed upwards of 10,000 petroglyphs; however a far greater number are at risk of obliteration. The chemical emissions from industry is altering the ph of the rock surfaces, changing the chemical and biological patterns which have protected the rock art for tens of millennia. It has fallen to a dedicated few concerned citizen, with the support of the Aboriginal custodians, to force industry and government to take seriously the adverse impacts that have been imposed.

Short of shutting down the resource sector operating on Burrup Peninsula, options for the protection of the petroglyphs require financial and physical effort by industry to eliminate harmful emissions. The Murujuga petroglyphs are a globally significant and irreplaceable cultural treasure; alternatives exist for industry, not so for the survival of the rock art.

WORLD CLEANUP DAY: THE IMORTANCE OF CLEANUPS AND FOLLOW-UP ACTIONS

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Abstract

On 15 September, 2018, volunteers and partners worldwide came together to clean the beaches, rivers, forests, and streets of our planet from litter and mismanaged waste. In total, 17 million people from 158 countries participated. The 'Let's Do it' (LDI) movement was born 10 years ago in Estonia, when 4% of the population joined together to clean the entire country from illegally dumped waste. This captured the imaginations of people worldwide, and led to the idea of cleaning up the entire world. This article describes how the global bottom-up civic movement, Let's Do It! World, has grown to be the biggest of its kind in the world, and the way it contributes to addressing some of major environmental issues of today, such as marine litter and shifting to a Circular Economy. The structure of the movement, and the expected effect of main messages is discussed – see it, map it, bag it, move it, learn.
Any kind of waste clean-up action is one-time event. As such, it's not a final solution in itself. The ultimate goal would be contributing to long-term effects and solutions. In this respect, the key benefit of cleanups is 3-fold: it helps fighting the "trash blindness", making people aware of the problem; it feeds into "Citizen Science", i.e. science that builds on data and info gathered by ordinary people: during cleanups and related mapping of trash points, not only do we pick litter, but also we collect valuable information on most common type of litter, related dynamics of dispersion, typology of materials that need targeted policies and practice in order to prevent dispersion and promote better management; and it keeps the issue high on the agenda for media and policy, thereby drawing attention by all concerned actors, as governmental institutions, communities, businesses and industry, civil society and individuals. This is the best precondition in order to define a concerted "roadmap" so as to have the issues around trash and litter sorted out, for good.
To achieve that, the Knowledge Team of LDI developed a *Keep It Clean Plan*, whose key message is to implement strategies, inspired by the "Zero Waste" vision and approach, for sustainable management of resources and discarded materials, harnessing the power of redesigning materials and systems, so as to connect to Circular Economy and prevent waste from being dispersed into the environment.

Keywords: mismanaged waste, trash blindness, cleanup, global civic movement, Zero Waste strategies, Circular Economy.

ENVIRONMENTAL, HEALTH AND SOCIAL IMPACTS OF DUMPING AND BURNING OF MUNICIPAL SOLID WASTE IN SOUTH AFRICA

ENVIRONMENTAL, HEALTH AND SOCIAL IMPACTS OF DUMPING AND BURNING OF MUNICIPAL SOLID WASTE IN SOUTH AFRICA

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Abstract

Global waste generation is escalating at a phenomenal rate and is closely associated with population increase, poor waste services, economic development and urbanization rates, leading to large amounts of waste being illegally dumped, burnt or disposed of at landfills. An estimated 1.3 billion tons of municipal solid waste (MSW) is generated globally per annum and is expected to rise to 2.2 billion tones by 2025. South Africa, in 2017, generated 78,085,869.5 tons of waste (46,220,203.9 tons MSW) and in the Free State Province (one of nine provinces) only 4,969.5 tons of the 4,572,320.2 tons generated was recovered/recycled. Poor service delivery impacts more severely on the urban poor and residents in developing countries as illegal and unregulated dumps and waste burning is a normal occurrence.

Landfill is used for 95% of MSW collected all over the world, including most of South Africa's waste. Data indicates that more than 19.2 million tonnes of general waste and one-million tons of hazardous waste were disposed of at 133 South African landfill sites in 2017. Waste in South Africa, as the rest of Africa is often disposed of in unregulated landfills, dump sites or open burning contributing to diseases, health implications, vector breeding, environmental pollution (air, water and soil), methane discharge and urban protests. The major South African cities have properly engineered landfills but the residents living in close vicinity of dumpsites in smaller towns and rural areas are exposed to extreme health risks. The Free State Province have one specially engineered landfill for waste disposal and 5 non-engineered landfills but most towns only have dump sites. Waste pickers operate on some landfill/dump sites, some people actually live on the dump sites while other residential housing are situated less than 200m from burning dump sites, children play in the waste, pigs are kept in pens, condemned meat carcasses, dead chickens lie around while cows eat plastic which are blown from the sites. Due to poor waste management services the municipal workers or community members burn the waste to reduce pests and bad odours causing air pollution and related respiratory diseases.

Results for 70 landfill sites in the Free State is included in the study describing the operational procedures at landfills, open burning of waste, using tyres and diesel to fuel burning of waste , unlined landfill sites and recycling practices. Air pollution monitoring (ambient air) will be done at 50 of these towns (FS) and 80 towns (10 per province) to determine the level of ambient air pollution and potential exposure of community members living in close proximity of these sites and descriptions of the additional sites will be added to existing data . The results of the study identifying the most prominent and harmful outdoor air pollutants directly affecting the health of the communities living in the vicinity of these burning dump sites will be compared to the records of local clinics and respondents living in a set radius from the dumpsites/landfills will be requested to complete questionnaires.

Study of dump sites and landfills in the Free State (personal observation, questionnaires and on site checklists) confirmed poor waste management (burning, dumping and air pollution) and extension of the study to the other South African Provinces with additional ambient air monitoring, GPS recorded of dump sites/landfills and closest residents affected compared with clinic results will provide important data to provide improved waste provision services.

Keywords: waste burning, ambient air monitoring, environmental pollution, diseases; environmental pollution

SOCIOECONOMIC AND ENVIRONMENTAL CHALLENGES IN BURKINA FASO A LANDLOCKED COUNTRY IN SAHEL, WEST AFRICA

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Abstract

Being the fourth biggest gold producer is Burkina Faso very limited on other natural resources, such as water, fertile farmland, forests and minerals (beside gold and manganese), but rich on young people. Since the population rate is 2,8%(2014) is almost half of the population less than 15 years old. Most people; 80% of the population make their living as farmers, but has a hard time to develop the agricultural sector, partly due to the fact that the land reform has not been done everywhere in the country, which makes it hard to get loans and to do long term investments.
Finally Burkina Faso borders Mali, which unstable peace situation, makes refugees and also terrorists' threats become more common.
Being one of the poorest countries in the world, Burkina Faso is well organized and has so far invested in suitable technology, both big and small dam constructions, antierosive technics, solar and thermic energy, mobile telephones, which also allow mobile banking, for example and mobile internet connections are possible in almost the whole country.

Bye showing some examples I hope to introduce an interesting discussion, which could maybe aim to technology cooperation and transfer and also help out Burkina Faso of the poverty.

Keywords: Socioeconomic issues, development, renewable energy

MATERIAL FLOW ASSESSMENT AS A TOOL TO ASSESS A WASTE MANAGEMENT SYSTEM IN A CITY

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Abstract

The accelerated growth of the world's population is increasingly advancing towards an urban future, which leads to an increase in the amount of municipal solid waste that the municipalities must manage in an environmental way. Cities in the developing world are facing many challenges, being one of them the lack of information regarding the amount of waste produced in the city, composition and the final disposal. "Material Flow Analysis" has been considered a tool to visualize the flows of solid waste within a system to identify the main existing problems based on the distribution of the masses of the materials and the final sinks. This study reports on a study in an urban small-size Costa Rican city in which the amounts of waste produced by the household and commercial sectors were addressed. Utilizing this tool it was possible to address the waste management situation, waste generation rates, composition, treatment and final disposal practices. It was determine the amounts of waste being burned, buried in the backyards of homes, illegal discharges in empty lots, rivers, side of roads and alike. It was also possible to determine recycling rates, and the amount that is disposed in the landfill. Using this tool, the municipality can observe where the challenges are and make informed decisions on where improvements must be done.

Keywords:

Material Flow Analysis, waste generation index, composition, developing countries

GLOBAL WARMING IMPACTS THE GEOCHEMISTRY OF SHALLOW MARINE SEDIMENTS OF THE BALTIC SEA

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Abstract
Global warming and its impacts are among the main concerns of our society. Effective action to tackle climate change problems need to be based on the best scientific knowledge available. However, if on one hand anthropogenic effects on global warming is unequivocal; the impacts are fairly less grounded and particularly in less accessible marine environments. Here we present preliminary results of a study based on coring campaigns in the Hamnefjärden area, Baltic Sea, which contains a warmed bay (artificially heated by the discharge of hot water from a power plant since the 1970's) and a cooler, unaffected control bay. The warm bay is used as analog to unravel possible future alterations in the marine environment related to climate change. Preliminary results suggest that anaerobic oxidation of organic compounds is strongly influenced by temperature and the related depth of sulfate reduction (and sulfate -methane interface) is significantly reduced in the warmer bay compared to the control bay. These results are consistent with laboratory experiments simulating warming of bottom waters in sediment cores obtained in the same areas, and indicate that reduced and toxic substances such hydrogen sulfide (and methane) will be formed at shallower depths below to the seafloor with potential impacts for benthic life in the already fragile environment of the Baltic Sea.

Keywords: climate change, geochemistry, Baltic Sea.

LONG-TERM MULTIDISCIPLINARY RESEARCH PROJECT OF SETTLEMENTS AND BURIALS IN TUVA REPUBLIC – THE ANCIENT PUZZLE OF SCYTHIAN WANDERINGS IN EURASIA

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Abstract

Tuva Republic is located in the centre of Eurasia, the southern part of Siberia. The area comparable to Uruguay is inhabited with density of only 1.85 people per km^2. Over the centuries, Tuva was affected by variety of powers: in the 6th-8th century, Tuva was included in Turkic and later in Uyghur Khaganate. In the 13th century the territory of Tuva was conquered by the Mongols whose influence prevailed until the middle of the 18th century. Chinese ruled later, until the territory gained independence in 1921, but in 1944 Tuva joined Soviet Union, later Russia Federation. Archaeological excavations in Tuva are regular in a large scale; however, the most important and largest excavation project in Russia and even worldwide takes a place at planned railway connection of Kyzyl-Kuragino, hundreds of kilometres long. Project is supported by the authorities of Russian Federation and Tuva Republic, Russian Geographical Society, the company "EVRAZ" and other supporters. Tuva's Valley of the Kings historically has been a major area of interest for archaeologists because it contains the largest burial mounds in the region of Tuva and in all the region of Altai. Therefore, the studies performed prior the construction of railway are the salvage of the World's Heritage. Leading archaeologists from Russia (e.g., Marina Kilunovskaya, Vladimir Semenov) as well as from other countries perform research projects. Additionally, each year from 2011 volunteers are invited by Russian Geographical Society to participate in excavations. Tuva's Valley of the Kings is an area of interest for multidisciplinary scientists due its largest burial mounds (kurgans) in the region. Large amount of burial sites are still under the study and have been dated by radiocarbon and archaeological methods. Each year archaeologists find great masterpieces of art as well as figures of animals, tools and other artefacts. According to the studies of Dr. Mikhail Piotrovsky, pins with animals carved into golden surface are assessed as "encyclopaedia of Scythian animal art because you have all the animals which roamed the region such as panther, lions, camels, deer and other". It applies to the original Scythian style of the Altai region, which eventually moved to the Black Sea region and finally affected the style of artworks in the ancient Greece. The research showed that fierce nomadic Scythian tribes wandered around the Eurasian steppe, from the northern borders of China and Mongolia to the west, the Black Sea region, around the period from the 7th to 3rd centuries B.C. In the 5th and 4th centuries B.C. they interacted with the ancient Greeks who had colonized the Black Sea region (Ukraine and Kalmykia). Research has shown that the ancient Greek influence was evident in Scythian culture and tools. The long-term systematic archaeological excavations and analyses of artefacts will open secrets of the Scythian history through times in order to solve the puzzle of ancient wanderings of peoples in Eurasiblica.

Keywords: Scythians, Tuva, burial mounds, kurgans, Kyzyl-Kuragino project

ENHANCED TRANSPORT ECONOMY MODELLING ALONG THE NEW SILK ROAD

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Abstract
A method is presented to enhance the transportation of cargo applied on the 'New Silk Road'. Allocation of shadow costs gives economic incentives to improve the Eurasian communications by employing the equality principle and the Efficient Use of Resources for Optimal Production Economy (EUROPE) model. The profitability and Gross Domestic Product increase, the technology is advanced, the environment and the living conditions improve. A single monetary key factor expresses aspects of interest and enables simultaneous monitoring, managing and evaluation. The method constitutes decision support tools for long-distance transportation at higher policy analysis organizational levels. The results of the case study point at a substantial usefulness for the launched methodology to reduce the spillages and losses when transporting cargo by truck along major transport routes. The global integration will go faster and easier. Peace and prosperity are promoted. The major benefits are: higher profits, and; less residuals.

Keywords: Cargo Transport, 'New Silk Road', Trucks, Economic Incentives, Equality Principle

SOLID WASTE MANAGEMENT TODAY

CONSTRUCTION WASTE FLOWS AND THE IMPACT ON THE ENVIRONMENT

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Ana Grettel Leandro-Hernandez

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Abstract

Historically the construction sector has been one of the most important contributors in the economy, since it generates many jobs, thus creating significant income and progress for the local economy. However, it causes environmental damage as it produces a large amount of waste, some of which are considered hazardous. This study intended to identify and evaluate the environmental impact of each of the hazardous wastes generated due to construction. A questionnaire was prepared and answered by members of micro, small, medium and big companies. Site visits were performed and the results were validaded by members of the Costa Rican Construction Chamber.
The most important hazardous found during the study include: acids, solvents, detergents, additives for concrete, oil containers, lubricants, brake fluids, fuels, paint residues and their packaging plastic and metal buckets, treated wood with chemical compounds, welding residues, silicones and sealants, contaminated soil, utensils containing chemicals substances and mercury fluorescent tubes. Each of the hazardous materials identified is associated with negative environmental impacts in soil, water and air. Most of the participante companies have no programmes to recover, provide for recycling nor treatment to those materials.

Keywords: Hazardous waste, construction waste, developing countries, impact environment

ZEROWASTE PROGRAMMES IN THE FRAME OF CIRCULAR ECONOMY

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Abstract
Previously considered by some as an unrealistic slogan (a consideration which mistakenly focuses on the number, and not on the engagement to move towards it), Zero Waste has lately been recognised as a working principle, and *a precious toolkit to turn the vision of the Circular Economy into operational reality*.
The first version of the EU Circular Economy package, issued in July 2014, was sub-titled "a Zero Waste programme for Europe", which showed the tight linkage between the CE agenda, as the general roadmap for the EU in the management of resources, and ZW as the methodological approach to make it real.
A Zero Waste commitment has already been adopted by hundreds Municipalities across Europe, which keeps them engaged on continuous improvement in the management of materials and discards, while delivering impressive achievements not only in terms of maximised recycling levels and minimised disposal, but also in terms of created jobs and economic benefits to taxpayers and local economy.

Zero Waste is typically described by people and experts involved in ZW programmes, as "more the journey, than the destination". Its key principle is to reduce, reuse and recycle as much as possible, and assess, afterwards, what materials are left behind in residual waste, so as to have them redesigned for better durability, reparability, reusability, recyclability.
The working method has already delivered impressive results in terms of minimisation of residual waste (with hundreds Municipalities and even large areas around and below 50 kg/person residual waste, and still dwindling) cost-optimisation of schemes for the management of MSW, and influence on industrial responsibility to have those materials that are not currently recyclable, duly redesigned for better end-of-life management in the near future.
The strategy has been adopted also in densely populated cities and areas, similarly allowing important achievements well above the EU long-term targets, and well before related deadlines.
The presentation will elaborate on:

- the background rationale for Zero Waste programmes, in the frame of Circular Economy,
- the ongoing initiatives to have the concept codified and operationally implemented,
- the operational schemes for communities that have committed to ZW programmes,
- it will also report on the achievements in terms of improved waste management, related economic optimisation and occupational implications.

Keywords: Zero Waste, Circular Economy, sustainability, economics of waste management

REDUCING BEFORE RECYCLING: TACKLING FOOD WASTE AND LITTERING

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Abstract
The reason for the increasing amount of plastic packaging waste, which tends to litter the oceans, is mainly seen in the consumer's behavior. Consumers tend to buy more, but smaller packets, which cause more material in total than big ones, and also seem to prefer plastic over paper, glass or metal. The demand for convenience food, portion packs and take-away options is also growing. These developments in turn may be caused by an increasing number of single or two-person households.

Another societal problem are the 1.3 billion tons of food waste by year worldwide, whose main percentage is also caused by private households. One reason for this phenomenon seems to be bad planning of the consumer, again mainly in small households, who buys more than he will eat – encouraged by special offers of big packages or multipacks.

As a consequence, the preference of larger entities of food, which on the first sight seems to be one of the means to decrease the amount of packaging waste, turns out to lead into the wrong direction in modern societies – it may finally increase both packaging *and* food waste: The more packed goods are bought and littered because they have gone bad, the more replacement purchases take place. In case the replacement products are packed as well, the consumer litters more packaging in the end. In addition, the packaging of adulterated food usually doesn´t end up in material but in thermal recycling because it is dumped into the general waste together with the rotten contents of the packaging.

The last mentioned aspect conflicts with the clearly emphasized increase of recycling rates and closure of material cycles as contained in actual EU and German national legislation, such as the European Plastics Strategy or the new German Packaging Act for 2019. However, encouraging material recycling alone will not accomplish the outstanding challenge of protecting the oceans, the fauna and in the end humans against piles of garbage and the waste of raw materials and energy: This can only be achieved by materially decreasing the amount of packaging waste from the beginning, i.e. by reducing packaging generally. So could the reduction of packaging and an increasing offer of unpacked goods, supported by legislation as well as appropriate education, solve both problems in the end – plastic and food waste?

Keywords: Packaging Waste, Food Waste, Sustainable Consumption, Zero Waste

SOLID WASTE MANAGEMENT IN EGYPT

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A**bstract**

In Egyptian urban areas, current collection rates for solid wastes are 30 to 77%, while no collection or disposal system is found in villages. All funds are directed to large cities. Changes in the life style in urban areas increase the amount, variety of produced wastes and waste disposal costs. Mixing hazardous, toxic industrial wastes with general waste in dumping sites poses a significant risk in such areas, such as the Delta region, where the water table is high. Toxic industrial solid wastes have toxicity for both aquatic life and human beings. Accumulation of toxic wastes in river sediments was observed near factories.
The amount of agricultural solid wastes in the selected general directorates is growing due to the increased use of other fuel sources for. The impacts of agricultural solid wastes include deterioration of surface water quality due to the discharging of wastes into. Burning of agricultural wastes may cause air pollution which recently prohibited by law. Slaughterhouses wastes represent a source of pollution on urban settlement.
The bulk of irrigation slime wastes resulted from maintenance and widening of canals is dumped on the banks and substantial quantities are subsequently moved to low-level lands as a stop-dressing. Whilst this recycling may appear to be beneficial, take care should be when dealing with wastes those may contain heavy metals and microorganisms which may represents a source of public health hazards. Constructing and demolition debris is suitable for re-use or it may be crushed into base materials for road building. These wastes may be seen disposed randomly on canals banks or on road sides throughout the cities. Waste management charges should ensure those who generate waste must pay the full cost of environmentally safe disposal. This will make waste recycling and resource recovery cost effective. For positive change to occur awareness needs to increase, and information generated regarding Egypt's environmental conditions must be disseminated by all means to reach most people.

Keywords: solid wastes: household, industrial, agricultural, constructing and demolition, solid waste management.

URBAN WASTE PROBLEM IN TOURIST CITIES AND NEW CONCEPTS OF WASTE MINIMIZATION

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Abstract
The urban waste in tourist cities needs comprehensive global research efforts and proceeded action as for metropolitan areas huge impact and load on waste management is generated. Waste management and resource conservation strategies are prepared in state-of-the-art level however implementation and future improvement of the current situation is crucial. Beside the collection of data for information base, analysis on selected pilot cities and metropolitan areas in terms of environmental impacts, social and economic aspects have been done. Best-practice examples in waste prevention and management for better tourism, waste and resource management are provided in the paper.

What we need is policy and tools based on information gathered by scientists, municipal and NGOs experience (e.g. separation of biowaste in catering industries, "sin-wastes" as from the bars, nightclubs and smoker places, reuse of unnecessary items that can serve for others and many more). However, regulatory instruments (e.g. ban of plastic bags, reduction of allowed biowaste in landfilling), economic instruments (taxes) and voluntary agreements (e.g. deposit systems. Cleaning actions by volunteers) should be used to implement and elaborate. Waste management and prevention practices in tourist metropolitan cities shall first of all be concentrated to deal with food waste prevention, management, special practices for festival waste and large amount specific waste generating facilities (e.g., entertainment industry, cruises etc.). The low-waste organisation of events and the promotion of re-use activities as well as waking of consumer consciousness are the positive trends. Eco-labelling and accompanying roadmaps shall lead the theory to the action. Entertainment and hospitality industries in concert with food and catering entrepreneurs do compete for better and greener marketing. The future outlook may be concentrated on digitalizing of waste flows and using the "big data" concept for better and smarter waste management.

Pilot studies were done in frame of the HORIZON2020 "Urban Strategies for Waste Management in Tourist Cities" as well as Swedish Institute supported activities in projects "PECEC" and "LASUWAMA". Additionally the authors performed studies in Tenerife, Nice, Rio de Janeiro, Sydney, Perth, Brussels, Copenhagen, Riga and many other tourist metropolitan areas through field studies on waste management and minimization activities in real life.

Keywords: waste prevention, minimization, reuse, recycle, tourist waste, metropolitan areas

RECYCLING OF MULTILAYER PACKAGING FOILS: USING DIFFERENT ORGANIC SOLVENT

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Abstract

Multilayer Packaging waste are one of the major problem in the world. About 6 billion tons of Packages are generated per year in the world (In EU is about 82 million tons per year). Multilayer packaging foils are approximately 17% of all produced packaging films. Most produced multilayer film is based on the different polymers, such as: polyester (PET), polypropylene (PP), and polyethylene (PE) as main components, and an aluminum layer. However, because of their poor recyclability, most multi layers are usually incinerated or landfill, this is counteracting the efforts towards a circular economy. There are different recycling methods for this type of waste, but the main problem is that there is less company which recycling multilayer packaging foils and also it is very important that, mostly they recovering only one or two components and others are burned or landfilled. The aim of this study was to find most suitable organic solvents for recovering two common components: polymer and Al. For the first experiment, there was chosen multilayer packaging foil's different samples, such as: packaging for chocolate, for chips, for medicines, for coffee. There was used several chemicals: acetic acid, acetone, dimethyl formamide, ethanol, ethyl acetate and toluene. These solvents are on the list of green chemicals and they were selected, due to their less impact on the environment and on the human health. The recycling process and result was different for each samples and solvents, because of their individual characteristics.

Keywords: Multilayer Packaging Waste (MPW), Recycling, Organic Solvents, Circular Economy

MEDICAL AND AUTOMOTIVE WASTE GENERATION AND ITS STATISTICAL DEPENDABILITY ON CERTAIN SOCIO-ECONOMIC INDICATORS ANALYSIS: CASE OF LITHUANIA

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Abstract
While exploring possibilities to efficiently forecast medical and automotive waste generation on national (Lithuania's) level, series of tests and calculations were made to analyze mentioned types of waste generation itself. In this attempt it was decided to separate medical and automotive waste each in two flows – total and hazardous waste. These waste flows composition and its changes over the period of 2004-2015 were analyzed to learn more about possible reasons for waste data fluctuations and dependability to predetermined socio-economic indicators. Annual total medical waste growth rate during 2004-2015 was 13,6%, hazardous medical waste – 19,19%. Total automotive waste generation experienced 9,41% annual growth and hazardous automotive waste – 23,33%. Spearman's rho test, scatterplots and PLS or MLR regression methods were used to determine waste generation data sensitivity and compare how sensitivity shifted when comparing observed and forecasted data to determined socio-economic indicators. Most of independent variables used for certain waste data set were highly collinear when counting monotonic correlation. Changes between independent and dependant variables sensitivity were noticed as developed statistical modelling methods that demonstrated highest efficiency strengthened variables sensitivity to develop better and more efficient structure for accurate forecasting.

Keywords: medical waste, automotive waste, waste generation, dependability, data sensitivity, statistics.

COMPOSTING OF FISH WASTE

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Abstract
Large amounts of fish waste is generated in fish processing industry, where approximately 25% of the round fish is cut off as waste; during fishing, where low-quality fish remains unused; but it also may be generated during die-off period under extreme hot weather conditions. Fish waste has to be stabilized. Composting is sustainable and environmentally friendly way to stabilize any type of organic wastes. Composting of fish waste, however, is uncommon in everyday life due to odour problems.
The main aim was to study different composting techniques to revalue locally available low quality small fish as nutrient rich fertiliser. The purpose was to find an effective and easily practicable technology, that can be carried out by local fishermen.
The compost experiment was conducted outdoors in three compost piles. The compost mixture was made from easily available wastes or by-products. Main components for compost mixture were fish and hay. Different C/N rates were used. To prevent the odour problem, ventilation with negative pressure was introduced. Compost mixing was organised by a Backhus 16.30 Windrow Turner, when CO2 content rised >10%.
Initial phase of composting was typical with temperatures reaching 70° C. At certain point, however, the process was inhibited. This also resulted in unpleasant odours, which were later eliminated by including a biofilter. On the other hand, the fish composted very fast (during three weeks).
This study showed, that composting is adequate low-tech technology to eliminate fish waste and offer nutrient-rich compost on-site where fish waste is generated. Optimisation of windrow composting will be tested further.

Keywords: Composting, Fish waste, Freshwater fish

SAFE & SUSTAINABLE FUEL STORAGE

SELF-HEATING PROPENSITY OF WASTE USING ISOTHERMAL CALORIMETRY

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Abstract

Increased recycling of waste has led to an extensive handling and temporary storage of different types during the last two decades. Self-heating is often experienced in waste storage facilities and if the heat generation is greater than the heat lost to the surroundings, it could lead to self-ignition Statistics show that 60-70 fires occur each year at Swedish facilities for waste handling and storage on an industrial scale. One of the main reasons for fires in stored waste is self-heating. Currently the level of understanding of self-heating is insufficient, and therefore, a methodology for determining the self-heating properties of waste is needed to provide the cause and to prevent incidents.

A methodology is being developed for measuring the self-heating potential of different types of waste using a sensitive and powerful technique known as micro-calorimetry. Using this approach heat release due to different process, e.g. biological or chemical reactions, can be measured.

Experiments were performed on different mixtures of a mixture of a burnable fractions of municipal solid waste and industrial waste, Heat release was measured at different temperatures between 40 °C and 80 °C. Results show that the technique can be used to differentiate heat release rate for waste obtained from different sources and potentially to determine what types of waste (and waste fractions) are mainly responsible for the production of heat. It can also be used to characterize new types of mixtures. The present study confirms that heat release can be higher in comparison to wood pellets and there is a need for further investigations and guidelines which can be used for the safe storage of waste.

Keywords: heat release rate, industrial waste, self-heating, isothermal calorimetry, storage

ENVIRONMENTAL IMPACT ASSESMENT OF THE LANDFILL FIRE CONSEQUENCES IN LVIV (WESTERN UKRAINE)

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Abstract

Outdated approach of solid waste management (landfilling), that is used in Ukraine nowadays, creates multiple environmental problems in the country. Disastrous landfill fires, that, according to statistics, are becoming more and more frequent in last years, must be mentioned as one of the most serious of them. Impacts of such events may be very serious, considering environmental as well as population health issues. These impacts must be accurately analysed through scientific methods to avoid future risks as well as to obtain geochemical and geophysical data describing spreading of the pollution that might have significant scientific value.

This article contains the results of the two-month long impact assessment study, that took place after the fire with partial collapse of constructions and massive leachate spill, in the Lviv landfill in 2016. Study of the migration of oil products and inorganic pollutants (Pb, Cd, Co, Mn, NO_2^-, Cl^-) performed with the help of chemical analyses of water and soil. Mapping of the polluted zone was done through hydrographic analysis. Land use of the polluted territory was analysed, using remote sensing and analysis of the cadastral data.

We have found diverse environmental impacts, including significant changes of soil pH, pollution with heavy metals and toxic organic substances in the lower catchment of the Malehovka river. Significant health risks for local population may be prognosed, considering land use of the studied area.

Keywords: landfill, waste, landfill fire, chemical pollution, leachate

BIOFUEL FROM MICROALGAE: THE THIRD GENERATION OF RENEWABLE FUEL

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Abstract

Biofuel research and development has been progressed in last decade as an emerging technology for the renewable energy sources. Microalgae is one of the most promising feedstock to obtain biodiesel. Microalgae are the most suitable source for biofuel production due to their high lipid content, green-house gas fixation, rapid growth rate and ease of cultivation. The main advantage of biofuel production from microalgae is that can produce 15 upto 300 times more energy than traditional diesel production methods. The oil content of microalgae has reached up to 80% of their dry body weight; moreover, some microalgae can duplicate their biomasses within 24 hours which turn microalgae as an excellent renewable source for energy and biofuel production. Researches indicate that municipal, industrial and animal wastewaters are great potential sources for biofuel production by the aid of microalgae. Somehow, there are many drawbacks and challenges of algal cultivation including: composition variation, weather condition, pre-treatment methods, unsuitable nutrient ratio (C/N, P/N), high turbidity, suspended solid particles and existence of other toxic and inhibiting compounds. These challenges would be resolve by designing a suitable and desired technological production processes. There are many alternatives to produce biofuel from microalgae feedstock such as: biochemical conversion, chemical reaction, direct combust, and thermochemically convert raw wastes to useful products. Microalgae generally produce carbon neutral biofuel; by burning this kind of biofuel, CO_2 is produced which is then consumed by microalgae biomass. Though, the process is considered as carbon-neutral and would be a viable alternative to fossil fuels. Recent researched on biofuel production from microalgae is turning towards the most promising species that can produce more biomass. Two common biomass production, photobioreactor systems and open air (pond) systems are used. There are several algae harvesting process such as biological, electrical, chemical flocculation and centrifugation methods which are needs further development for producing commercially viable biofuel. In addition to biofuel production, many other valuable compounds such as vitamins and food additives were produced with valuable food and pharmaceutical applications.

Keywords: Biodiesel, Biofuel, CO_2 biofixation, Microalgae, Photobioreactor, Vitamin B12

PYROLYSYS AND GASIFICATION OF WASTE DERIVED FUELS: HISTORY AND PERSPECTIVES

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Abstract

Waste management is one of the central environmental challenges in todays linear economy. Moreover, we are forced to admit that concept of linear economy as well as the term “waste” itself are outdated and does not meet today's needs of the humanity. Recycling and reusing become the main approaches of waste management and many countries are bringing their economies closer and closer to the concept of circular economy. While, also developing this concept we need to take in account that infinite recycling is impossible: todays technology allows to recycle some kinds of plastic several times, and this number is even smaller, if we are speaking about cellulosic materials. It means that by recycling we cannot avoid the end of life management of these materials, it is possible only to postpone it, so traditional recycling technology is not a solution that allow to achieve circulation of carbon in economy. Even less this goal can be achieved using waste incineration, that not only wastes carbon as a resource, but also is a source of atmospheric pollution and serious problems connected with it.

Pyrolysis and gasification are alternative thermal processing approaches suitable for most of carbon containing wastes, that probably can overcome mentioned problems. This approach still can not be considered as well developed, while multiple technologies are established and successfully commercialised. The aim of this study is to review historical development of pyrolysis and gasification technologies, to characterise physical and chemical processes characteristic for waste pyro-gasification as well as to examine future perspectives of such approach. Literature review and statistical analysis of literature data are used to achieve this aim. Results show great perspectives of this approach.

Keywords: Pyrolysis, Gasification, Waste Management

POWER GENERATION AND WASTEWATER TREATMENT USING NAFION AND SPEEK / SGO MEMBRANES IN MICROBIAL FUEL CELLS

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ABSTRACT

Microbial fuel cells are systems which can directly convert chemical energy to electrical energy using microbial biocatalysts while treating wastewater and they are important systems for sustainable and clean energy production. A lot of research on MFCs is under way to improve the conditions and to increase the power and energy produced. Also, many studies have focused on synthesizing new membranes which have low cost, high energy recovery and proton conductivity. In the present study two different membranes including commercial Nafion 117 and synthesized SPEEK/SGO have been compared in a two-compartment MFC in order to measure the power density and their ability to remove the COD of the wastewater. The maximum power density of 43.8 and 61.3 mw/m^2 has been observed in the system working with Nafion and SPEEK/SGO, respectively which shows that sulfonation of the membrane has a great effect on its efficiency to produce electricity.

Keywords*:* wastewater treatment; Microbial fuel cell; Nafion 117, SPEEK/SGO; Power density

CAPABILITY STUDY OF ELECTRO-PEROXONE PROCESS IN A CYLINDRICAL REACTOR IN DEGRADING ACID ORANGE 7

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Abstract
Electro-peroxone is a novel advanced oxidation process that surpasses ozonation or peroxone because of its advantages. In this technology, combining ozone and hydrogen peroxide produced electrochemically leads to the generation of hydroxyl radicals, which are the strongest oxidizing agents. In this study, a cylindrical reactor with a continuous circular flow using novel arrangements of electrodes was used to examine the effects of variant parameters on dye removal efficiency. Acid Orange 7 ($C_{16}H_{11}N_2NaO_4S$) served as an indicator pollutant. Based on overall energy consumption and energy consumption per dye removed weight, electro-peroxone not only has a proper efficiency at high dye concentrations, it also has the least energy consumption per dye removed weight; 53 KWh/kg is achieved for 500 mg/L initial dye concentration at 99% removal efficiency after 40 minutes. The OFAT method was used to optimize parameters including dye concentration, pH, ozone injection rate, current intensity, flow rate, and electrolyte concentration; finally, COD and TOC removal were measured. The results show that at the optimum condition of [Dye]=500 mg/L, pH=7.7, applied current=0.5 A, O_3=1 L/min, [Na_2SO_4]=0.1M, and Q=8.5 L/hr, dye is removed completely after 90 minutes and COD and TOC removal is 99% and 90%, respectively.

Keywords: Electro-peroxone; energy consumption; advanced oxidation process; Acid Orange 7; hydrogen peroxide.

CONSTRUCTION OF A PILOT-SCALE METHANE DEGRADATION WINDOW AT OPERATING LANDFILL

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Abstract
A landfill is a large bioreactor, in the body of which landfill gas is generated due to anaerobic degradation of organic material. According to European legislation, the emissions of the landfill gas should be kept to a minimum. With large volumes, gas can be used for energy production, but if the collection is uneconomic, an attractive option would be to cover the landfill with a bioactive layer to degrade methane in-situ. In operational Uikala sanitary landfill, Estonia, where active gas collection system exists, it was found that uncaptured gas could be degraded in bioactive cover layer. To check whether such cover layer could be built from fine fraction from mechanical biological treatment (MBT), two experimental cells were constructed (0-20 mm and 0-40 mm fractions). The paper presents the design of experimental cells, a description of materials for construction and construction process, and preliminary results. Measurement system was installed in both cells: gas wells at eight depths and on three locations on surface. Three-level lysimeters were installed to determine water balance. Research is planned for two years with monthly gas sampling. The objective of the work is proving which of the MBT fractions, <20 or <40 mm, functions better for methane degradation. Confirmation of the methane degradation efficiency in fine MBT fraction is important not only from the ecological point of view. The use of a fine fraction as a material for methane degradation layer would reduce the cost of processing this fraction and become a good example of a circular economy since the landfill would be recultivated using its own resources.

Keywords: Landfill gas, MBT fine fraction, Methane degradation layer, Landfill cover

WASTEWATER TREATMENT: NEW CHALLENGES

REMOVAL OF MICROPLASTICS CURRENT RESULTS FOR A RESOURCE-EFFICIENT, SUSTAINABLE AND ECONOMICAL SEPARATION TECHNIQUE OF MICROPLASTIC PARTICLES IN MUNICIPAL WASTEWATER TREATMENT PLANTS

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Abstract
The concept for removing microplastics from wastewater consists of two steps. Cloud- Point Technology, which is already known from nanotechnology, provides the basis. The capture unit (CU), the bioinspired part of the whole molecule, forms the backbone. It is characterized by a characteristic preorganization and the ability to interact with the material to be included via the functional groups introduced. This makes it possible to first locate the particles in one place. The CU is finally implemented in the second partial step to the inclusion compound (IC) by the fixation unit. Inter alia, alkoxysilyl-functionalized substituents serve to establish the desired three-dimensional network structure, which is induced by contact with the effluent sol-gel process. In 2016 it was possible to confirm the conceptual approach on a laboratory scale for the first time. By adding inorganic-organic hybrid precursors, particle growth is initiated, forming agglomerates that are 10,000 times the original volume. A successful scale-up of the experimental setup into a 2000 l batch reactor confirmed the findings from the laboratory experiments. Again, particle growth was observed. Currently, a larger continuously working pilot plant is being installed to transfer the batch process to continuous process control. Previous research dealing with the removal of reactive organic stressors will be combined with the presented technique.

Keywords: Microplastics, Elimination, Cloud-Point-Technology, Particle Growth

MICROPLASTICS IN STORMWATER RUNOFF: CASE STUDY VITSIPPSBÄCKEN

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Abstract
Microplastics are defined as the fraction of plastics with a particle size smaller than 5 mm. Plastics are synthesized oil products made of organic polymers primarily by industry and applied broadly because of its persistent characteristics. Microplastics are either primarily produced in form of pellets or are the result of mechanical breakdown of organic polymer materials originating from human activities like industrial exhaust, traffic, urban surfaces or littering. Although the omnipresence of microplastics on land surfaces, sea and surface water bottom sediment and soil is acknowledged, their effect on the environment is unclear. Some of the main concerns are the leakage of environmentally toxic materials like PAHs following with microplastics from the production process. PAH´s are persistent hazardous substances interacting with hormones in living organisms and having cancerogenic properties. Furthermore, due to their continuous accumulation in living organisms microplastics (as well as plastics) can mechanically block the flow of food uptake due to saturation effects. Due to an exponential increase of global plastic production in the last 50 years microplastics are found all over the world in the environment as a result of leakage and permanent accumulation of this persistent material. According to Swedish EPA traffic activities are one of the main sources of microplastics in the environment. Polymers found in bitumen like materials in the asphalt and gummi tires of cars as well as in plastic litter, accumulate during dry weather and are washed off during rain from traffic surfaces. Hence stormwater runoff is the major transport link of traffic related microplastics in urban areas. To assess the importance of stormwater runoff in the discharge of microplastics, stormwater sampling was carried out during five rain events in an urban catchment with heavy traffic and samples were assessed for the abundance of organic polymers, their type and amount in stormwater samples. Mainly three different categories of organic polymers were identified in traffic stormwater; Bitumen like asphalt particles, gummi particles of car tires and hard microplastics. Gummi particles of car tires were highest in number, up to 6000 particles per liter stormwater. Stormwater was identified as one of the main transport links of microplastics from traffic, contributing to a continuous discharge and accumulation of these pollutants in the receiving waters.

Keywords: Microplastics, Asphalt particles, Gummi particles, Traffic stormwater

TURNING UP THE HEAT: A THERMOANALYTICAL APPROACH FOR THE DETECTION OF MICROPLASTICS

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Abstract
Plastics are essential in our daily life. Their numerous advantageous properties have led to increasing consumers demand and production volumes. On the other hand, there are global challenges with unwanted inputs into the environment. Due to globally poor disposal practices, littering, insufficient waste and wastewater treatment and the regular use plastic products in the environment, millions of tons have entered and still enter the environment. Environmental stresses (i.e. UV irradiation, oxidation, hydrolysis, abrasion) fragment the polymeric products in particles smaller than 5 mm, colloquially called microplastics. Microparticles originated from thermoplastic and elastomeric materials are found in all compartments all over the world, especially in aquatic water systems.

To reduce possible impacts on the environment, sources, pathways and sinks need to be identified. Therefore, fast and high throughput analytical methods regarding sampling, sample preparation and measurement protocols are required. A recently developed, fully automated method, thermal extraction and desorption gas chromatography coupled with mass spectrometry (TED-GC-MS), meets most of these requirements. It is suited to quantitatively detect all relevant thermoplastics as well as an elastomer that can be used as marker substance for tire wear. Key features of this method are good reproducibility due to the use of an internal standard, high sample mass inputs granting representative results, low maintenance requirements and fast measurements with low limits of detection. In contrast to microscopic-spectroscopic methods, minor or even no sample pretreatment is necessary.

The present contribution demonstrates the methodological key parameters of TED-GC-MS as well as its application for water filtrate samples, generated by fractionated filtration of representative water volumes. Data from a waste water treatment plant, a surface water body and street run offs are presented exemplarily.

Keywords: Microplastics, TED-GC-MS

MODIFIED CLAYS FOR TEXTILE DYES AND RARE EARTH ELEMENTS SORPTION AND POTENTIAL RECOVERY

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Abstract
Textile manufacturing as well as waste management are core sectors which discharge heavy loads of contaminants which are toxic and potentially carcinogenic, thus affecting aquatic biota and human health. As a result, the ineffective treatment of wastewater from manufacturing and leachate from industrial/municipal solid waste landfills not only causes environmental concerns but also lost potential secondary resources. The research aims to evaluate the removal efficiency and the recovery potential of textile dye and rare earth elements (REE's) from aqueous solutions using modified clays. Lanthanum (La), Cerium (Ce (III)) and Neodymium (Nd) have been selected as representatives of REE's while Congo Red (CR) has been chosen as the toxic and suspected carcinogen and mutagen textile dye. The chosen sorbents were smectite type clays modified with imidazolium based ionic liquids (IL) and hydroxyapatite (HAp). The properties of the modified clays were studied using X-ray diffraction, scanning electron microscopy, Fourier transform infrared spectroscopy and thermogravimetric technique. The sorption of CR and La, Ce (III), Nd from aqueous solutions onto the IL and HAp modified clays was studied using batch sorption experiments. The maximum sorption capacity of CR onto the IL modified clays was 150 mg/g; but maximum sorption of La, Ce (III) and Nd onto HAp modified clays was found to be 247 mg/g, 252 mg/g and 255 mg/g respectively. The results showed that CR and La, Ce (III), Nd ions can be efficiently removed from aqueous solutions by modified clays and the dye and REE's can be potentially recovered; furthermore, modified clays can be recycled and reused.

Keywords: Congo Red, Lanthanum, Cerium (III), Neodymium, Modification, Clays, Sorption, Recovery, Wastewater Treatment

DEAMMONIFICATION NITROGEN REMOVAL, ORP AIDED OPERATION BENEFITS ON MFC TECHNOLOGY

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Abstract
Sidestream wastewater was used to maintain autotrophic nitrogen removal in mobile pilot-scale (3 m^3 process tanks) reactor configurations -deammonification in biofilm. Biofilms were developed after adaption of biomass on carriers with undiluted liquid effluent of municipal wastewater treatment plant biogas facility. The highest total nitrogen removal rate (TNRR) was achieved in the deammonification biofilm reactor (0.33 kg-N m^{-3} d^{-1}). Time-based and concentration-based (optimal dissolved oxygen (DO) concentration was 0.3-0.8 mg O_2 L^{-1}) aeration control proved reliable when reject water characteristics were relatively stable. The biofilm from deammonification biofilm reactor was then tested in microbial fuel cell (MFC) technology in order to understand the exo-electrogenic behavior of it. Two MFCs with the biofilm (Test) and another one with septic tank mix consortia as control (Control) were observed to be capable of generating continuous bio-energy with operating voltage of 262 ± 17 mV and 163 ± 18 mV for Test and Control, respectively. Test (9.5 W.m-3) showed almost two times higher volumetric power density than Control (4.9 W.m-3) with lower internal resistance of 161 Ω than that of Control (386 Ω). The coulombic efficiency was also found to be higher in case of Test (27.5 ± 1.7 %) than Control (17.7 ± 1.9 %), demonstrating the applicability of ANAMMOX in MFC to achieve efficient wastewater treatment as well as higher energy recovery from MFC. Proper ORP range for biofilm ANAMMOX operation was -200 mV-0 mV.

Keywords: MFC, denitrification, pilot-scale, ORP, coulombic efficiency

WATER AND NITROGEN MASS BALANCE FOR NABLUS-EAST

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Abstract
Analyzing the urban water cycle is crucial for adequate urban water management and pollution control of the natural water cycle. Knowledge about exfiltration from sewer networks is very limited; but the few available studies indicate that exfiltration pollution loads pose un-counted serious threat to groundwater. The research was carried out on Nablus-East with a population of 94,910 inhabitants, to assess the pollution load of wastewater exfiltration from the sewers network and outlets. The investigations were carried out mainly on two catchments; a sub-main small controllable catchment, and a main catchment representing 86% of Nablus-East. The wastewater flows and loads from the two catchments were measured, and water consumption records were obtained as ArcMap software shapefiles. The results revealed that 82.2% of the consumed water ends up in the sewer network. The exfiltration wastewater from the sewer network resembles 12.8% of the consumed water, while 65.2% drains untreated to wadi Al-Sajor through the outlets, and 4.2% ends up in cesspits. The specific water consumption, wastewater production, wastewater exfiltrated from the sewer network and wastewater reaches the outlet are respectively 79.6, 65.4, 10.2 and 55.2 L/c.d. The specific pollution loads exfiltrated from the sewered part of Nablus-East are 2.4(g N/c.d), 0.25 (g TP/c.d), 23.5(g CODt/c.d) and 13 (g BOD/c.d). The total nitrogen load of the produced wastewater from Nablus-East is 1.88 (kg N/ha*day), out of which 1.49 (kg N/ha*day) reaches the outlets as a major point source pollution. The remaining 0.39 (kg N/ha*day) routes into exfiltration from sewer network of 0.29 (kg N/ha*day) and in cesspits is 0.10 (kg N/ha*day). The annual urban nitrogen loading of Nablus-East wastewater is 688 (kg N/ha*yr), which is very high due to high population density. Therefore, a wastewater treatment plant should be constructed as a first priority, and the sewers network should be rehabilitated.

Keywords: Sewer network, Municipal Sewage, Exfiltrationt, Pollution fluxes, Groundwater pollution, urban water cycle, natural water cycle

UPGRADING SEPTIC TANKS EFFICIENCY USING SELECTED BACTERIAL ADDITIVES

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Abstract

The experimental work was executed on 6 septic tanks represent two modified types located in villages of the Upper Egypt. Three of them receiving waste with medium organic load, while the others receiving waste with high load. Mixture of five locally selected, adapted, enzyme active producers, bacillus bacterial species has been used as additive to the septic tanks in order to test its ability to improve the effluent quality.
Regarding those receiving the medium load, a slight improvement in the effluent quality was achieved few days after the addition of the bacteria. At day 60, the effluent of tanks that supported with cultured bacteria had the following values: 77.2-104.8 ; 44.1-58.7mg O_2 /l for COD and BOD_5 ; 52.9-70.6; 4.1-15 mg /l for TSS, oil & grease and 10^4-10^6 MPN/ 100ml for coliforms. Septic tanks without bacterial additives (control) were able to show removal percentages ranged as: 79.3-88.5, 80 - 85.5, 75.1 - 83, 28 - 41.7, and 98.5 - 99.85 for COD, BOD_5, TSS, oil & grease and coliforms, respectively.
Septic tanks that receiving influent with high load of pollutants, again the actual improvement in the effluent quality appeared at the 6^{th} day with maximum removal after 36 days, and may extend to 42 days, after addition of bacteria. During this period, the removal percentages for COD, BOD_5, TSS, oil & grease and coliforms were ranged as 93.8 - 97.2, 94.5 - 97.0, 94.0 - 97.9; 64.0 - 93.8; 99.81 - 99.99, respectively. Control tanks showed percentages of removal ranged as 64.7 – 87.2, 73.4 – 89.6, 56.7 – 86.9, 34.6 – 45, and 92.8 – 99.28 for COD, BOD_5, TSS, oil & grease and coliforms, respectively.
Although, the removal efficiency of septic tanks with bacterial additives was higher in case of those receiving the high load of pollutants than those receiving medium load, the pollutants residual in the final effluent (after 60 days) of the first case are higher.

Keywords: Egyptian Rural area, Septic Tanks, Bacterial Additives, improvement the effluent quality.

QUATIFICATION OF BIOMASS ATTACHED TO CARRIERS IN A MBBR-PHOREDOX REACTOR: ULTRASOUND EXTRACTION

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ABSTRACT

One of the indicators for monitoring a Moving Bed Biofilm Reactor (MBBRs) is the biofilm formation adhered to the carriers or media, particularly in the aerated tanks. For that, a suitable method for extraction of the adhered biomass from the carriers is required. Different methods have been used so far, but there is a lack of standardization among the methods used. With the objective of establishing a cost-effective method for extraction of biomass adhered to carriers as biofilm in a Moving Bed Biofilm Reactor (MBBR) for urban wastewater treatment, a two-phase investigation was carried out using Design of Experiments (DoE) for process optimization. During Phase I, mechanical agitation versus ultrasound, different volumes and exposure times were tested. Since ultrasound showed better results, in Phase II, only ultrasound was associated to manual agitation in another run of experiments based on DoE. The best combination of ultrasound with manual agitation and time of exposure to ultrasound was defined. The best combination of variable has now to be applied repeatedly for the establishment of a protocol for extraction of biomass from carriers.

KEYWORDS: Wastewater treatment; Biological Processes; Biofilm

BIOTECHNOLOGY APPLIED FOR REMOVAL OF ORGANIC COMPOUNDS BY PHYCOREMEDIATION

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ABSTRACT

The chemical residues generated by research and/or teaching laboratories at universities and research centers raise a serious concern due to risks posed to the environment if not handled properly. Residues of some organic compound are discarded incorrectly because of inappropriate glass washing and equipment cleaning. Ethidium Bromide (EtBr) is an organic compound widely used as a DNA intercalator in molecular biology procedures and the EtBr ability of intercalating itself in the DNA molecule, makes it a toxic substance. Among biological wastewater treatment strategies, the use of microalgae (phycoremediation) has been appreciated as a potentially effective option to remove target contaminants from water. The objective of this study was to evaluate the removal of EtBr from water by three species of unicellular microalgae individually (*Chlorella vulgaris*, *Desmodesmus subspicatus*, and *Raphidocelis subcapitata*) and in a mixture (Mix). No large variations in the number of algae/mL were observed after 3 hours of exposure to a 0.5 mg/L solution of EtBr in mineral water, starting and ending with 10^6 algae/mL, excepting for *R. subcapitata* that ended with 10^7 algae/mL. The results in absolute values of EtBr removal (measured by fluorescence) after 1 h of treatment were: Mix> *D. subspicatus*> *C. vulgaris*> *R. subcapitata*. After 3 h the best result in absolute values (mg of EtBr) were: Mix> *D. subspicatus*> *R. subcapitata*> *C. vulgaris*. However, if relative microalgae density (mg/algae/mL) data are considered, the ranking after one hour was: *C. vulgaris*> Mix> *D. subspicatus*> *R. subcapitata;* after 3 h the ranking was: *D. subspicatus*> *C. vulgaris*> Mix> *R. subcapitata*. Therefore, it was concluded that, despite the low percentage of EtBr removal (<11%) achieved with Mix, this was due to the low microalgae density 10^6 algae/mL in the treatment assays. Based on these results, it was possible to estimate the density of each microalgae species required for the total EtBr removal as following: 10^{10} algae/mL for *C. vulgaris*, *D. subspicatus* and Mix; and 10^{11} algae/mL for *R. subcapitata*.

KEYWORDS

Phycoremediation; Laboratory effluent; Ethidium bromide; Tertiary effluent treatment; Algal biomass, Microalgae density.

EVALUATION OF 9-CHAMBER QUADRIPARTITE MICROBIAL DESALINATION CELL FOR HIGH-STRENGTH WASTEWATER TREATMENT, BIOLECTRICITY GENERATION AND SALT REMOVAL

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Abstract
Microbial desalination cells (MDCs) are the most attractive and eco-friendly technology for simultaneous wastewater treatment, bioelectricity generation and salt removal. Most MDCs in the previously reported works were consisted of 3 chambers, fed with synthetic or actual municipal wastewater. In this work a 9 chamber quadripartite MDC (QMDC) fed with septic tank sludge (septage) was examined for the first time. Desalination rate, organic pollution removal, Columbic efficiency and energy production were investigated over short and long-term operation. The roughened surface graphite (RSG) was used as both anode and cathode electrodes in the fabricated MDCs. The obtained results showed that QMDC can produce a power density of up to 8 W m^{-3}, maximum COD removal of 91.1% and desalination efficiency of 72.8%. In addition, long-term operation of QMDC under repeated batch cycles caused a significant drop in MDC performance, in terms of both electricity generation and salt removal. Through SEM images, a multilayer of biofilm was observed on membranes surface which had an inhibitory effect on MDC performance.

Keywords: Septic tanks sludge, Bioelectricity, COD removal, 9 chambers quadripartite microbial desalination cell

IWAMA: SMART WASTEWATER MANAGEMENT-DESIGN & RECYCLING

THE EUROPEAN SUSTAINABLE PHOSPHORUS PLATFORM AND ITS ACTIVITIES

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Abstract

A stakeholder group lead by the Dutch Phosphorus Platform initiated and organized the First Sustainable Phosphorus Conference on 6 and 7 March 2013 in Brussels. Besides seven key messages, including smart cooperation, developing EU-policies and incentives for efficient use and recycling, the European Sustainable Phosphorus Platform (ESPP) was launched as result of the conference.

The Platform was established as Belgian a not-for-profit association (statutes online at www.phosphorusplatform.eu, European Transparency Register n° 260483415852-40). ESPP is 100% membership financed, a key to credibility and independence, and has today nearly fifty members (industries, associations, governments, R&D institutes and innovation projects). ESPP supports research, technology and innovation projects, particularly the exchange and dissemination of results, but does not directly participate in European or national projects. It decides by consensus of its members – if no consensus can be achieved, ESPP does not publish or advocate positions but tries to mediate between controversial opinions. The communication tools encompass a continuously updated web-site, social media, eNews and Scope Newsletter, addressing more than 40,000 stakeholders worldwide.

The national nutrient Platform in the Netherlands anticipated the ESPP. Other national platforms followed: in Germany (2015), North America (2017), or are in project in Czech Republic, Ireland, Italy and Switzerland (2018). In addition, ESPP cooperates with initiatives pursuing compatible goals like the Baltic Sea Action Group and the Phosphorus Recycling Promotion Council of Japan that was just renamed to Phosphorus Industry Development Organization of Japan (PIDO). In cooperation with the International Nitrogen Initiative (INI), ESPP supports the Global Partnership for Nutrient Management (UN Environment Program).

Phosphorus stewardship is the wide objective of ESPP including food security, environmental protection, circular economy, food safety and healthier diets. ESPP understands itself as coalition for action bringing together water, waste and animal by-product industries, mineral & organic fertilizers, chemicals, technology suppliers, national & regional governments, knowledge institutes and interested stakeholders from other areas.

ESPP actions focus on closing the nutrient loop by recovery, recycling and sustainable use. Among others, challenges such as improving use, losses to aquatic bodies and eutrophication are addressed. Particular attention is paid to the regulatory framework: European policies like CAP, the Circular Economy Package and the Critical Raw Materials list as well as European regulations and directives such as the proposed new Fertilizing Products Regulation, the Animal By-products Regulations, water policy (including the Nitrates Directive) and the Emission Ceilings Directive and the Industrial Emissions Directive (BAT). In addition to the European legal framework, national and regional nutrient related policies are monitored and reported. In this context, highlights are the new P-recycling obligations in Switzerland (2016) and Germany (2017) as well as recommendations (HELCOM recommendation 38/1, 2017) and objectives (Finland, 2017 goal to process 50% of manure and sewage sludge for recycling).

The organization of meetings, workshops and conferences is also an important part of ESPP activities. After the ESPC1 in Brussels, ESPC2 was organized in Berlin 2015 and ESPC3 in Helsinki 2018 with increasing numbers of delegates from one conference to the next one. ESPC4 is scheduled for May/June 2020 in Vienna. Annual meetings for nutrient related research and innovation projects are organized, 2015 in Berlin, 2017 in Basel and on 8-9 November 2018 in Rimini, Italy. ESPP has also organized stakeholder meetings to develop proposals and enable networking addressing the EU Fertilizing Product Regulation proposal development and the evaluation of new Component Material Categories (CMCs) by the EU Joint Research Centre's (JRC) STRUBIAS Expert Group, recycled nutrient products in Organic Farming, contaminants in sewage sludge and economic tools for the Circular Economy. Meetings with representatives of relevant Directorates of the European Commission, Members of the European Parliament (MEPs), representatives of national authorities (e.g. of the country presiding the European Council and countries opposing joint European solutions) complement ESPP's networking activities.

In response to the initiative of Commissioner Moedas and a report by the well-known economist Mariana Mazzucato, a joint Nutrient Mission "To halve the nutrient footprint of food by 2030, for more resilient farms,

healthier diets and a better environment" was drafted and presented to DG ENVI, DG AGRI, DG Santé and DG Grow. It aims at selecting, coordinating and disseminating nutrient related research and innovation activities following a clear mission.

Finally, ESPP disseminates success stories of its members, provides a platform for networking between solution providers, regulators and users and raises the public awareness for nutrient stewardship. Due to its varied and balanced membership base, capacity in developing shared opinions and its commitment to science-based arguments, ESPP has been acknowledged as preferred partner of European and national policy makers for exchange of opinions and consultation.

PLATFORM ON INTEGRATED WATER COOPERATION: ENHANCING CONTINUOUS TRANSNATIONAL COOPERATION IN THE WATER SECTOR

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Abstract

Knowledge transfer has strategic importance influencing the long-term development towards the sustainable Baltic Sea Region. However, in the field of water management, knowledge transfer does not take place unhindered on the transnational level. Limiting factors can be connected with restricted time of project implementation, specifics of national practices on lifelong learning and experience exchange, or insufficient communication efforts in reaching relevant target groups.

The project *BSR Water – Platform on Integrated Water Cooperation* sets an ambitious goal of addressing these matters by creating an interactive online water platform "Baltic Smart Water Hub" for international knowledge and expertise exchange. The Hub gathers experts from water companies and associations, local authorities, academia, private companies producing clean-tech and innovative water-related solutions, as well as NGOs, initiatives and foundations working with water issues. The open access portal promoting most recent good practices, technical solutions and tools covers four water sections: fresh-, sea-, storm- and wastewater. The platform allows wide dissemination of piloted practices and tools leading to improved professional capacity of operators and further implementation of smart management of water resources in the Baltic Sea Region.

BSR Water brings together a partnership representing diverse projects with replicable and unique outputs, covering a broad variety of water-related issues: smart nutrient management and sludge handling, stormwater management, wastewater treatment, energy efficiency. Outcomes of the contributing projects are used to facilitate the long-term development of regional environmental policy and recommendations, which will further serve to strengthen policy-practice link in implementation of advanced water protection measures. Development of policy recommendations will enable alignment of national and macro-regional environmental policies further promoting implementation of advanced water protection measures resulting in clean and resilient Baltic Sea Region.

Keywords: Water management, transnational cooperation, knowledge transfer

KEY FIGURES FOR ENERGY BENCHMARKING IN THE BALTIC SEA REGION

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Abstract

The current energy demand of variously scaled and equipped wastewater treatment plants (WWTPs) in the Baltic sea region (BSR) which are operated under different legal requirements and diverse restrictions regarding nutrient effluent values (mostly according HELCOM) has been analyzed. In the framework of Interreg BSR project Interactive Water Management (IWAMA), operating data has been collected with a questionnaire addressing WWTPs in the region. A total number of 66 responses (reference year 2015) could be assessed for evaluation of the energy consumption related to nutrient removal. The information was provided from Sweden, Finland, Russia, Estonia, Latvia, Lithuania, Poland, Belarus and Germany. The data collected revealed that different technologies are applied with varying success in high treatment efficiency combined with low energy consumption. However, there is no clear region based dependency.

Half of the WWTPs considered in the evaluation are operated using less than 37 kWh/($PE_{COD,120}$·a). But only 20 % consume less than 23 kWh/($PE_{COD,120}$·a). This benchmark is proposed to be aimed by all plants in the region, still considering that the main task of a WWTP is treating wastewater in a proper way.

Keywords: Wastewater treatment, Nutrient removal, Energy optimization, Benchmark

COMBINED ANAMMOX-CONSTRUCTED WETLAND PILOT PLANT AT GDAŃSK WWTP

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Abstract

Deammonification has been widely applied at wastewater treatment plants (WWTPs) as a cost effective process to treat sidestreams with high nitrogen load. Applying the deammonification process in the mainstream, however, still presents a challenge. Major barriers in this application include low temperature, low ammonia concentration and high COD/N ratio. This report presents the results of pilot testing mainstream deammonification concept that was conducted at the Wschód WWTP in Gdańsk (Poland). The examined process configuration included primary, secondary and tertiary treatment steps. The physical-chemical primary treatment consisted of two stage flocculation tank and primary sedimentation tank. The secondary treatment incorporated integrated fixed-film activated sludge (IFAS) reactor, equipped with mixer and fine bubble air diffuser, and coupled with the secondary sedimentation tank. The IFAS reactor was inoculated with anammox bacteria immobilized on AnoxKaldnes K5 plastic carriers from the Sjölunda WWTP in Malmö and suspended growth activated sludge from the Wschód WWTP in Gdańsk. Removal efficiency of organic compounds and nutriets were observed after aech step of the wastewtaer teratment process. The effect of C/N ratio and temperature variations on nitrogen removal were investigated, with particular attention to the efficiency and resilience to low temperature of deammonification. The results of this study revealed very high efficincy of the tested pilot system. The measured average total nitrogen removal efficiency was 77% and 96% at process temeperature 13.5°C and 30°C, respectively.

Keywords: Mainstream anammox; deammonification; autotrophic nitrogen removal; nitritation; wastewater treatment.

DECISION MAKING TOOL FOR OPTIMIZED PROCESS OPERATION AND MASS FLOW MANAGEMENT AT GREVESMÜHLEN WWTP

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Abstract
The "IWAMA" (Interactive Water Management) project, funded by the BSR INTERREG 2014 - 2020 program aims to improve the water quality of the Baltic Sea. One of the most important tasks is to train the participating operators of the treatment plants, with regard to energy efficiency and sludge management. WWTP Grevesmühlen currently has a capacity of approx. 65,000 PE. The incoming wastewater is characterized by high proportions of industrial discharges (dairy, coffee production). In addition to the biological treatment, based on the activated sludge process, a central sludge treatment forms the core of the plant. Due to additional digestion of sewage sludge from surrounding WWTPs and various co-substrates, the biogas yield is improved/high. Besides a sludge thickening and co-substrate receiving station the plant is equipped with a thermal hydrolysis unit to intensify the digestion processes, aiming to further improve the biogas production and dewatering characteristics of the digested sludge. The sludge liquor is treated in a partial flow treatment, based on a two-stage deammonification to significantly reduce the nitrogen load. The complex overall system allows an energy-efficient treatment of wastewater without compromising the effluent quality. The decision-making tool aims to link the inter-dependent treatment components. For this reason a simulation model of the WWTP Grevesmühlen was developed in a step-by-step approach, based on a detailed baseline study and operational data analysis. Based on a successful calibration and validation of the simulation model including pre-treatment, aerobic biological treatment, sludge digestion, co-fermentation, thermal hydrolysis and deammonification, optimization potentials will be identified. Subsequently, the findings will be implemented in the full-scale operation of the treatment plant. The verification process includes a detailed measurement campaign before and after implementation of the optimization measures. The IWAMA project started in March 2016 and has a term of three years with a total budget of € 4.6 million.

Keywords: Simulation, energy efficiency, plant wide modelling

DEGRADATION OF PHARMACEUTICAL AND PERSONAL CARE PRODUCTS DURING SEWAGE SLUDGE COMPOSTING

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Abstract

The aim of this work was to determine the impact of different ratios of bulking agent on the degradation of pharmaceutical and personal care product (PPCP) residues in sewage sludge compost. The behaviour of four PPCPs has been studied during 30 days composting period: one anti-epileptic (Carbamazepine), one non-steroidal anti-inflammatory (Diclofenac), one anti-eptileptic (Metformin) and one antimicrobial (Triclosan). Sewage sludge samples (anaerobically digested and dewatered by centrifugation) were collected from municipal wastewater treatment plant. The sludge was mixed with different bulking agents. The results of the analyses indicated that none of the compost samples was originally free of Carbamazepine, Diclofenac and Triclosan residues. Among the substances considered, the higher removal efficiencies (over 90%) were evident for the Diclofenac and Metformin. For Triclosan these values ranged between 55% and 81% (depending on the ratios of sludge and bulking agent). Carbamazepine showed no degradation. The results of this study show that by using different amendments, the effectiveness of the degradation of pharmaceuticals may increase during composting, whereas for the elimination of CBZ from sewage sludge different means should be used.

Keywords: Degradation, Compost, Carbamazepine, Diclofenac, Triclosan, Metformin, Sewage Sludge

BIOSEP², SUSTAINABLE SINGLE HOUSE WASTE WATER TREATMENT SYSTEMS FOR THE FUTURE

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Abstract

Water saver The BIOSEP² system saves 80% of drinking water

Rotating Bio char filters
The BIOSEP² system has a proprietary bio char filter with different types of bio coal parts depending of use mounted in a rotating stainless steel carousel rig.

Ban on sewage sludge on farmland in the future
As of now, an investigation is taking place in Sweden regarding how a ban on spreading of sewage sludge on farmland shall be drafted.
Sweden is following Germany in this respect. The ban aims to lower the risk for cadmium-, led-, and micro-plastics contamination of the fields where we grow our food. The ban also opens possibilities, and likely also the need for a circular economy, closer to where the sewage is produced decreasing transportation and increasing local business.

Phosphor
Researchers agree that there will be a shortage of Phosphor in the world in the near future.
The main part of the phosphor used today in Sweden is mined abroad and then transported to Sweden, while at the same time the phosphor in the human waste ends up in rivers, lakes and the oceans, causing over fertilization. The suggested ban will help Sweden to mine the phosphor out of the sewage sludge and make the Swedes self-sufficient of phosphor. With the BIOSEP² solution no chemicals or complicated processes is needed to separate the phosphor since it is captured in its natural form, and ready to use in the BIOSEP² tank.

Scalable system
The system is totally scalable: from single households to groups of houses to villages and cities. The difference is only sizes and numbers of filters, tanks and rotation and maintenance intervals.

Keywords: Sustainable, wastewater treatment, circular economy, bio char, phosphor, sewage sludge ban, bio fertilizer, BIOSEP² project

REMOTE SENSING TECHNOLOGIES AND SAMPLING METHODS IN ARCTIC AND ANTARCTICA

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Abstract

In last four years scientists from the University of Latvia have carried out six scientific expeditions in the Arctic and the Antarctic focusing on geophysical studies of modern glaciers and performing interdisciplinary studies in the fields of geology, geomorphology, glaciology, soil science, remote sensing, and microbiology. Scientific expeditions to Iceland were carried out in 2014, 2015, 2017 and 2018, and the expedition to Greenland was accomplished in 2016. In the last year's (2017) expedition to Iceland, researchers tested new study methods and equipment, which were used for future research in the Arctic and Antarctic. The first Latvian scientific expedition to Antarctica was carried out in 2018.

The main goal in these polar expeditions was an investigation of glacier thickness, structure and subglacial topography using ground penetrating radar (GPR). GPR measurements were performed by GPR Zond 12-e and 38 and 75 MHz antennas. Assuming that the average dielectric permittivity of ice is equal to 3.5, it allowed detecting the reflections of depth up to 160 m beneath the ice surface. The coordinates of each GPR profiles and sampling points were determined by GPS system Magellan Promark 3 or Emlid Reach RS+ that are composed of two GPS receivers. Working with this particular GPS allowed us to take measurements and post-process results with geodetic accuracy, with or without GSM or radio support.

Surface topography of the glaciers is articulated, as a result, GPR data gathering and creation of precise surface elevation maps is difficult. Starting from Greenland expedition in 2016, aerial unmanned vehicle (UAV) is used to create three-dimensional models of the marginal zone of glaciers. Surface elevation maps of the surveyed part of the glaciers were created using a large number of aerial photographs captured with drone DJI Phantom 3 advanced and DJI Phantom 4 Pro V2.0. To anticipate bad weather and high risk of wind, in the last expedition to Iceland Dji Mavic Air was used as a reserve in case of possible technical problems with main UAV. To control UAV and generate missions DJI GO4, Drone Harmony and Pix4Dcapture apps were used. Usually, flight altitude was 60-70 m with profile overlap of 80-85%. Digital elevation models and orthophoto maps of the research areas with the precision of 5 cm were created with Agisoft and Pix4D Mapper software. Models of the subglacial topography and ice surface were created by SAGA GIS software and Thin Plate Spline (Global) interpolation method.

A number of issues were encountered during the capture of aerial photographs with UAV during expeditions. Smallest of them were damaged and wearied out connection cables even they were new. Incomprehensible problems are associated with aircraft and remote controller connections, signal lost or apps support.

In addition to these investigations, sediment, water, and cryoconite samples were collected from ice, as well as from different environments as small ponds, streams, and inlets to characterize sand formation processes, soil development, and microbial diversity in this part of Arctic and Antarctica.

Keywords: aerial unmanned vehicle, three-dimensional models, ground penetrating radar

REMEDIATION AND ENVIRONMENTAL RISK ASSESSMENT

HOW CAN YOU PROTECT YOURSELF AGAINST HEAVY METALS? INTERACTIONS BETWEEN ESSENTIAL MINERALS AND HEAVY METALS

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Abstract
Heavy metals like cadmium (Cd), lead (Pb) and mercury (Hg) interact with essential minerals like zinc (Zn), iron (Fe), copper (Cu) and calcium (Ca) in different stages of absorption, in distribution in the organism and in excretion.

Among the heavy metals, Cd is one of the most toxic and Cd accumulation in the key food crops like wheat leads to risk to the health of consumers. Cd in soils has increased due to the human use of fertilizers, the combustion of garbage and sludge. Simultaneously the concentrations of essential minerals in crops such as grains have decreased.

Interactions between Cd and Zn / Fe have been reported in numerous papers. Sufficient dietary Zn and Fe intake and Zn and Fe status in the body plays a significant role in preventing and reducing adverse actions and the toxicity of Cd.

Over 60% of the world´s population is estimated as Fe-deficient and over 30% as Zn-deficient. More than two billion people, particularly in developing countries suffer from so called "Hidden hunger". Grain products from wheat, rice and maize are globally the most important sources of essential micronutrients. Wheat stands for 30% of all cereals produced for food purposes. Thus, wheat contributes more to intake of heavy metals than the other cereals.

Whole grain products are naturally rich in essential minerals and many varieties of ancient grains of wheat have even higher density than modern wheats. In refined wheat and polished rice micronutrients have been reduced by up to 75%. All seeds contain phytate, an anti-nutrient that binds and protects the minerals in the seeds until the minerals are needed for growing of the germ. Phytate affects the bioavailability of essential minerals however phytate even has capacity to bind heavy metals in the intestines.

It is a challenge for the agricultural as well as for the food industry to produce and develop staple foods for daily use that are proven to be healthy!

PRELIMINARY RESULTS FROM AN OIL SHALE DEPOSIT IN SWEDEN REMAINS FROM 2ND WORLD WAR

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Abstract

During 2nd world war there was shortage of oil in Sweden and one of the assets available were oil shales which could be used to extract oil through pyrolysis. In 1942 the annual production of oil shale reached 100,000 cubic meters and production continued until 1966. The remaining shales were deposited outside the city of Kumla reaching approximately 100m in height and still to this day some parts in the pile is undergoing pyrolysis causing temperature inside the deposit to reach more than hundreds of degrees Celsius. The oil shale contained elevated concentrations of uranium making it a NORM (Naturally Occurring Radioactive Materials) waste.

Samples taken for this study included soil cores of 45 cm depth, moss growing on the top of the deposit, hare droppings found in the area, surface water from a nearby lake and hair samples taken from a nearby barber shop. The samples were analyzed by gamma and alpha spectroscopy.

Analyzed cores showed ^{238}U ranging from 0.44 to 1.62 Bq/g with an average of 1.26 Bq/g. For comparison, the average ^{238}U activity concentration in Swedish soil is 0.07 Bq/g for 0-50 cm depth. It was found that the average ratio of ^{234}U/ ^{238}U in the cores were 0.95 with a max value of 1 and average ratio of ^{210}Po/ ^{238}U were 1.13 and max value was 1.34. The results from the external dose survey showed that the dose above the ground ranged from 0.112 to 1.200 µSv/h.

The results obtained from this preliminary study shows that the uranium concentration in the remaining oil shale are about twenty times the average concentration found in Swedish soil. It is also seen that the concentration is increasing with depth and that a more severe disequilibrium in the ^{238}U decay chain exists along the depth.

Keywords: Shales, NORM, Waste, Alpha, Gamma spectroscopy

THE PHYTOREMEDIATION APPLICATION IN ABANDONED URBAN BROWNFIELDS

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Abstract
The abandoned brownfield are associated not only with degraded landscape but also with polluted or even contaminated soil. The brownfields in Baltic region mostly are areas with industrial ruins. The one of challenge is to remediate urban brownfields in acceptable way for society, owner and local municipality. This study investigate three brownfields in Latvia and Lithuania. The objective of the research is to develop, new knowledge for innovative and environmental friendly regeneration of brownfields using Triple Helix concept. In the research innovative approach of phytoremediation is used for a first time for cleaning and revitalizing of soils of brownfields in Latvia and Lithuania. There is three brownfield territories revitalized within the research project: first territory of former linen factory in Kraslavas Street 1, Ludza with total area 8.97 ha, second territory of former Kazitiškis heating plant in Kazitiškis sub-district, Ignalina district with total area of 385 m^2 and third territory of former Oil products station in Naivių village, Skapiškis sub-district, Kupiškis district with total area of 313 m^2. The investigation of brownfields were made by environmental engineers, landscape architectures and botany experts. The phytoabstraction will be applied in linen factory territory to remove nitrogen pollution from diches and pounds, the phytostabilisation will be applied in heating plant territory after excavation of crude oil spill and the phytodegradation will be applied to reduce oil pollution.

This research was done with support of Interreg V-A Latvia – Lithuania Programme 2014-2020 project LLI-325 Innovative brownfield regeneration for sustainable development of cross-border regions (BrownReg)

Keywords: phytostabilisation, phytoextraction, phytodegradation.

OCCURRENCE AND ECOLOGICAL RISK ASSESSMENT OF ENDOCRINE DISRUPTING COMPOUNDS IN AN URBANIZED SUB-BASIN OF RIO DE JANEIRO STATE

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ABSTRACT

The João Mendes river is one of the most important contributors to the Piratininga/Itaipu lagoon system in Niterói oceanic region, Rio de Janeiro State, Brazil. It is known that this basin is suffering with the discharge of untreated domestic sewage. The objective of the present study was to contribute to the environmental diagnosis of this sub-basin by assessing the ecological risks related to the presence of endocrine disrupting compounds in the surface water of João Mendes river. Four monitoring campaigns were carried out during a seven-month period with four sampling points. One of these points was taken as reference (P0) assuming absence of relevant contamination due to sewage discharge plus three points (P1, P2, P3) suspected of being seriously affected by sewage discharge. The Ecological Risk Assessment (ERA) model applied was based on the Dutch Triad, which integrates Chemical and Ecotoxicological Lines of Evidence (LoE) to estimate the environmental risk of the studied area. The presence of Bisphenol-A and 17α-ethynylestradiol were investigated as Chemical Substances of Interest (CSI) to integrate the Chemical LoE using ultraperformance liquid chromatography (UPLC-MS/MS). The ecotoxicological assays selected to integrate the Ecotoxicological LoE were: micronucleus frequency in fish *Oreochromis niloticus*; growth inhibition of the microalgae *Raphidocelis subcapitata*; reproduction of micro-crustaceous *Ceriodaphnia dubia* and; Yeast Estrogen Screen (YES) with genetically modified *Saccharomyces cerevisiae*. In P0 very low concentrations of CSI were found and no significant differences were observed when compared to the controls of the ecotoxicity assays. The sampling points P1, P2, P3 presented Extreme Risk (>0.75) in all campaigns for both Chemical and Ecotoxicological LoE. The Integrated Ecological Risk in all points was estimated as extreme (P1>0.99; P2>0.99; P3>0.99). The extreme risks were associated to the highest concentrations of 17α-ethynylestradiol being this compound considered the main responsible for the risk attributed to the monitored points.

KEYWORDS: Urbanized Basin, Emerging Micropollutants, Ecological Risk Assessment, Aquatic Toxicology.

ASSESSMENT OF ENVIRONMENTAL RISKS IN A BLACK SHALE AREA, CENTRAL SWEDEN

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Abstract
Black shales of marine origin are common in Europe. Cambrian shales are found in S Sweden and along the Caledonian mountains. They are enriched in trace metals like U, Mo, V, Ni and Zn. They have been utilized for extraction of alum, as energy sources and for the extraction of uranium. This study aims at assessing the environmental risks of trace metals in the Viken area in Central Sweden. The tectonic forces have created a "loaf", 200 m thick, about 4 km wide with a length of a few km containing about 400 000 tons of U.

The situation has been studied by sampling soils, plants and water. Soils are rich in trace metals, however a variable percentage has been lost in soil formation as compared to the black shale. Only As is of similar levels in soils and shale and has been adsorbed on site onto ferric oxyhydroxides in soils. Mo is taken up in common forage plants like red clover, risking molybdenosis, secondary Cu-deficiency in cattle. However, farmers buy concentrate enriched in Cu which seems to avoid this. Water is rich in U (> 100 μg/l), however calculations with Visual MINTEQ show that U is in the form of Ca-uranyl-complexes (97-99 %) not toxic or uptakeable.

While the current situation does not seem to be of serious concern, there are plans for mining 700 M tons of shale over a 30 year period. This would leave almost the same amount of finely ground waste with 15-25 % of the trace metals left after microbial leaching. The deposition of this waste is crucial as U and Mo would leach under oxidizing conditions while arsenic would do so under reducing conditions. The distance to lake Storsjön, a water source for about 50 000 people, is less than 2 km.

Keywords: Shale, Trace metals, Environment, Water, Plants

THE PHYTOREMEDIATION APPLICATION IN AGRICULTURAL POLLUTION REDUCTION

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Abstract
The phytoremediation is effective solution for agricultural non-point source pollution reduction. One of phytoremediation technology is to build constructed wetlands. Meteorological and hydrological factors and their effects on nutrient retention in surface flow constructed wetland treating agricultural non-point source pollution were analysed in this study. The main objectives were to determine the factors that contribute to nutrient removal and provide maintenance recommendations that could optimize performance of constructed wetlands. In order to estimate removal efficiency of nitrogen and phosphorus compounds water samples were collected from the surface flow constructed wetland located in Zalenieki County, Latvia, twice per month since June, 2014. Water quality parameters such as total suspended solids, nitrate nitrogen, ammonium nitrogen, total nitrogen, orthophosphate phosphorus, and total phosphorus were monitored. The V-notch weir and water level loggers were installed at the inlet and outlet of the wetland to measure water flow. Daily precipitation and air temperature was obtained from the nearest meteorological station to determine the impacts of meteorological conditions on nutrient retention.
The seasonal impact of meteorological conditions on nitrogen transformations in surface flow constructed wetland was demonstrated by increase of ammonium-nitrogen concentrations and decrease of nitrate-nitrogen concentrations during the vegetation period. In the study period the retention efficiency of surface flow constructed wetland for total phosphorous was higher during the vegetation period by 53%. The concentrations of suspended solids were higher after the wetland during March, April and May, which is related to occurrence of high flow conditions in the spring period.

Keywords: constructed wetland, non-point source pollution, total nitrogen reduction.

REMEDIATION, LANDFILL & HARBOR MINING

ARE NON-CONVENTIONAL DREDGING ANY BENEFICIAL USE OF BOTTOM SEDIMENTS FEASIBLE IN THE REAL WORLD?

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Abstract
Nowadays several water recipients have been suffering of contamination due to sources such as urban and industrial stormwater runoff, port and harbour activities, and leakage from old contaminated masses. Many of these recipients are located in coastal areas and discharge their waters to the sea/oceans such as the Baltic Sea. Besides contamination, our planet has been overexploited and our natural resources, such as phosphate-rocks and metals are being depleted in a tremendous high speed which has been raising serious concerns. There is an urgent need for remediation, preventive actions and also the development of technologies that can transform any type of waste, such as dredged sediments as raw material for different end-users to phase out the pressure over our planet. However how is this done in the real world? Is this feasible? If feasible what are the main barriers to be overcome? Can we use bottom sediments for civil engineering purposes, agriculture and forestry activities and energy production? This is a concept that goes beyond the circular economy and these questions are being currently taken at a large-scale project implemented in Kalmar, Sweden called LIFE SURE. The project has the main objectives of: 1) demonstrating an innovative dredging technology that does not cause any resuspension, release and pose risks to environmental and human health and 2) developing treatment techniques that make it possible the beneficial use of dredged sediments and 3) developing cost-effective techniques for recovery of valuables such as nitrogen, phosphorus and different metals such as copper, zinc and lead. It is expected that by the end the project 70% of the total amount of dredged sediments (approx. 30,000 m3) are recovered and used as secondary material for end-users. Furthermore, the project has the mission to spread and disseminate the possibilities of implementing a cost-effective dredging technique and treatment system to recover the environmental and ecological status of coastal waters that suffer from eutrophication and metal contamination within the EU.

CIRCULAR ECONOMY PERSPECTIVES IN MANAGING OLD CONTAMINATED GLASS DUMPS

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Abstract

Landfills and dumpsites have been the ultimate end of life sinks for various materials and products. As such, they are considered rich stocks of secondary raw materials for the circular economy. However, most of them are non-sanitary as they lack protective measures against environmental contamination. Over the years, the need to exploit the resource potential of landfills as well as to mitigate their contamination problems, among other factors, has led to the concept of landfill mining, resulting in a number of mainly pilot scale mining of landfills and dumps globally. In southeastern Sweden for instance, where there are over forty old, contaminated glass dumps, a number of remedial dumpsite excavations have been going on, with eventual landfilling of excavated materials in sanitary landfills. Hence, based on the Swedish situation, this study presents three scenarios about: contaminated materials in non-sanitary dumps as they currently stand; ongoing material excavations with subsequent landfilling; and material excavations coupled with materials recovery towards reduced landfilling. The third scenario is presented as more suitable from the circular economy perspective. The scenario is thus discussed in terms of technological implications of the process from identification of concealed valuable materials in dumps to their excavation, sorting, temporal storage, valorization and eventual resource recovery. In addition, legal implications as well as potential social, economic and environmental barriers against the scenario's implementation are discussed. Finally, the study provides recommendations that would be useful in decision making surrounding the management of contaminated and non-sanitary dumpsites.

Keywords: Circular economy, glass waste, heavy metals, landfill mining, waste management

SMÅLANDS GLASSWORKS- A REVIEW OF THE RECENTLY PUBLISHED STUDIES

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Abstract
The historical contamination of Smålands glass industry by hazardous concentrations of different trace elements (such as Pb, As, Zn, Cd and others) is a fact that has been approved by many researchers. These studies covered the situation of the glassworks contamination from different angles. However, the recommended solution by the Swedish Environmental Protection Agency is landfilling. Dumping these masses means, on the first hand, losing huge amounts of the Earth natural resources as wastes and, on the second hand, losing any future opportunity of recycling or reusing due to mixing these masses with other hazardous wastes generated by different sectors. In this paper, we are trying to review and highlight the results obtained by some of the already published studies in this field to identify the gap and challenges of recycling or reusing options.

Keywords: Smålands glassworks, trace elements, recycling, reusing, contamination

GLASS – SO MANY OPPORTUNITIES FOR REUSING AND RECYCLING

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Abstract

Glass is a perfect recyclable material as it can be re-melted over and over again. It is less energy consuming and leaves a much smaller carbon dioxide foot print to melt glass than melt raw-materials. We have shown that it is possible to remove lead from lead crystal and obtain a glass with less than 0,1% lead. The glass can be modified to obtain a high quality colored glass with good resistance. Thus our landfills in the Kingdom of Crystal are a resource for glass recycling and lead excavation. There are other glass streams today that are not fully recycled and they provide a complementary uncolored glass. Thus there is a wide variety of possibilities with both colored and uncolored glass which is unexplored.

Keywords: waste glass, landfill, excavation, recycling

BASAREHOLMEN- THE ISLAND SELF-SUFFICIENT PROJECT

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Abstract

Basareholmen is an island close to the city center of Karlskrona. The island has been used for ammunition manufacturing from the early 1800s until 1986. Since then there has not been any activity on the island until Karlskrona municipality focused its attention on it in 2018.
Basareholmen is together with two other islands in the archipelago, part of the Karlskrona Culture Archipelago concept. The islands have different themes, where Basareholmen will be characterized by art, innovation and sustainability.
During the spring of 2018, the municipality and an innovation company fulfilled workshops with local companies, entrepreneurs, students and public organizations. The purpose was in order to find sustainable and innovative solutions to different challenges of Basareholmen, like transportation, clean water, energy, waste management and handling of contaminated soil. The workshops resulted in several ideas of how to solve these challenges.
Some of these solutions were prioritized, one of them being the idea of using plants to measure and clean the contaminated soil. Plants have the availability to absorb pollutants; wish is a highly analogous solution in an increasingly technically oriented society,
The disposal of sewage was another prioritized solution. The suggested solution recommends extracting the sewage and transformed into biogas, which maybe can be used as fuel for transport. There is a vision that this process can be done on the island, thus making the island self-sufficient.
The design of transport system of the island is another challenge. Instead of buying an existing transport system, it was suggested that the transports could be designed for its purpose with the aim of in an open-minded way to find the optimal transport.

CHARACTERIZATION OF MARINE SEDIMENTS AND ITS POTENTIAL FOR RESOURCE RECOVERY- CASE OF MALMFJÄRDEN BAY, SWEDEN

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Abstract

Millions of tons of dredged sediments are produced every year. Sediments must be extracted to guarantee the navigation levels and to retain minimum ecological water volumes. Dredged sediments are, in general, contaminated by nutrients and heavy metals. The successful recovery of valuables can represent new resources of metals and nutrients. Nevertheless, the recovery varies on a case-by-case basis and depends on the composition of the sediments. Malmfjärden is a semi-enclosed bay located in Kalmar, Sweden. Currently, the water body is becoming extremely shallow, and therefore extraction of sediments is required. The retrieved sediments will be recycled for beneficial uses. Before sending to end-use, the project aims to recover heavy metals or nutrients from the sediments. This study focuses on characterizing the dredged sediments from the bay. The results showed that the sediments are mainly constituted by silt and clay and having high levels of nitrogen and phosphorous, which present a potential for extraction. Additionally, the sediments have none or little presence of organic pollutants (PAH, PCB and aliphatic components) and low-medium concentration of heavy metals.

Keywords: sediments, nutrients, heavy metals, organic pollutants, recovery

REMOTE DETECTION AND RECLAMATION OF LAND DAMAGED BYAMBER MINING

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Abstract
The problem of illegal amber mining in the forest areas of Ukrainian Polissya has been in existence for more than 15 years. Primitive mining technologies are causing degradation of large areas of forest lands, destruction of the earth's surface and changes in the water-chemical balance of damaged territory. As a consequence, local communities losing significant forest areas triggering serious economic losses to landowners. Disturbed biotopes require a large-scale reclamation measures. However, local authorities do not have appropriate methods for assessing the losses incurred and suitable measures for planning the scale of remediation operations. The purpose of the study is developing a methodology for detecting measures of the land damage caused by amber mining and providing recommendations on remedial operations to local authorities. Sentinel-2 space images with atmospheric correction class 2A were used to determine the affected area. Numerical data processing was performed using SNAP and ArcGis programs. The proposed methodology is based on the applied vegetation index GEMI, the water index NDWI2 and the composite of short-wave infrared radiation (SWIR2), close infrared (NIR) and green (GREEN) channels. Recommendations for the planning of restoration activities are provided on the basis of research on forest land reclamation methods and existing peer review reports.

Keywords: Amber mining, Land damage (degradation), GIS methodology, Space images, Atmospheric correction, SNAP and ArcGis programs, Land reclamation

REVIVING BALTIC RESILIENCE

DIMETHYL ETHER - ALTERNATIVE FUEL FOR MARINE ENGINES

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ABSTRACT

New transportation fuels are needed to reduce both particulates and gaseous pollution. Environmental protection standards set higher demands for fuels, particularly the content of sulphur. For exhaust gas, standards for the content of aromatic compounds, nitrogen oxides, soot and unreacted hydrocarbons are continuously being reduced.
Currently, the cleanest transportation fuels are liquefied natural gas (LNG) and dimethyl (DME). However, DME has advantages over LNG due to its:
-Superior performance in various fuel applications, e.g. as a 'standalone' substitute for diesel fuel; and
-Lower transportation and distribution costs.
DME can be indirectly produced from methane or natural gas. A number of technologies for the usage and conversion of methane have been developed and implemented. Besides LNG, it is also used in a compressed form, CNG. However, as a fuel it has some disadvantages and limitations. LPG is commonly used. This fuel, in comparison to gasoline, has numerous advantages but cannot be used in compression-ignition (diesel) engines, mainly due to its low cetane number. On the other hand, a gaseous fuel which may be used in diesel engines without limitation is DME. Although fuels from crude-oil processing dominate the market, DME is the subject of extensive research. DME can be used as a transportation fuel on land and at sea. In the marine sector, stringent standards for designated emission control areas (ECAs) mean there is a requirement for cleaner transportation fuels. In the Baltic Sea ECA, for example, vessels operate powered by LNG and by DME produced onboard from methanol. Another need for DME is associated with natural gas production areas where there is low local demand for gas and no access to a gas pipeline. In this case, a mobile system allowing the conversion of methane to DME could be considered. In addition, local voluminous sources of biogas may also serve as a source of methane for DME production. All of this justifies the commencement of work on new technologies for DME production from natural gas.

Keywords: ship transportation, marine engines, fuel, DME

PHYTOREMEDIATION AS A PROMISING METHOD FOR THE TREATMENT OF CONTAMINATED SEDIMENTS

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Abstract
Dredging activities are necessary to maintain the navigation depth of harbors and channels. Additionally, dredging can prevent the loss of water bodies. A large amount of extracted sediments is produced around the world. Removed material is widely disposed of in open seas or landfills. Much of the dredged material is polluted and is classified as unsuitable for open-sea disposal. In Sweden, many dredging activities are taking place nowadays like that in Oskarshamn harbor, Inre harbor Norrköping municipality and Malmfjärden bay in Kalmar. In this review, the potential of phytoremediation as a treatment method is discussed with focus on suggested methods for reusing the treated sediments. Recycling or reusing of dredged and treated sediments would preserve Earth natural resources as well as reduce diffusion of contaminants to the environment.

Keywords: phytoremediation, metals, sediments, dredging

ADVANTAGES AND DISADVANTAGES OF THE ANTHROPOGENIC IMPACT ON THE SANDY COASTS: PALANGA STUDY CASE

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Abstract
An attitude to the understanding of the anthropogenic impact always has a negative connotation. Nevertheless, positive impact of the human activities is always existed as well, but usually neglected. For instance, impermeable promenade built in the end of the XIXth century at the Palanga coast is the reason of the wide sandy beach with high dunes that is attractive zone for the local and foreign tourists. At the same time, the overwhelming amount of the holidaymakers has negative consequences to the qualities of the seacoast interaction zone. The method of comparable evaluation of the historical shoreline's evolution taking into consideration the hydrodynamic and human activities fluctuation on the Palanga sandy beach is applied. Therefore, the indication of the negative and positive results of the human impact on the coast is stated. Two kind of exposure signs of the anthropogenic impact on the coastal zone are distinguished - long term (shoreline changes due human impact) and short term (the same shoreline erosion, pollution by marine litter, etc.). It makes sense to show that short-term negative changes should be prevented or protection measures should be organised in order to reviving natural wealth and to recognise the long-term advantages. For these purposes, the Palanga coastal zone pollution is analysed. It should be noticed, that marine litter founded on the Palanga beach have both origins: coming from the sea and directly from the coastal zone. The predominant direction of the marine litter on the shore depending on the touristic season and hydrodynamic situation is determined.

Keywords: Anthropogenic impact, marine litter, coastal erosion, sandy coast, hydrodynamics

INDUSTRIAL WASTEWATER

RECIRCULATION OF PROCESS WATER IN A WET FERMENTATION OF OFMSW

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Abstract
The MBT plant of Freienhufen is used to stabilize residual waste. Since the rural districts Elbe - Elster and Oberspreewald - Lausitz match their waste management with federal law, oFMSW will be collected separately in future. Hence the AD process has to be converted. The accomplishment has to refer to the existing operating regime to reduce investment costs. This contains a wet fermentation. In order to facilitate the conversion of the operating process, suitable particle sizes and volumetric loads have to be examined. In addition the liquid phase of the digestate shall be recirculated maximal to save both fresh water and waste water disposal costs.

The one year lasting investigations were performed in lab-scale with a various number of reactors. Before feeding the biowaste was pre-treated. In order to that, the biowaste was milled to particle sizes of 10, 8, 4 and 2 mm. Additionally the digestate was dewatered to gain process water. While using the process water fresh water was substituted in varying proportions. The feeding of the reactors was adjusted to the standards of the operating plant. For that reason the dry matter content in the reactor was adjusted at 10.5 %. Depending on the delivered raw material, this restriction led both to unsteady water requirements and volumetric loading.

As result of the investigations an optimal particle size as well as the optimal proportion of recirculated process water shall be provided. For that reason comprehensive analyses were conducted weekly to characterise the delivered raw material as well as the solid and liquid phase of the digestate in order to determine critical moments due to recirculation of process water. In conclusion, liquid and solid phase of the digestate should be evaluated with regards to application as fertilizer.

Keywords: oFMSW, bio waste, anaerobic digestion, wet fermentation, process water, recirculation

BIOANODE IN MFC FOR BIOELECTRICITY GENERATION, DESALINATION AND DECOLORIZATION OF INDUSTRIAL WASTEWATER

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Abstract

The most attractive and eco-friendly technologies in biological treatment is Microbial fuel cells (MFCs). In this work desalination rate, organic pollution removal and energy production in the MFC with and without desalination function were compared. A modified MFC was designed and fabricated for desalination process. The rough surface graphite (RSG) was used as anode electrode in the both reactors. The modified MFC for desalination unit the columbic efficiency improved from 16.8 to 23.4%. Maximum power density and desalination rate were 13.4 W/m3 and 81.2 %, respectively. A consortium of Enterobacter had special potential to remove dye (Acid Red 27) while bioelectricity is generated. The open circuit voltage (OCV) for 0.3 g/L AR27 with 24h retention time at 30 °C was 0.81 V; while, 91 % decolourization was achieved. The obtained results demonstrated that in operated MFC with mixed culture of bacteria was successfully applied for the decolourization of AR27 dye and bioelectricity generation and salt removal.

Keywords: Bioanode, Bioelectricity, Decolorization, Desalination, Microbial Fuel Cells

PHARMACEUTICALS IN WASTEWATER: EFFECTS OF CARBAMAZEPINE ON MARINE PHYTO AND ZOOPLANKTON

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Abstract
Pharmaceuticals present in wastewater (as they are not effectively eliminated by the purification plants) end up in the sea, where they can persist for a long time (as they are poorly biodegradable due to their high chemical stability). Unlike other types of chemicals, these are designed, tested and used specifically to induce effects on organisms, at very low concentrations. A report of 2017 shows as many substances, commonly used in medicine to treat the most varied diseases, are present in the Baltic Sea. However, little is known yet about the effects of these molecules on marine organisms. Among these there is carbamazepine, a substance commonly used in medicine to treat various neurological and psychiatric diseases. In this study, this active substance was tested both on marine phytoplankton (*Dunaliella tertiolecta* and *Rhodomonas salina*) and on marine zooplankton (*Acartia bifilosa*), with the aim of investigating the effects on these organisms. As hypothesized, deleterious effects were found on zooplankton (given that, even if the molecule was tested and marketed for its properties to induce benefits in humans suffering of epilepsy, is toxic): the highest concentrations tested were those that induced higher mortality in the copepod. However, it has also been seen to have effects on phytoplankton: in this case, but only on one of the two species considered (*Dunaliella tertiolecta*), the lower concentrations are those which induced significant effects, as strongly stimulate cell division (this observation could indicate an its possible role as an eutrophic factor). These results suggest the importance of the elimination of this substance from water. A help could derive from the use of GMOs to be used in sewage treatment plants: to create a selective "biological filter" by inducing the expression on the surface of *Saccharomyces cerevisiae* of high affinity molecules for carbamazepine.

Keywords: wastewater, pharmaceuticals, carbamazepine, Baltic Sea, marine phytoplankton, *Dunaliella tertiolecta*, *Rhodomonas salina*, marine zooplankton, *Acartia bifilosa*, GMO, sewage treatments plants, *Saccharomyces cerevisiae.*

LEACHATE TREATMENT IN NATURAL SYSTEMS

EXPERIENCE FEEDBACK AFTER SEVERAL YEARS OF OPERATION AT MOSKOGENS LANDFILL, KALMAR

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Abstract

At Moskogen Landfill outside Kalmar the leachate water has since 2010 been treated in a local nature-based system. The systems consist of a numerous of different steps. After the treatment the leachate water is led of to small local recipient. The activity is regulated by limit values for ten different parameters.

After eight years of being operational there now is a good amount of data available concerning the function of the system. The set up of the system will be presented and the function of the different steps will be presented related to the parameters with limit values.

The treatment system essentially consists of big ponds with aeriation for seasonal storage, a drained surface planted with salix, and a wetland system. The primary aim is to reduce the content of nitrogen in the water. Organic substances and heavy metals also reduce throw the system.

LONG TERM OPERATION OF PARTIAL NITRIFICATION PROCESS TREATING HIGH AMMONIUM CONCENTRATION WASTEWATER

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Abstract

Partial nitrification is a promising technology for nitrogen removal from wastewater. The major challenge is its stability at low temperature and nitrate accumulate because nitrate oxidizing bacteria (NOB) abundance increasingly.

The goal of this work was to investigate the long-term operation of partial nitrification processes at low temperatures. Integrated fixed-film activated sludge that combines the activated sludge and attached biofilm has been applied in mixed wastewater treatment to promote nitrification. Stable nitrite accumulation ration remained over 91% and the COD in the effluent met China's national standards.

The potential of partial nitrification systems to compete with conventional treatments for biological nitrogen removal both in terms of removal rates and overall effluent quality was proven.

Keywords: partial nitrification, low temperature, nitrite accumulation, long term

DEVELOPING ELECTRICAL ENERGY EFFICIENCY INDEX OF WASTEWATER TREATMENT PLANTS IN IRAN'S INDUSTRIAL ZONES USING DATA ENVELOPMENT ANALYSIS

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Abstract
The economics of wastewater management and treatment is the subject of growing interest by water agencies and wastewater treatment plant (WWTP) operators. Currently, the plant production process and efficiency improvement of WWT plants became a challenge for WWT plants. The need of cost-efficient and reliable treatment processes has significantly increased so as to meet the level of environmental regulations and national goals. WWTPs are energy-intensive facilities. In addition, energy efficiency of WWTPs is the starting point for any energy-saving initiative. In this paper, energy efficiency of wastewater treatment plants is investigated. A case study has been carry out in 79 sampling of WWTPs in Iran's industrial zones with the purpose to identify electrical energy efficiency indices (EEEI). For this goal, Data Envelopment Analysis (DEA) methodology was applied Data and the problem was implemented in Lingo11 software. The great advantage of this methodology is that it enables the identification of cost items on which to act to increase the efficiency at plant level. In a second stage analysis, the electrical energy efficiency index was estimated for different quality effluent with regression equation and formulated usingMinitab17 software.

Keywords: Industrial wastewater, Electrical energy efficiency, Wastewater treatment, Data envelopment analysis

AGRICULTURE AND FOOD

MODERN TECHNOLOGIES OF NATURAL MANURE TREATMENT IN LIVESTOCK PRODUCTION

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Abstract
Literature review was done about methods of reduction of ammonia emissions and GHG from livestock production. Many techniques require high investments costs by low reducing level of emissions. Among all known methods, the most effective is slurry cooling and decreasing slurry pH to obtain high ammonia emission reductions. When talking about GHG, anaerobic digestion and slurry separation are good solutions. Regarding sustainable development in agriculture production, not only environmental effects, but also economy is important.

Keywords: ammonia, GHG emissions, natural manure, slurry management, slurry separation, slurry cooling, anaerobic digestion

FROM FIELD TO PLATE: DISCUSSION ON TRANSFER OF METALS IN FOOD CHAIN

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Abstract
Transfer of essential major, minor and trace elements from environment to food, as well as possible contamination of food chain with toxic and potentially toxic elements (e.g., As, Cd, Ni, Pb) in step with impact assessment of environmental pollution is a hot topic not only at scientific level but very important for the interest and safety of society. The discussion involves investigation of metallic element transfer specifics in regard to *soil-plant* segment of food chain based on performed laboratory and field experiments. A question arises how transfer and bioavailability of elements can be affected at agricultural or gardeners' level with the main aim to gain safe and healthy food of plant origin – how soil can be treated, what can be added to soil to diminish the transfer of pollutants, what local resources can be used to improve soil quality. Another point of discussion involves an overview of quantitative research of food samples derived regionally in Latvia to reveal element composition of local food and to discover possible contamination risks as well as to compare the results with similar worldwide studies. Furthermore, also fruit and vegetable samples grown in allotment gardens of Riga city have been collected and quantitatively analyzed looking for impact of urban pollution on *soil-plant* segment of food chain. Results of experiments and analyses revealed influence of several factors that may have a key role in element transfer 'from field to plate', e.g., seasonality, botanical origin, site-specific factors, applied agricultural practice, food processing. Anyone can join this discussion and see related topics on the project's website: http://wise.lu.lv/.

Keywords: element transfer, environment, food composition, major and trace elements, quantitative analysis

TOWARDS SUSTAINABLE CONTROL OF PEST INSECTS -REDUCTION OF PESTICIDE USE

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Abstract
The use of pesticides in agriculture and food production can be replaced or at least reduced by use of integrated pest management (IPM) in combination by control methods that use the pest insects own chemical communication signals.
Examples from the applied side will be given, e.g. the substitution of the pyrethroid permethrin by Conniflex for pine weevil damage control, monitoring of mealy bugs in vineyards in NZ, mass trapping vs mating disruption of the pea moth and success in applied IPM of the wine moth.

Keywords: Pesticide reduction, sustainable control, pest insects, pheromones, semiochemicals

STORMWATER, WETLAND SYSTEMS AND FLOOD CONTROLL

STORMWATER MANAGEMENT IN A HISTORICAL PERSPECTIVE

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ABSTRACT

Different elements of the hydrological cycle has been studied for hundreds of years but stormwater started to be an important part in the middle of the last century when our cities begun to increase in size and the imperviousness of urban areas grow fast. At this time it was common to lead the drain- and stormwater in a combined sewage pipe system to the municipal wastewater treatment plant before discharge. When more and more impervious surfaces was added to the sewage net we got problems with flooding in cellars and combined sewer overflows had to be constructed. The action was to lead the stormwater in a separate pipe direct to the receiving water without any treatment. This was a natural measure because we didn´t have so many polluting cars and industries so the stormwater was rarther clean. Furthemoore, the stormwater should be lead out as fast as possible from the cities in order to avoid flooding problems. This action affected the water balance for the cities and gave ground water depletion and settling on the buildings. The water budget for the cities should then be repaired by infiltration and percolation storages was constructed and surfaces which allowed infiltration of the rainwater were created and also pervious parking lots and roads were established. The stormwater should be seen as a resource rather than an obstacle in the urban planning. However, during decades the stormwater development was almost standing still but during the new millennium the stormwater issues have been highlighted again and are considered very important to solve. The stormwater management philosophy since the middle of last century will be presented during the talk

KEYWORDS

Hydrological cycle, urbanization, stormwater, CSO, percolation storages, receiving waters, urban planning.

MEASUREMENTS OF CARBON DIOXIDE FLUXES OVER AN OLIGOTROPHIC BOREAL RIVER IN NORTHERN SCANDINAVIA

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Abstract
Carbon dioxide (CO_2), as one of the major anthropogenic greenhouse gases, is widely acknowledged to contribute to global warming and climate change. Historically, the major focus on the role of the aquatic environment in the carbon cycle has been on the atmosphere-ocean exchange. More recent findings suggest the importance of freshwater (lakes, rivers and streams) as a source for atmospheric CO_2. The freshwater contribution is, however, poorly understood, mainly due to a paucity of data, especially from running waters.

To address this issue, eddy covariance (EC) measurements in a large boreal river in Northern Sweden (Indalsälven), are being made as part of a two-year long continual study of the carbon dioxide fluxes between the air and water. This is one of the first known studies of its kind where EC measurements are conducted in a river setting. Continual data acquisition began in April 2018, monitoring a variety of general meteorological parameters, turbulent fluxes of carbon dioxide, latent, and sensible heat, together with water-side measurements of CO_2. The aim of the study is to investigate the temporal control on river carbon dioxide fluxes covering timescales from hours to seasons.

This paper describes the ongoing work, and reports on the present status of the project. The primary focus lies on data that indicates a dependence of carbon dioxide flux on wind-speed. Wind speed demonstrates a positive correlation with the measured fluxes, with the highest fluxes measured corresponding to the directions where the upwind distance to land was greatest, indicating that the wind-generated turbulence has a strong influence on the carbon dioxide fluxes over a boreal river.

Keywords: Carbon flux, Eddy covariance measurements, Boreal river

STREET SWEEPING AND ITS EFFECT ON STORMWATER QUALITY: CASE STUDY VITSIPPSBÄCKEN

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Abstract
Stormwater runoff is the main transport media of traffic related pollutants to the recipient waters in urban areas. Surface- and groundwater supplies serving for ecosystem services, drinking water production and recreation are subject to WFD regulations of priority pollutants that must comply with target or threshold values. The rapid densification of urban areas makes it difficult to implement stormwater measures in heavily polluted areas like trafficked roads or parking lots. Furthermore, other measures implemented in the sewer system, like gully filters, imply constant maintenance and higher costs. Thus, frequent street sweeping is a plausible source control alternative to implement in highly polluted areas for the reduction of pollutant fluxes induced by stormwater runoff. A mixed urban catchment draining stormwater to Vitsippsbäcken, a natural stream in the South of Gothenburg, was used as a case study area to test the effects of weekly street sweeping on stormwater runoff quality compared to gully filters. Vitsippsbäcken is a sensitive stream receiving untreated, highly polluted stormwater from the area of Sahlgrenska Hospital and the adjacent parkings and traffic roads with up to 25.000 cars/day. Weekly street sweeping with simultaneous stormwater sampling was implemented during a three-month period and its effect compared to gully filters.

The measurements under weekly street sweeping showed a reduction of most of trace metals, benzo(a)pyrene, oil and nutrients (P, N), compared to reference values from previous years measurements. Two of the main pollutants specific to the area, Cu and Zn were reduced with 40% and 30%, respectively during street sweeping in stormwater runoff. Oil and benzo(a)pyrene concentrations were 80% and 60% lower under street sweeping, respectively. These results were comparable to the reduction efficiency of gully filters with an average reduction efficiency between 40 – 60% for most of the pollutants. However, none of the above measures tested were sufficient to reduce stormwater concentration levels to local target values, due to the historically polluted areas in the studied catchment. As a conclusion, weekly street sweeping shows comparable results to gully filters and can be implemented complementary to other source control measures and possibly as full measures in less polluted areas.

Keywords: Trace metals, Street sweeping, Stormwater measures

ARTIFICIAL WETLANDS AND IRRIGATED VEGETATION FOR EXTRACTION OF NUTRIENTS FROM RESIDUAL SOLID WASTES TREATED IN LANDFILL BIOREACTOR CELLS

– AN IMPORTANT PART OF A CIRCULAR ECONOMY

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Abstract
A sustainable biological waste management strategy for residual wastes, after material recycling, includes a combination of biogas extraction and recirculation of nutrients.
During treatment in landfill bioreactor cells, about 90-95 % of the produced biogas can be collected. Due to long-term accumulation of organic fractions, the landfill acts as a carbon sink, like a peat-land, balancing increased CO2 concentrations in the atmosphere. A 100 000 tons/yr bioreactor landfill can compensate for the annual CO2 emissions from approximately 20 000 cars. At the same time, fossil materials, like e.g. plastics, do not take part in the biogas production and is brought back to long-term storage. Therefore the landfill can be regarded as a "Resource bank" for future raw material, when the availability has decreased and prizes increased.
Another important carbon sink is caused by increased biomass production and thus improved soil organic matter accumulation after irrigation of leachates to vegetation systems within the controlled landfill area. During full scale experiments in a major Swedish landfill leachates were irrigated to vegetation. The system comprised of an open aeration pond followed by nitrogen reduction in a small constructed wetland, and finally irrigation to a mixed deciduous forest plantation for final capture of the nutrients. The wetland consisted of two sections with hydraulic communication via pipes. The leachate was distributed to the units consisting of a sand and peat matrix. The water was stored in the wetland for about six days, and was then transported to the forest plantation with birch (*Betula verrucosa*) and willow (*Salix caprea*), The irrigation system was operated from May to October.
Fertilization with leachates improved tree vitality and increased biomass production, which also resulted in increased water evaporation (evapo-transpiration). Nutrient levels in the upper soil were increased, while the effects in deeper soil horizons, down to 50 cm, were limited indicating a high plant uptake and immobilization in the humus layer. The increased standing biomass, as well as higher soil humus contents, improved total accumulation of organic carbon.

Keywords: Leachates, nutrient recovery, bioreactor landfill, constructed wet-land, forest irrigation, CO2 concentrations.

WETLANDS UNDER INFLUENCE OF ACID SULFATE SOILS, CASE STUDY: SOUTHERN SWEDEN, KRISTIANSTAD, NORRA LINGENÄSET

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Abstract

In recent years, wetlands have drawn scientific attention due to their environmental and economic importance. Preliminary studies show that wetlands in southern Sweden in the vicinity of Kristianstad may be contaminated by iron and aluminium (and possible other metals). Iron precipitates has led to the loss of flora and fauna within the protected natural wetland "Norra Lingenäset" over the last decade. The source of iron is the focus of our investigations, and it is possibly associated with drained acid sulphate soils (ASS) in the north of the wetland. The drained water (varying pH 3-8) from the nearby crop land is pumped to the Norra Lingenäset wetland. Therefore, the interrelation and correlation among the ASS (source of iron contamination) and the wetland are of interest. Our primary results shows 5-70 mg/L of iron in drained water from the ASS and 50-150 mg/g of iron in the accumulated sediments in the draining ditch. Hence, the conditions and state of the cropped ASS regarding iron species and concentrations will be studied. The results from this stage will enable us to design an iron pool for the Kristianstad case study. Understanding metal transportation, speciation and depositions will aid Kristianstad crop lands and wetland managers to provide efficient and effective management plans.

Keywords: Metal, Contamination, Acid Sulfate Soil, Wetland

SUSTAINABLE STORMWATER MANAGEMENT BY PREDICTING CLIMATE CHANGE USING FNN AND GIS

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Abstract
Analysis of the urban climate changing is the basis for the implementation of stormwater management measures. Climate tensions such as changing precipitation patterns, fluctuations in temperature, and extreme events are already affecting water resources. For instance, precipitation pattern will be changed due to more water vapor in the atmosphere. Hence, it will be not evenly distributed. Some places will see more rain, others will get less snow. However, climate changes, such as the amount, timing, and intensity of rain events, in combination with land development, can significantly affect the amount of stormwater runoff that needs to be managed. Firstly, this essay will be discussed about prediction of climate change using fuzzy neural network (FNN) and it shows the accuracy of this method for anticipating stormwater. Secondly, based on results of the first phase, it determines the critical area for preparing stormwater systems with the application of GIS tools and technology.

Keywords: Stormwater management, Climate change, FNN, GIS

CONSTRUCTED WETLANDS IN LATIN AMERICA – SUSTAINABLE WASTEWATER TREATMENT SYSTEMS?

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Abstract

80% of all wastewater worldwide is released untreated into the environment, leading to deteriorating water quality. Achieving universal access to sanitation while improving water quality by halving the proportion of untreated wastewater and increasing its safe reuse are targets 6.2 and 6.3 of the Sustainable Development Goals (SDGs).

Wastewater treatment needs to be re-thought from a linear input-output process towards a circular re-use system where additional benefits for the environment can be derived. The use of CWs can treat various kinds of wastewater such as domestic or municipal wastewater, agricultural runoff, industrial effluent, mine drainage, landfill leachate, stormwater, polluted river water, and urban runoff. CWs can additionally provide secondary benefits such as providing an ecosystem for aquatic species, energy production through the use of the harvested biomass, effluent used for irrigation, etc. Understanding the risks and benefits that a wastewater treatment system can offer to its community is not limited to the technical understanding of its components. It demands understanding the multiple dimensions of sustainability.

Constructed Wetlands (CWs), a Nature-based Solution (NbS), can contribute to the SDGs. Currently, there is little knowledge about the contribution of CWs to the global amount of treated wastewater. UNU-FLORES has initiated the development of CWetlands and produced a pilot version (www.CWetlands.net). Our expectation is to link CWetlands to the ongoing monitoring and reporting efforts of the custodian agencies of SDG 6.

As a by-product of the participatory nature of the project, we expect to promote and raise awareness about NbS and the usefulness of CW for sustainable wastewater treatment. The guidelines, documentation, and informational material that will be made available on CWetlands will also provide a significant contribution to raise awareness on NbS and their potential to contribute to a sustainable future, in particular for the 80% living in CELAC cities.

Keywords: sustainable development goals, nature-based solutions, wastewater

POSTER SESSION

PHOSPHORUS SORPTION AND RECOVERY: MAJOR CHALLENGES TO CLOSE THE PHOSPHORUS CYCLE

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Abstract
Phosphate rock and phosphorus are listed by the European Union as the critical raw materials due to the risks of their shortage of supply and the impacts of a shortage on the economy are greater than those of most other raw materials. Although, high concentration of P in surface waters is the leading cause of eutrophication, which is a serious environmental problem in many countries of the world. Eutrophication of both freshwater and coastal marine ecosystems leads to a decrease in oxygen concentration and increases the abundance of toxic algae and aquatic plants. Discharge of untreated or semi-treated wastewater into the environment is one of the main causes of eutrophication; therefore, it is necessary to use effective wastewater treatment methods. One of the possibilities for the removal of P from wastewater is the use of biomaterial sorbents modified by iron oxohydroxide, which is an alternative to traditional wastewater treatment methods. As a prospective solution for P removal from wastewaters peat and other biomaterials has been suggested and tested. The obtained sorbents characterize high sorption capacities, fast sorption and relatively high sorbent saturation capacities and possibilities to run sorption process both in static and dynamic conditions. The results showed that P can be efficiently removed from wastewater by modified biomaterial sorbents; furthermore, after the purification process sorbents saturated with P can be recycled and used as fertilizers in agriculture. The saturated sorbents can be composted and transformed to a high value fertilizer considering significant amounts of phosphorus as well as presence of iron and nitrogen compounds. Further tests using domestic wastewaters were done and the presence of metals as well as toxicity of the sorbents were tested, proving application prospects. Thus biomaterial based sorbents can be a feasible approach for phosphorus removal from wastewaters and return of nutrient for agricultural applications as well as reduction of phosphorus load to waters.

This work was funded by the project “Sustainable Management of Phosphorus in Baltic countries” (InPhos) No. 17022 (2018-2019), that is financed by the EIT Raw Materials.

Keywords: Phosphorous, Modification, Iron Oxohydroxide, Biomaterial Sorbents, Sorption, Recovery, Wastewater treatment

CARBON SEQUESTRATION POTENTIAL OF AGROFORESTRY SYSTEMS FOR PHYTOREMEDIATION IN CHINANDEGA, NICARAGUA

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Abstract
Greenhouse gases in the atmosphere have increased to earlier unrecorded levels, causing global climate change that increases GMT and threaten ecosystems and livelihoods. IPCC report suggest that agroforestry offers considerable carbon sequestration (c seq.) potential, especially for developing countries. The purpose of this study is to estimate the c seq. potential in different agroforestry systems suitable in Chinandega, Nicaragua - a deforested region where the ground is polluted by toxaphene and other POP:s. Three scenarios where studied; Shading system using *Tectona grandis* and *Pogostemon cablin*; Alley cropping using *Erythrina poeppigiana* and *Ricinus communis* and Silvopasture using *Cordia alliodora* and *Brachiaria ruziziensis*, the last scenario being divided into two subscenarios; unmanaged (grazed) and managed (harvested) grass. Calculations were performed using the modelling program CO2FIX v. 3.2, with a runtime of 100 years and assuming deforested area with no previous land use. Results show a significantly higher c seq. potential in Shading system (168/217 MgC/ha). Alley cropping yields 71 MgC/ha and Silvopasture results in 80/84 MgC/ha unmanaged and 65/70 MgC/ha managed. The higher number includes products from harvest. All scenarios show fluctuations over time due to thinning and harvesting practices. Phytoremediation potential of POPs has been shown in *Ricinus communis* and grass species. Soil c seq. is especially important to consider in long-term scenarios as this c seq. can be sustained over longer time. The inclusion of crop residue, the effect of grazing animals or changes in density of trees and crops and environmental fate of the toxic compounds need further assessment before considering large scale applications. Agroforestry practices could contribute to several benefits, including climate change mitigation and phytoremediation.

Keywords: Carbon sequestration, Phytoremediation, Agroforestry, Climate change mitigation

SEARCH TECHNOLOGIES FOR RESTORATION OF SOIL POLLUTED AGRICULTURE

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Abstract

Animal waste considered to be traditional organic fertilizers, but in the " open " form to make them acceptable to the fields due to the presence of pathogenic organisms, pathogens of parasitic diseases , toxic substances and other pollutants.

In this regard, relevant scientific and practical direction is the development of effective technologies disposal of organic waste. For economic and environmental safety parameters preferably biotechnological techniques are based in particular on the microbial degradation of organic substances and antagonistic effects on pathogenic microflora.

This paper presents the results of using the yeast family Saccharomycetaceae for recycling solid manure of cattle.

The results of these studies show the effectiveness of the use of yeasts for rapid recycling of organic waste. Within a few days after the treatment mentioned specific odor removal, due to the ability of these organisms to assimilate nitrogen from urea and render the substrate of the bacteria causing anaerobic putrefactive processes accompanied by emission of toxic gases (ammonia, hydrogen sulfide , etc.). The use of microorganisms significantly reducing microbial contamination of the substrate. Thus, the number of coliform bacteria was less than 1 lg CFU / g, against 6,3 lg CFU/g in the control and the initial substrate. Salmonella in processed substrate did not show up in the control of their content was 6,1 lg CFU/g.

The use of microorganisms for manure prevented the loss of nutrients. Nitrogen, phosphorus and potassium treated substrate was 3.7, 2.6 and 0.38 %, respectively, untreated - 2.2, 2.1 and 0.3%.

The content of toxic elements in the treated substrate was at the MPC, pesticide residues were not detected.

Keywords: Animal waste, treatment, pathogenic organisms, environmental protection, pesticide

METHANE OXIDATION AND STABLE ISOTOPE PROBING OF ACTIVE METHANOTROPHS IN COLD-TEMPERATE RICE FIELDS

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Abstract
Paddy rice fields represent a unique anthropogenic wetland ecosystem which contributes considerably emission to the atmosphere greenhouse gas methane. Yet, the ecology and diversity of methanotrophs that regulate active methane oxidation and attenuate the methane emission potentials remain largely unclear, especially in the less studied cold-temperate regions. Here we used stable isotope probing technique to investigate the methanotrophic potentials, and further identify the active methane oxidizers in 3 different paddy soils from Jian-San-Jiang (one Baijiang-derived, JB and one Meadow-derived, JM) and Qing-An (Meadow-derived, QA) of Northeast China. After microcosm incubation under 1% v/v 13C-labeled methane condition, all soil 13C abundances significantly increased from background 1.08% to 1.21% in average, representing an approximately 36.9% methane-derived carbon assimilation induced by methanotrophy. High enrichment of methanotrophic biomarker pmoA genes in 13C-labeled DNA by quantitative PCR demonstrated great propagation of methanotrophs supported by methane oxidation. High-throughput sequencing of 16SrRNA and pmoA genes from 13C-labeled DNA further revealed a diverse guild of both type I and II methanotrophs in all three soils. Specifically, Methylobacter-affiliated type I methanotrophs were highest stimulated in JB and JM soils, whereas Methylocystis-affiliated type II dominated the methanotrophic activity in QA soil. Collectively, our results suggest high potentials of methanotrophy by phylogenetically divergent microorganisms in soils from cold-temperate region, implying great physiological diversification of soil methanotrophs that might be due to constant environmental fluctuations in paddies.

Keywords: Methanotrophs; Cold-temperate rice paddy; DNA-SIP; High-throughput sequencing

SCYTHIAN AND KYRGYZ BURIALS IN TUVA AND UPPER YENISEY REGION – FROM REMOTE SENSING TO ARCHAEOLOGICAL EXCAVATIONS

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Abstract

Archaeological excavations in Tuva Republic and Krasnoyarsk Region, Russia Federation, take a place along the planned railway line Kyzyl-Kuragino. Wide archaeological works are done due to the high number of burial sites situated on the planned route of railway and therefore will be destroyed during the construction works in, so called, Tuvian Valley of the Kings and Upper Yenisey region. The burials of Scyths, who wandered around the Eurasian steppe, from the northern borders of China and Mongolia to the west, the Black Sea region, are remaining from the 7th to 3rd centuries B.C.; some of the burials belong to Yenisey Kyrgyz culture and they are thought to be of younger age. The structure of burial site, named 'kurgan', firstly is shaped by using satellite and remote sensing pictures as visual distinctions of burials in the area can be observed more clearly from above. Further, potential expedition routes in taiga and steppe environments are planned and archaeologists do the preliminary inspection of the burial mounds to be excavated and researched in details. Under the supervision of scientists, brigades of volunteers are formed and clean-up of each individual burial mound starts by removing vegetation and land body mass which covers the structures. Stones are cleaned from dust and greenery; picket-marks are installed and detailed photographic sessions from several meters above kurgans provide the set of pictures for subsequent processing and research. Every stone is measured using geodetic instrumentation. Next comes removal of kurgan stones, except the main concentric circle structures of larger stones, digging is performed until the natural soil layer is reached. The two thin land-strips oriented athwart and crossing all the concentric structure are maintained from the original mound structure. Fresh cuts on both sides of these land-strips are made until the surface of the natural soil layer. Geodetic and photogrammetric measurements after data processing and application of special software allow to create the 3D model of the kurgan structure. Afterwards, based on the experience from previous archaeological studies in similar sites and specifics of each structure, digging in depth can begin close to the central part of the kurgan. Unfortunately, most of the burial sites have been robbed already in ancient times; these irruptions can be pinpointed if the central part of the structure itself is slightly depressed, but texture of soil layers is folded and disturbed. Wooden coffins can be situated in various depth, from 2 m to 6 m, and are remaining in different conditions. Therefore, careful investigation must be performed before removal of bones and artifacts prior further analytical part of studies is proceeded. Research of Scythian and Kyrgyzian kurgans in the Kyzyl-Kuragino railway project area have been performed intensively during the last decades, more intense works are done from 2011 till present with the great help of federal and local governmental authorities, scientific community, international company "EVRAZ" and Russian Geographic Society.

Keywords: Scyths, Yenisei Kyrgyzs, Tuva, photogrammetry, kurgans

LATE GLACIAL TIME IN BALTIC SEA REGION: REINDEER HUNTERS COLONIZING THE NORTHERN TUNDRA DESERTS – THE CLIMATE AND LANDSCAPE CHANGES IN SPACE AND TIME

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Abstract

Eurasian and North American continental glaciers reached Last Glacial Maximum around 21 kyr back. Lower sea level exposed *Bering land bridge* that opened human migration routes from Asia to North America. Large ice sheets blanketed much of the northern hemisphere. Northern Europe underwent significant ecological shifts at that time and later. Pleistocene–Holocene transition transformed also Baltic Sea Region, it was one of last colonized areas by Paleolithic societies. Periglacial environments with glacier retreat process made up deglaciated territories and during Younger Dryas and Preboreal time major shifts in climate happened whilst animals and plants adapted to new environments. Inland dunes were forming and sporadic eventual settlements of ancient reindeer hunters appeared near shorelines of rivers. Human colonization process is difficult to be assessed for that time due to sparse findings, fluctuations of sea level and natural processes that destroyed archaeological evidence, however geomorphological, paleobotanic and archaeological evidence has been studied for the region. Research of the Fennoscandian ice sheet retreat, deglaciation phases, ancient shores and following paleoecological processes of the Late Weichselian and Preboreal include modern analytical methods in combination with geomorphological studies. Thus it is possible to fill the gap of poor archaeological evidence through restoration of environmental situation. Modern humans first arrived and quickly spread across southern Europe c. 45–40,000 cal BP. Around 14-15 kyr back in history Southern Baltic region experienced the Hamburgian and Ahrensburgian traditions with remarkable site locations of archaeological findings, some of which are extended also in Scania and Denmark regions, however most part of Fennoscandia and Baltic remained under ice cover. Tremendous environmental transformations occurred during deglaciation phases when changes in plant and animal communities occured, e.g., presence of reindeer herds became important for human approaching the harsh northern tundra deserts. Finally, the human colonization is point in prehistory when Paleolithic societies of southern Europe migrated north and settled new developed ecosystems. Recognition and chronology of the Late Weichselian deglacial phases is complicated and have yet unresolved regional and local interpretations however end moraines and geomorphological evidence help to restore the prehistorical geographical map and history of ancient sea stages. Ages are based on radiocarbon, cosmogenic isotopes 36Cl and 10Be, OSL and thermoluminescence dating, supplemented by 'floating' chronologies based on laminas of ice-dammed lake deposits counting, nevertheless not continued until the present. Hundreds of thermoluminescence dates from glacial sediments were seriously questioned and available ages usually are interpreted together providing sketch in a regional context. Interesting works have been performed on inland dunes using OSL, they pinpoint on stabilization of periglacial and post-glacial dunes stabilization dyring Younger Dryas and Preboreal. The results suggest that distribution of parabolic dunes is in close association with distribution of sandy glaciofluvial and glaciolacustrine sediments. High-precision spatial analysis suggest that, e.g., in Latvia, at least four morphological types of inland dunes can be distinguished and the parabolic dunes are dominant. They have started to form under cold and dry climate approximately 12.3 –

11.3 kyr OSL years ago. Later degree of aeolian processes and parabolic sand dune formation gradually subsided. Inland dunes still serve as geomorphological proxies helping to restore Periglacial and Post-Glacial landscape history in Baltic Sea Region helping also archaeologists to explain their findings. The East Baltic Stone Age is known for its array of bone and antler artefacts. Several hunting and fishing tool sets of bone and antler were determined, in, e.g., Latvia, pointing each stage of the Baltic Stone Age. Oldest were formed when ice sheet retreated and the conditions for human habitation made possible. The ethnic and cultural identity of paleolithic people in East Baltic is not known, but it is accepted view that they were reindeer hunters and anthropologically close to nowadays saami (Lapland) and nency cultures in Russia Far North. C14 evidence in East Baltic points that reindeers were present from Alleröd times till beginning of Preboreal.

Keywords: Northern Hemisphere; Baltic Sea Region; deglaciation; late glacial time; reindeer hunter people; inland dunes

DETERMINATION OF PPCPs AND ENDOCRINE DISRUPTORS IN THE GUANDU RIVER BASIN BY UPLC-ESI-MS/MS

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ABSTRACT

Pharmaceutical and personal care products (PPCPs) and endocrine disrupters (EDs) are micropollutants found in concentrations ranging from ng L^{-1} to μg L^{-1} and are potentially hazardous to the environment as well as to human beings. Among the most widely used pharmaceutical drugs one can mention: Trimethoprim (antibiotic), Bromazepam, Clonazepam and Diazepam (benzodiazepines psychoactive drugs), Ibuprofen (anti-inflammatory) and Benzophenone (UV radiation blocker). EDs, in turn, are substances that impair the normal functioning of endocrine systems. Among them, it can be mentioned 4-Nonylphenol (surfactant), Bisphenol-A and Diethyl-phthalate (plasticizers). The development of analytical methods with increasing reduction of limits of detection and quantification, capable of detecting micropollutants at concentrations in the range of ng L^{-1} has been essential mostly for drinking water quality control and assessment of surface water quality. The objective of this work was to develop analytical procedure susing solid phase extraction (SPE) and ultraperformance liquid chromatography coupled to mass spectrometry (UPLC-MS/MS) with electrospray ionization (ESI) for the determination of Trimethoprim, Bromazepam, Clonazepam, Diazepam, Ibuprofen, 4-Nonylphenol, Bisphenol A and Diethyl phthalate in surface water of Guandú River, which has the highest national priority due to the water supplied in Rio de Janeiro State. For concentration and extraction of the analytes from the matrix, solid phase extraction (C18 stationary phase cartridge and 500 mg) was used. The separation was done using a BEH C18 (2.1 mm ID x 50 mm, 1.7 μm) chromatographic column, with a running time of 8 min, and mobile phase of methanol and ultrapure water, both with 0.01% ammonium hydroxide in gradient mode with a flow rate of 0.4 mL min^{-1}. The recovery rate of all analytes ranged from 57% for Clonazepam to 99% for Benzophenone; the accuracy of all analytes was adequate (RSD <20%), the uncertainty lower than 20% with acceptable standard error (less than 7.88). The limits of quantification (LQ) of the method ranged from 10.0 ng L^{-1} for Bromazepam, Clonazepam, Diazepam and Trimethoprim to 100.0 ng L^{-1} for Diethyl phthalate. The first four sampling campaigns (April, May, June, July 2018) of a monitoring program in a segment of Guandu River with focus has already shown the presence of some of these pollutants.

KEYWORDS: benzodiazepine drugs; method validation chromatography in liquid phase; water quality

OIL & GAS OFFSHORE PLATFORMS IN CAMPOS BASIN, RIO DE JANEIRO, BRAZIL: MONITORING OF PRODUCED WATER QUALITY

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ABSTRACT

Oil and gas production activities generate effluents with significant potential to cause environmental impacts. The "production water" (wastewater generated during offshore oil exploitation) is the largest generation effluent in the petroleum production activity and presents polluting potential due to its typical composition. The present study was carried out based on production water monitoring reports received by The Brazilian Institute of Environment (IBAMA) referring to 46 oil and gas offshore platforms of the Campos Basin, Brazil, between 2012 and 2016. Descriptive statistics and multivariate statistics (PCA) with data from the production water indicated great variability in concentrations for variables monitored according to CONAMA Resolution No. 393/2007, due to the inherent characteristics of each platform. In general terms, the produced water presented concentrations for chemical variables compatible with this type of effluent monitored in other oil producing regions. However, in terms of median values, it was observed higher concentrations of Barium and Radio-226 and Radio-228, in addition to the increased toxicity, when compared to previous studies carried out in Brazilian offshore platforms.

KEYWORDS: Produced water; Oily wastewater; Ecotoxicity; Gas and oil industry

NON-CONTACT METHODS FOR MONITORING OF AQUATIC ENVIRONMENT

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Abstract
Nowadays, the problem of environmental pollution, in particular water bodies, is an urgent problem. According to this, new methods of ecological monitoring of water bodies are being actively developed. But most of them are based on remote monitoring of large areas of open water surfaces. However, due to the almost total obstruction of a large number of places on the coast because of the dense vegetation there — not all of these methods might be efficient enough. In such conditions, the most effective method is hand sampling. Nevertheless, the possibilities of this approach are greatly limited by the number of samples taken and their further logistics.
Therefore, it is important that basic information on the state of the water samples is available immediately at the sampling site, and only suspicious samples are sent to stationary laboratories for deeper studying. One of the methods that allows you to quickly get information about a sample state and take action as fast as possible is control in an express mode. Chemical and optical methods are usually used for control in an express mode. However, both of them have certain disadvantages.One of the possible solutions to this problem is the compact nuclear magnetic spectrometer developed in our laboratory. The only thing necessary for its operation is the presence of particles with nonzero magnetic moments. This requirement is always satisfied in the researches of water bodies, because water contains protons with the greatest magnetic moment. It is also worth noting that research using nuclear magnetic resonance is non-destructive.
The state of the medium can be determined using the measured values of the relaxation constants T_1 and T_2. If the measured values differ from the values corresponding to the standard state of the medium, impurities may be present in the medium and in this case additional study of the medium is necessary. In addition, in a small-sized nuclear magnetic spectrometer, we have implemented the ability to register a signal not only from protons, but also from some other nuclei. This allows in some cases at the site of sampling to establish the cause of the deviation in the medium (to classify the impurity). It is very important for decision-making about the use of this medium.

Keywords: nuclear magnetic resonance, express control, spectrum, medium state.

THE RIVER FLOW MANAGEMENT BY A SYSTEM OF FLOOD CONTROL FACILITIES DISTRIBUTED ON A DRAINAGE BASIN

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Abstract
In this work a river flow management during extreme river discharges for a hydro complex with hydroelectric power plant (HPP) on a main river and flood control facilities on its side tributaries is studied. The mathematical models are developed and used to determine the operating modes of hydro facilities, considering the modern economic and environmental requirements, revision of their parameters, estimation of the energy-economic and environmental effects after creation of flood control facility systems distributed on drainage basins. These mathematical models are realized in the computer program and test calculations using this program show the possibilities of river flow management in the whole river basin. The research was supported by Russian Science Foundation (grant №16-17-00050).

Keywords: river flow management, hydropower, computer simulation, environmental protection, flood control

ENVIRONMENTAL ASPECTS OF WASTE GLASS STORAGE

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Abstract
There are only few researches about possible environmental impact of waste glass, mostly focusing on crystal glass industry waste and not on packaging glass waste. The aim of the current research was to examine properties of stored waste glass and to assess environmental impact of waste packaging glass storage.
Waste glass fractions and types were examined across the entire waste management chain. Samples of waste glass were taken from storage sites at landfill and glass sorting company in Estonia. In the lab the leachates of the collected waste glass samples were prepared and physical-chemical properties (pH, conductivity, water soluble carbon and nitrogen content, metal content) and phytotoxicity of leachate were examined.
The main problem with glass recycling as well as its storage is the quality of the glass collected. The results of the study showed that packaging glass waste was still mixed with other wastes after secondary sorting and residual glass from sorting of packaging glass waste was potentially hazardous to the environment. The leaching of metals from the residue of glass sorting was higher than that from the other samples of stored waste glass, reaching to 419 mg/kg for Pb, 11 mg/kg for Cd, 59 mg/kg for Cr, 866 mg/kg for Zn and 722 mg/kg for Cu. Although it was determined that metals were leaching from the glass waste, their content in the leachates did not affect negatively the germination of cress seeds.
The results pointed out the potential hazard to the environment from packaging glass waste at temporary storage places, where runoff from stored glass heaps are not collected. To avoid the potential pollution the waste glass must be stored in place where rainwater cannot reach or runoff must be collected and drained into sewage treatment plant.

Keywords: waste management, waste glass, packaging glass, metal leaching

AN ECONOMIC MANAGEMENT INSTRUMENT FOR ENHANCED SUPPLY OF UTILITIES TO MEGACITIES

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Abstract

A cost structure is proposed to enhance the supply of utilities to megacities on a regional operating scale. Estimation is enabled of the economic impact of megacities on the GDP in a certain region or the trade bloc in question from a utility-supply point of view. The introduced methodology involves business administration theory and economics and employs the previously introduced equality principle and the model for Efficient Use of Resources for Optimal Production Economy (EUROPE) to impose shadow costs on supply losses to induce economic incentives to improve the functionality of megacities. A case study presents the practical application of the proposed theory in an Asian context. It is concluded that the introduced methodology makes the megacities more efficient and improve their functionality. Profitability increases, technology is advanced and environmental conditions improve when the EUROPE model is applied on activities that involve supply-flow at higher policy analysis levels. Application of an introduced single monetary key factor encapsulates many megacity aspects of interest. The equity of the regional access to facilities is improved. The developed methods support decision-making when managing megacity supply.

Keywords: Megacities, Supply, Optimisation, Economic incentives, Equality principle

SOLID WASTE DISPOSAL SERVICE REGULATION IN LATVIA

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Abstract

In order to implement and manage a centralized waste management system in Latvia in the first waste management planning period 2006 - 2012, all territory was divided into ten waste management regions (WMR), and each one has their own regional sanitary landfill. In the common waste management system only, municipal waste disposal service is a public service, therefore all landfill's operators are public service providers.

The Public Utilities Commission (Regulator) is institutionally and functionally independent, autonomous body governed by public law which carries out regulation of public services in the five sectors, incl. waste management, in accordance with the law "On Regulators of Public Utilities" and special legal acts of the regulated sectors. The public service provider for the provision of solid waste disposal service at a landfill for solid waste shall calculate tariff in accordance with the Methodology for the Calculation of Solid Waste Disposal Service Tariff.

To evaluate the comparability of the accumulated and technical indicators within the merchant supervision, the Regulator elaborated a benchmarking for comparing the costs, technical and social parameters included in the waste disposal service tariff. The benchmarking for waste disposal service consists from four steps: General characteristics of the regulated service and WMR; Direct production costs and parameters; Other operating costs and parameters, and Comparison and monitoring.

In this study only first step is analyzed, that include the characteristics of the infrastructure used by the merchant, information on the essential differences in the provision of the regulated service among the merchants, which make an influence of the tariff formation costs and revenue from recovery and recycling materials.

Keywords: solid waste disposal service, regulation, benchmarking, government, authority


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