

2022

ABSTRACT COLLECTION 2nd International Conference for
Sustainable Resource Society: Seizing a Sustainable Future

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2nd International Conference for Sustainable Resource Society: Seizing a Sustainable Future

03 Nov 2022 - 04 Nov 2022

University of Eastern Finland, Kuopio Campus, Yliopistonranta 1, 70210 Kuopio, Finland

The 2nd International Conference for Sustainable Resource Society: Seizing a sustainable future was an international two-day conference jointly organized by a consortium of University of Eastern Finland Research Communities and focused on challenges of sustainability transition in society, environmental change and sustainable use of natural resources.

The conference was held on-site at the Kuopio campus of the University of Eastern Finland accompanied with a limited online participation. The general conference theme was organized around the following thematic tracks (working groups): biosociety, climate, water, energy & minerals, circular economy and sustainable society.

The conference offered a platform for researchers across various fields to share research insights and discuss the complex global and local challenges on sustainability transitions, use of natural resources, environmental and climate change, and circular economy.

We welcomed submissions from multidisciplinary approaches to sustainability, such as environmental policy and law, business sciences, environmental and biological sciences, nutrition, social sciences, geography, geology, aquatic sciences, forest sciences, photonics, material sciences, applied physics, digital geosciences, and environmental technology.

The Limnological Division of Water Association Finland had a joint session, "Carbon cycle in surface waters", with UEF Water that delved into the causes and consequences of surface water browning.

This publication is a compilation of the abstracts from the conference.

Nearly 200 participants from around the globe participated in the two-day event.



PROGRAM

3 – 4 November 2022



CONFERENCE DAY 1

Time (Finnish time, GMT+2)	Activity	Programme	Building and room
8:00-15:00	Registration	Badge, lunch tickets and general information	Medistudia, Entrance Hall, Yliopistonranta 1A, Kuopio
9:00-12:00	Limnological Division of Water Association Finland, Sessions	Session 1. Surface Waters are Browning – Does it Show and How? WATER and Limnologists Posters available at 9:00	Medistudia, MS300, The Sigrid Jusélius Foundation Hall Medistudia, MS307
11:00-12:30	Conference Lunch		Canthia, B-wing, 2nd floor
13:00-13:30	Opening by Conference Chairs	Welcome to the Conference: Professor Rauno Sairinen , Head of RESOURCE Greetings: Professor Heli Peltola , Head of FOBI Professor Annele Virtanen , Head of CLEHE Professor Jussi Kukkonen , Head of WATER Professor Jyrki Saarinen , Head of PHOTONICS	Medistudia, MS301, IKEA Hall



13:30-14:15	Keynote	Climate Change and Biodiversity Loss – Challenges to Policies and Research Professor, Chairperson Markku Ollikainen University of Helsinki, and The Finnish Climate Panel 2020-2023	Medistudia, MS301, IKEA Hall
14:15-14:45	Coffee Break		Medistudia, Entrance Hall
14:30-15:30	Limnological Division of Water Association Finland, Sessions	Session 2. Surface Waters are Browning – Is There Anything We Can Do?	Medistudia, MS300, The Sigrid Jusélius Foundation Hall
14:45-17:30	Parallel sessions 1	<p>Session 3: Climate Smart Forestry</p> <p>Session 4: Social Perspectives on Sustainability</p> <p>Session 5: Organizational Perspectives on Sustainable Circular Economy</p> <p>Session 6: Regulative Perspectives on Energy and Industrial Production</p> <p>Session 7: Measuring, Monitoring, and Modelling Aquatic Systems in Changing Climate NOTE: Session starts at 15:30</p> <p>WATER and Limnologists Posters available at 9:00</p>	<p>Medistudia, MS301, IKEA Hall</p> <p>Medistudia, MS303</p> <p>Medistudia, MS305</p> <p>Medistudia, MS400</p> <p>Medistudia, MS304</p> <p>Medistudia, MS307</p>
19:00-23:00	Dinner	Sokos Hotel Puijonsarvi, Puikkari Conference	Minna Canthin katu 16, 70100 Kuopio



CONFERENCE DAY 2

Time (Finnish time, GMT+2)	Activity	Programme	Building and room
8:00-10:00	Registration	Badge, lunch tickets and general information	Medistudia, Entrance Hall, Yliopistonranta 1A, Kuopio
8:30-10:00	Parallel sessions 2	<p>Session 8: Sustainable use of Aquatic Systems</p> <p>Session 9: Critical Materials in Sustainable Mining</p> <p>Session 10: Perspectives on Sustainable Transition – Institutions and Education</p> <p>WATER and Limnologists Posters available at 8:30</p>	<p>Medistudia, MS303</p> <p>Medistudia, MS304</p> <p>Medistudia, MS305</p> <p>Medistudia, MS307</p>
10:00-10:20	Break		Medistudia, Entrance Hall
10:20-12:00	Parallel sessions 3	<p>Session 11: Adaptive Governance of Catchments</p> <p>Session 12: Mining, Minerals, and Society</p> <p>Session 13: Businesses Accelerating Sustainable Transition</p>	<p>Medistudia, MS303</p> <p>Medistudia, MS304</p> <p>Medistudia, MS400</p>
12:00-13:00	Conference Lunch		Canthia, B-wing, 2nd floor



SESSIONS



Carbon cycle in surface waters I 9:00-12:00

SESSION 1. SURFACE WATERS ARE BROWNING – DOES IT SHOW AND HOW? (CHAIR ANTTON KETO, MEDISTUDIA, MS300) [CLICK HERE TO JOIN THE MEETING](#)

1. Opening. Antton Keto (Ministry of the Environment & Limnological Division of Water Association Finland).
2. Keynote. Prof. Jukka Horppila (University of Helsinki), **Lake brownification: Effects and relationship to ecological status classification.** [ONLINE](#)
3. Antti Räike (Finnish Environment Institute), **Is browning of Finnish water bodies progressing? Long-term changes in streams, lakes and coastal waters.** [ONLINE](#)
4. Eerika Albrecht (University of Eastern Finland), **Browning of boreal lakes: Do public perceptions and governance meet the biological foundations?**
5. Jenni Attila (Finnish Environment Institute), **Observing brownification from space - The benefits of using satellite observations.**
6. Jussi Jyväsjärvi (University of Oulu), **Browning alters food-webs and leads to biodiversity loss in riverine ecosystems.**
7. Satu Estlander (University of Helsinki), **HUMI project - Lake browning indicators.**
8. Kristiina Vuorio (Finnish Environment Institute), **Diversity of lake plankton and its responses to brownification.**
9. Sami Taipale (University of Jyväskylä), **Browning impacts on fish communities and the nutritional value of fish for human consumption.**

Carbon cycle in surface waters II 14:30-15:30

SESSION 2. SURFACE WATERS ARE BROWNING – IS THERE ANYTHING WE CAN DO? (CHAIR JOUKO SARVALA, MEDISTUDIA, MS300) [CLICK HERE TO JOIN THE MEETING](#)

1. Anne Ojala (Natural Resources Institute Finland), **Connecting silvan and lacustrine ecosystems – Two decades in Finnish forests and on numerous lakes.**
2. Inese Huttunen (Finnish Environment Institute), **VEMALA TOC: towards better national scale carbon leaching estimates.**
3. Laura Härkönen (Finnish Environment Institute), **Mitigating freshwater ecosystem browning calls for a systemic change in peatland forestry.**

Parallel sessions 1 14:45-17:30

SESSION 3. CLIMATE SMART FORESTRY (CHAIR MATTI MALTAMO, MEDISTUDIA, MS301, IKEA HALL) [CLICK HERE TO JOIN THE MEETING](#)

1. Heli Peltola (University of Eastern Finland), **Climate smart forestry.**
2. Päivi Merilä (LUKE), Antti-Jussi Lindroos, Heljä-Sisko Helmisaari, Sari Hilli, Tiina M. Nieminen, Pekka Nöjd, Pasi Rautio, Maija Salemaa, Boris Ťupek and Liisa Ukonmaanaho, **Carbon stocks and fluxes in coniferous boreal forests along a latitudinal gradient.** [ONLINE](#)
3. Ville Vähä-Konka (University of Eastern Finland), Lauri Korhonen, Kalle Kärhä and Matti Maltamo, **Towards more accurate forest information with the joint use of operational harvester and remote sensing data.**
4. Jenni Miettinen (University of Helsinki), Markku Ollikainen, Artti Juutinen, Jouni Siipilehto, Leena Stenberg, Anssi Ahtikoski, Hannu Hökkä, Sakari Sarkkola and Mika Nieminen, **Strip harvesting in drained boreal peatlands when water quality matters.**
5. Johannes Pohjala (University of Eastern Finland), Mika Vahtila, Ville Kankare, Juha Hyypä and Kalle Kärhä, **Effect of prior tree marking on cutting productivity and quality of remaining stand in thinnings.**
6. John Alexander Pulgarin Diaz (University of Eastern Finland), Markus Melin and Olli-Pekka Tikkanen, **Thermal sum drives abundance and distribution range shift of *Panolis flammea* in Finland.**



7. Veli-Pekka Ikonen, Ranjith Gopalakrishnan, Petteri Packalen, Janne Rätty, Ari Venäläinen, Mikko Laapas, Pentti Pirinen and Heli Peltola, (School of Forest Sciences, University of Eastern Finland and Finnish Meteorological Institute) **Wind damage risk assessment tool (prototype) with GIS software.**

SESSION 4. SOCIAL PERSPECTIVES ON SUSTAINABILITY (CHAIR ANNA HEIKKINEN, MEDISTUDIA, MS303) [CLICK HERE TO JOIN THE MEETING](#)

1. Robert Massimo Alfonsi (The University of Tokyo, Graduate Program in Sustainability Science (GPSS-GLI)), M. Naidoo and A. Gasparatos, **Stakeholder perspectives on the impacts and barriers for Information and Communication Technologies (ICTs) for sustainable food systems in South Africa.** [ONLINE](#)
2. Ida Herdieckerhoff (University of Eastern Finland), Irmeli Mustalahti, Almeida Siteo and Estevao Chambule, **Uncertainty and forest concessions in a globalized world: Insights to local access to forest resources in Mozambique.** [ONLINE](#)
3. Anna-Maija Lämsä, Viljanen Soilikki (University of Jyväskylä) and Pucetaite Raminta (University of Vilnius), **What kind of social innovations appear in for-profit social enterprises?** [ONLINE](#)
4. Sajal Kabiraj (Häme University of Applied Sciences Ltd. (HAMK)), Samant Shant Priya, Sushil Kumar Dixit and Meenu Shant Priya, **Food waste in Indian families: Status and potential solutions.**
5. Anna Heikkinen (Tampere University), Johanna Kujala and Sybille Sachs, **Nature as a stakeholder: Typology.**

SESSION 5. ORGANIZATIONAL PERSPECTIVES ON SUSTAINABLE CIRCULAR ECONOMY (CHAIR SUBHANJAN SENGUPTA, MEDISTUDIA, MS305) [CLICK HERE TO JOIN THE MEETING](#)

1. Hanna Lehtimäki, Subhanjan Sengupta, Kristina Leppälä and Ville-Veikko Piispanen (University of Eastern Finland), **Business, and societal perspectives on circular plastics economy.**
2. Steve Waitschat, Kim Strunk, and Susanne Kiener (University of Passau), **It's not "one size fits all": Why size matters in organizational sustainability transformation.** [ONLINE](#)
3. Jatta Pitkänen, Hanna Lehtimäki (University of Eastern Finland) and Ari Jokinen (Tampere University), **Project champions as emergent environmental leaders.** [ONLINE](#)
4. Heta Leinonen (Tampere University) and Henna Paananen, **Stakeholder engagement practices in local and regional public organizations: A longitudinal study in the context of a circular economy in Finland.** [ONLINE](#)

SESSION 6. REGULATIVE PERSPECTIVES ON ENERGY AND INDUSTRIAL PRODUCTION (CHAIR SÉBASTIEN NOËL, MEDISTUDIA, MS400) [CLICK HERE TO JOIN THE MEETING](#)

1. Harri Kalimo (UEF Law School, CCEEL, RESOURCE), Reid Lifset, Antti Jukka, Petrus Kautto and Mirella Miettinen, **Reviving the incentives for eco-design in extended producer responsibility: The challenges for eco-modulation.**
2. Sébastien Noël (CCEEL, University of Eastern Finland), **Achieving greenhouse gas emissions through the utilization of hydrogen: Case study of the EU renewable energy directive differentiating renewable and fossil-based hydrogen.**
3. Leonie Reins (Erasmus University Rotterdam) and Julia Wijns, **"Safe and Sustainable by Design" as a regulatory approach for a more sustainable biobased circular economy in the European Union.** [ONLINE](#)
4. Katrien Steenmans (University of Copenhagen), **Legal risks of extended producer responsibility adoption.** [ONLINE](#)
5. Paola Apollaro (University of Urbino - UNIURB), **Recognizing the right to a healthy environment: Implications in climate litigations.** [ONLINE](#)



SESSION 7. MEASURING, MONITORING, AND MODELLING AQUATIC SYSTEMS IN CHANGING CLIMATE (CHAIR RAINE KORTET, MEDISTUDIA, MS304). NOTE: SESSION STARTS AT 15:30.

[CLICK HERE TO JOIN THE MEETING](#)

1. Sapna Sharma (York University), **Keynote: On thin ice: Are lakes feeling the heat?** [ONLINE](#)
2. Victor Carrasco-Navarro, Suad Musse (University of Eastern Finland), Suvi Seppänen, Patricia Caballero-Carretero, Jose Luis Martinez-Guitarte and Jussi V. K. Kukkonen, **Are plastic additives a threat to aquatic ecosystems?**
3. Surendra Pradhan (University of Eastern Finland), Eila Torvinen, Helvi Heinonen-Tanski, David Fewer, Tania Shishido, Salla Venäläinen, Sanna Kanerva, Asko Simojoki, **Phosphorus harvesting from digested sludge using acidophilic microorganisms.** [ONLINE](#)
4. Olga Tammeorg, (University of Helsinki), **Recycling of sediment phosphorus from eutrophic Finnish and Estonian lakes in agriculture.** [ONLINE](#)
5. Irina Levchuk, (University of Eastern Finland), Gaurav Singhal, Iita-Reetta Niskanen, Victor Carrasco Navarro, Juan Jose Rueda Marquez, Anna Lähde, **Post-treatment of real municipal wastewater effluents using combination of advanced oxidation processes and photobiotreatment: towards sustainable resource recovery and urban wastewater reuse.** [ONLINE](#)

FRIDAY, NOVEMBER 4, 2022

Parallel sessions 2 8:30-10:00

SESSION 8. SUSTAINABLE USE OF AQUATIC SYSTEMS (CHAIR ANSSI VAINIKKA, MEDISTUDIA, MS303)

[CLICK HERE TO JOIN THE MEETING](#)

1. Faiqa Atique, (University of Jyväskylä), Heli Juottonen, Minna Maarit Kytöviita, **Companion planting enhances the plant production in aquaponics system.**
2. Harri Kokko (University of Eastern Finland), Semberg, S., Nykänen, H., Jussila, J., Nousiainen, A., Roponen, T, **Nitrogen and carbon dynamics and circulation in the aquaponic system followed using ¹³C and ¹⁵N isotopes.**
3. Anssi Vainikka, (University of Eastern Finland), Aatu Turunen, **Numerical methods towards quantitative and predictive management of inland fisheries.**
4. Eevi Kokkonen, (University of Jyväskylä), Tommi Perälä, Laura Härkönen, Pekka Hyvärinen, Anna Kuparinen, **Modelling the effects of different fishing methods on fish size structures.**

SESSION 9. CRITICAL MATERIALS IN SUSTAINABLE MINING (CHAIR DIANA CAROLINA ARBELAEZ RUIZ, MEDISTUDIA, MS304) [CLICK HERE TO JOIN THE MEETING](#)

1. Rauno Sairinen (University of Eastern Finland) and Juha Kotilainen, **Multi-level governance of recycling electric vehicles' battery metals.**
2. Emily Burlinghaus (Institute for Advanced Sustainability Studies), **Improving the sustainability of EV battery supply chains: Prospects for sourcing, manufacturing, and end-of-life management.**
3. Marco Giuli (Vrije Universiteit Brussel) and Sebastian Oberthuer, **Assessing the EU's evolving position in energy geopolitics under decarbonization.**
4. Hanna Lempinen (University of Lapland), Leena Suopajarvi and Mari Tulilehto, **Social license to explore? Critical raw materials and social acceptance in the AGEMERA project.**
5. Diana Carolina Arbelaez Ruiz (University of Eastern Finland), **Socio-political aspects of electric vehicle battery minerals supply chains.**



SESSION 10. PERSPECTIVES ON SUSTAINABLE TRANSITION – INSTITUTIONS AND EDUCATION (CHAIR OLENA LIAKH, MEDISTUDIA, MS305) [CLICK HERE TO JOIN THE MEETING](#)

1. Sini-Tuulia Suokas (University of Eastern Finland), **Circular economy sharing platforms - Customer value and active value creation.** [ONLINE](#)
2. Kaisa Henttonen (University of Eastern Finland), Beatrice Re (University of Trieste), Ville-Veikko Piispanen and Hanna Lehtimäki (University of Eastern Finland), **The role of institutional environment in catalysing circular entrepreneurship: Cross-country comparison of CE ventures in Finland and Italy.**
3. Elina Oksanen and Elli Hämynen (University of Eastern Finland), **How to fight against biodiversity loss – Actions by the biodiversity education network.**
4. Olena Liakh (University of Macerata), **Sustainability transition in higher education institutions: the role of formal university sustainability strategies.**

Parallel sessions 3 10:20-12:00

SESSION 11. ADAPTIVE GOVERNANCE OF CATCHMENTS (CHAIR NIKO SOININEN, MEDISTUDIA, MS303) [CLICK HERE TO JOIN THE MEETING](#)

1. Mia Pihlajamäki, (Aalto University), Irina Mancheva, Marko Keskinen, **Adaptive Baltic Sea eutrophication governance: lessons from the implementation of water framework directive and marine strategy framework directive in Finland and Sweden.**
2. Antti Iho (Natural Resources Institute Finland, Luke), Niko Soininen, Iivo Vehviläinen, Saija Koljonen, Janne Artell, Antti Belinski, **Rivers under pressure – interdisciplinary feasibility analysis of sustainable hydropower.**
3. Minna Santaoja (University of Eastern Finland), **Mix & match for transformative wetland restoration governance.**
4. Antti Belinskij, (University of Eastern Finland), Niko Soininen, **Legal deadlock in the catchments: Three ways to reconcile hydropower generation with environmental objectives.**
5. Thomas Banafa, (Aalto University), Susa Eräranta, Lasse Peltonen, Marko Keskinen, **Mapping the networks of flood risk governance and management.** [ONLINE](#)

SESSION 12. MINING, MINERALS, AND SOCIETY (CHAIR JUHA KOTILAINEN, MEDISTUDIA, MS304) [CLICK HERE TO JOIN THE MEETING](#)

1. Lasse Peltonen (University of Eastern Finland), **Understanding societal acceptability of mining - emergent legitimacy and the control of legitimization resources.**
2. Nuppu Mielonen (University of Eastern Finland), **Leadership sensemaking – mining industry leadership interpreting their business environment.**
3. Julia Loginova (Centre for Social Responsibility in Mining, Sustainable Minerals Institute), Vigya Sharma and Deanna Kemp, **Towards just transitions? Consultation, consent, and energy transitions in the Arctic region.**
4. Juha Kotilainen (University of Eastern Finland) and Jocelyn Fraser, **Collaborating beyond the concession: Moving towards water stewardship in mining.**



SESSION 13. BUSINESSES ACCELERATING SUSTAINABLE TRANSITION (CHAIR IDA PARKKINEN, MEDISTUDIA, MS400) [CLICK HERE TO JOIN THE MEETING](#)

1. Simona Chilba and Sajal Kabiraj (Häme University of Applied Sciences), **Circularity as a new mindset: Lessons from the industry.** [ONLINE](#)
 2. Henri Teittinen (University of Eastern Finland, Business School), **Management accounting and control systems in circular economy.**
 3. Kang Li, Riikka Holopainen and Esa Hiltunen (University of Eastern Finland), **The study of sustainability report disclosure and its influence on firm performance: evidence from Finnish listed companies.** [ONLINE](#)
 4. Ida Parkkinen and Hanna Lehtimäki (University of Eastern Finland), **Innovation in an ecosystem: Making sense of sustainability transition.**
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ABSTRACTS



Topic groups: Climate Forcing, Ecosystems and Health (CLEHE)

Recognizing the Right to a Healthy Environment: Implications in Climate Litigations

Apollaro, Paola: University of Urbino – UNIURB, Italy

Keywords: climate change, human rights, healthy environment, climate litigations, international law

Content:

According to the principles of international law, promulgating and protecting human rights is an obligation of all States. This obligation requires addressing the transnational impacts, especially on environmental conditions such as climate change. International law evolves along the societies following global and contemporary issues. This tendency has been confirmed again recently as the United Nations General Assembly declared that everyone on the planet has a right to a healthy environment. In the official resolution, climate change and environmental degradation are confirmed to be among the threats to humanity. The recognition of this right enables States to commit to giving access to a clean, healthy and sustainable environment to their population. At the same time, this means that people can challenge their governments for environmentally destructive policies under human rights legislation. People will be able to demand clean air, to access safe and sufficient water, healthy food and ecosystems to shape their identity through their social and work life. First of all, this article aims at defining what is the right to a healthy environment by analysing the road with which international recognition was achieved. Second, it will explore the dimension of the city as a healthy environment and citizen life are strictly linked. Lastly, the legal dimension of litigation will be taken into consideration as litigation are an essential tool in the hands of the people to claim justice. In this regard, the Columbia Case is significant to understanding how the right to a healthy environment can be invoked in courts.



Topic groups: Sustainable Co-management of Water Resources and Aquatic Environments (WATER)

Mapping the networks of flood risk governance and management

Banafa, Thomas¹; Eräranta, Susa¹; Peltonen, Lasse²; Keskinen, Marko¹

1. Aalto University, Finland
2. University of Eastern Finland, Finland

Keywords: flood risk governance, flood risk management, network governance, social network analysis

Content:

Addressing flood risks calls for collaboration among diversity of actors, typically with varying interests and responsibilities. This is highlighted by the on-going shift from mere flood protection to multi-functional flood risk governance, which also emphasizes the importance of adaptive approaches. One way to analyze flood risk governance is to investigate the relations through which actors interact with each other. Such interactive processes and their influence on actors' power relations can be unraveled through network governance analyses. In this study, we analyze the actor networks unfolding from flood risk management plans to visualize the diversity of roles and connections between actors participating in flood risk management measures. We introduce a new framework for analyzing flood risk management plans and related actor networks using Social Network Analysis and test it in the context of Finland. This is accomplished by translating the institutional setting of flood risk governance and management into analyzable actor networks. The framework helps to visualize the diversity of networks for different flood risk management strategies. The analysis also reveals the central role that different types of actors – including those outside public sector - occupy in the network, emphasizing the importance of active public-private collaboration in flood risk governance. The abstract above is based on a manuscript submitted for review.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Circularity as a New Mindset: Lessons from the industry

Chilba, Simona; Kabiraj, Sajal: Häme University of Applied Sciences

Keywords: Strategy, Resilience, Framework, Stakeholders, Sustainability of Stocks

Content:

Circularity is a concept that has started being slowly implemented in many industries. The main importance of it is balancing the use of resources by prolonging the liability over the point of sale and the change in business processes with regards to how the resources are being used, but not wasted. The authors are looking into the implementation of circularity within several industries and analyzing the resilience encountered with respect to the brought changes within the strategic frameworks. The importance of sustainability, and in more particular, of circular economy is being defined. The effects of circularity over the profitability of businesses are aspects brought into discussion. Rebuilding new business models is a challenge that affects not only the involved company, but all linked stakeholders. Shifts in strategy are taking their toll on the mindsets of business owners. The applicability of circularity within strategic operations is being investigated and the concrete emerging results of closing the loop are being presented. To gain expertise in applying the circularity concepts, there is a need to reexamine sustainability frameworks and techniques. This will enable us to understand the reasons for good or bad performance by an industry, generate strategy options for an industry, assess available options under conditions of imperfect knowledge, select the most appropriate strategy, and recommend the best means of implementing the chosen strategy.



Topic groups: Forests and Bioeconomy (FOBI)

Uncertainty and forest concessions in a globalized world: insights to local access to forest resources in Mozambique

Herdieckerhoff, Irina: University of Eastern Finland

Keywords: access to resources; uncertainty; ambiguity; forest concessions; Mozambique

Content:

Forest-based communities are embedded in complex and uncertain global processes. We aim to understand the repercussions of uncertainty on forest-based livelihoods, focusing on implications in terms of access to resources for inhabitants of forest concessions. Uncertainty is conceptualized as unpredictability (not knowing), limited knowledge (knowing too little) and ambiguity (knowing too much, too differently). This research is based on an ethnographic case study in Zambezia Province, Mozambique. In-depth interviews and participant observations were conducted in local communities and triangulated with interviews with NGO and government officials. The findings indicate that multiple actors draw on formal and informal institutions to mediate access, which exacerbates uncertainties. Unpredictability, limited knowledge and ambiguity undermine access to resources for local communities. This paper contributes to an understanding of uncertainty and suggests collaborative approach to reduce or cope with different uncertainties in the quest towards sustainable forest-based livelihoods.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Stakeholder Engagement Practices in Local and Regional Public Organizations: A Longitudinal Study in the Context of a Circular Economy in Finland

Leinonen, Heta: Tampere University

Keywords: Stakeholder engagement, regional actors, circular economy, sustainability, thematic analysis

Content:

This study identifies and organizes the stakeholder engagement practices of forerunner local and regional public organizations in the context of a circular economy in Finland. The study first examines stakeholder engagement practices in 2019 and 2021 and then analyzes the development of these practices. Examining the stakeholder engagement practices of local and regional public organizations in a circular economy is topical because adopting a circular economy is crucial to addressing environmental changes caused by humans. In this study, a 'circular economy' refers to reducing the use of natural resources, closing material, energy, and nutrition cycles, and retaining the value of products, materials, and resources for as long as possible. The stakeholder engagement practices of local and regional public organizations anchor a circular economy in a specific context and thus, enhance social progress. The research data were collected through ten semi-structured interviews with the forerunner local and regional public organizations of the circular economy in Finland in 2019 and 2021. Braun and Clarke's (2006) phases of thematic analysis were used to identify and analyze stakeholder engagement practices within the interview data. The study contributes to the discussion on stakeholder engagement, regional actors, and a circular economy. First, the study extends the theory of stakeholder engagement practices by exploring how forerunner local and regional public organizations that operate in a circular economy collaborate with their internal and external stakeholders and how collaborative practices are advanced through real-world applications. Second, the study increases and broadens the practical and theoretical understandings of stakeholder engagement practices and their development in recent years in local and regional public organizations.



Topic groups: Sustainable Co-management of Water Resources and Aquatic Environments (WATER)

Post-treatment of real municipal wastewater effluents using combination of advanced oxidation processes and photobiotreatment: towards sustainable resource recovery and urban wastewater reuse

Levchuk, Irina: University of Eastern Finland

Keywords: wastewater, Advanced Oxidation Processes, ecotoxicity, microalgae

Content:

Aim of this work was to emphasize the high value of urban wastewater effluents and its potential for recovery of nutrients and water reuse. In this work the efficiency of suggested post-treatment train for real urban wastewater effluents was studied in order to recover "waste" nutrients and reach water quality suitable for reuse. The post-treatment train consisted of combination of Advanced Oxidation Processes (AOPs), such as UVC/H₂O₂ and catalytic wet peroxide oxidation, followed by photobiotreatment. Decomposition of organic compounds in wastewater effluents including pharmaceutically active compounds (PhACs), inactivation of microorganisms (E.coli, Enterococci, Total coliforms), concentration of nutrients, concentration of metals was monitored after each treatment step. Moreover, ecotoxicity of water was assessed after each treatment step using six different species (*Daphnia magna*, *Lemna minor*, *Chlorella vulgaris*, *Desodermus perdis*, *Synura laticarina*, *Acutodesmus* sp.). Microalgae biomass growth rates were estimated and uptake of nutrients from wastewater effluents was monitored. Presence of valuable compounds in obtained microalgae biomass (e.g. carotens, proteins) was analyzed in order to evaluate possibility to obtain added-value products from it.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

The study of sustainability report disclosure and its influence on firm performance: evidence from Finnish listed companies

Li, Kang: University of Eastern Finland

Keywords: firm performance, sustainability report, circular economy, profitability

Content:

Sustainability report has attracted increasing attention in academic world for almost two decades. However, most of them were concentrated on the necessities and urgent needs of sustainability report from responsibility perspective, while few of them focused on the benefits of sustainability report disclosure actives from motivation and profitability perspective. The objective of this study is to investigate whether firms' sustainability report disclosures have the impact on firm performance. The authors empirically test whether there is a relation between sustainability report disclosure activities and firm performance by using a cross sectional sample of Finnish listed companies in 2019. From a theoretical point of view, our study extends firm performance research filed to a new interdisciplinary area of sustainability which is a precedent in literature. In practical implications perspective, our study could be valuable for managers to understand the importance of sustainability report disclosure that it could assist them in maximizing overall firm performance.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Stakeholder perspectives on the impacts and barriers for Information and Communication Technologies (ICTs) for sustainable food systems in South Africa

Alfonsi, Robert Massimo: The University of Tokyo, Graduate Program in Sustainability Science (GPSS-GLI)

Keywords: Sustainable food systems, small scale farmers, information and communication technologies (ICTs), food security, sustainable livelihoods, South Africa

Content:

Abstract Food systems in Sub-Saharan Africa (SSA) face multiple sustainability challenges related to climate change, rural-urban migration, farmers' access to markets, funding, and logistics. The use of ICTs can assist stakeholders in SSA economies to improve food system sustainability in different ways, such as increasing transparency and encouraging local production and consumption that enhance sustainable food systems and food security. However, there are various challenges for the adoption and use of ICTs for food systems. This research presents the diverse perspectives of non-end user stakeholders engaged in the South African food and ICT sectors to identify and understand the critical issues shaping the adoption, use and outcomes of ICTs for sustainable food systems. To achieve this, we first identify through an institutional analysis the main organizations engaged at the interface of ICT and food systems in South Africa, and then conduct 31 in depth expert interviews with stakeholders from academia, government organizations, civil society, producer groups and the private sector. Our results show that respondents strongly associate ICTs with positive social and environmental benefits such as behavioral change of producers and consumers, improved access to markets and increased support for small-scale farmers, improved transparency and traceability, decreased food waste and shifts to agroecological farming. However, challenges related to high Internet data costs, low digital literacy of producers, access to funding, information quality and access, shortage of software developers for poverty alleviation initiatives, and corporate misconduct are perceived as significant barriers for ICT adoption and use for food systems in South Africa. Some of the ways forward to enhance the effectiveness of ICT for food system sustainability in South Africa could include the development of multi stakeholder platforms and collated databases to strengthen transparency, and government engagement with small scale farmers in co-designing ICT projects and policies for the food system.



Topic groups: Forests and Bioeconomy (FOBI)

Carbon stocks and fluxes in coniferous boreal forests along a latitudinal gradient

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Keywords: boreal forest ecosystems; carbon fluxes; carbon pools; ICP Forests, Norway spruce; Scots pine; site fertility

Content:

Carbon sequestered in the vegetation and soil of boreal forest ecosystems plays an important role in climate regulation. This study's objectives were to quantify the differences in the components of the forest carbon (C) cycle along a 1,000 km latitudinal gradient within the boreal region (southern vs northern boreal) and between dominant coniferous species in Fennoscandia. The study included typical mineral soil forests and comprised seven xeric-sub-xeric and eight mesic-herb-rich heath forests dominated by Scots pine and Norway spruce respectively. The total site carbon stock (CS) ranged from 81 to 260 Mg ha⁻¹. The largest ecosystem component CSs were tree stems, mineral soil, and humus layer, representing 30±2%, 28±2%, and 13±1% of total CS respectively. On average, the spruce sites had 40% more C than the pine sites, and CS stored in most compartments was higher on spruce than on pine sites. As exceptions, understory vegetation and litter layer had a larger CS on pine than on spruce sites. The northern sites had an average of 58% less C than the southern sites. Humus layer CS was the only compartment showing no latitudinal trends. Northern plots had a significantly larger fine and small root CS and understory CS than southern plots. Most CS compartments were significantly correlated with litterfall C flux components. Dissolved organic carbon (DOC) flux in throughfall was positively correlated with the aboveground tree compartment CS. Our study revealed patterns of C distribution in major boreal forest ecosystems along latitudinal and fertility gradients, which may serve as a reference for Earth system models and in the evaluation of their projections.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Project champions as emergent environmental leaders

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Keywords: Project leadership, environmental leadership, emergent environmental leader, champion, project champion

Content:

This study examines the personal characteristics and leadership behaviors of the project team members that have been identified in the previous champion literature and how these characteristics and behaviors drive change in the city organization. As our empirical case, we study a two-year project focused on urban circular economy. The longitudinal study with bi-weekly meetings with the project team members, allowed us an in-depth view to the project teams everyday work and gathering of rich, qualitative data. The study contributes to project management literature by engaging in a micro-level inspection of contemporary project leadership. The study also contributes to project management literature by bringing the concept of emergent environmental leadership into project management research. The results of the study suggest that the project team, indeed, had personal characteristics and that they engaged in leadership behaviors and utilized strategic networking in a way that was recognized in previous literature as typical for champions. The results also suggest that these personal characteristics and leadership behaviors work as a driver of organizational change.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Phosphorus harvesting from digested sludge using acidophilic microorganisms

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Keywords: Phosphorus recovery, acidophilic bacteria, digested sludge, nutrients recycle

Content:

Digested sludge contains a significant amount of phosphorus (P) which needs to be recycled to save natural P resources, food security and protect surface waters. The use of raw sludge in agriculture recycles the nutrients but it has several constraints such as; it is expensive to transport a large volume of sludge and it might contain heavy metals and pharmaceutical residue. Extraction of P from sludge and producing a phosphate fertilizer is a good option for nutrient recycling. In this study, acidophilic bacteria (*Acidithiobacillus ferrooxidans* and *Acidithiobacillus thiooxidans*) were mixed with digested sludge (4%TS) and supplemented with 30, 50 and 80 g/L of elemental sulfur (S). This mixture was incubated at 30 °C in a shaker incubator at 175 rpm. This study includes two experiments, the first experiment was conducted to understand the S need for the process and the second experiment was conducted to understand process stabilization time. Both experiments were conducted as a semicontinuous process by replacing 20% of sludge during different days of incubation. The first experiment showed that 30 g/L of S applied sludge achieve a similar pH reduction result to the sludge supplemented with the higher amount of S. The second experiment showed that 8 days of incubation was enough to establish the process. This process extracted 95% P and produced a 1.5% P-containing product. A thiooxidans needed more time for adaptation compared to A ferrooxidans in the beginning. Local acidophilic microorganisms were adapted better and achieved similar P extraction results to the used acidophilic bacteria. It is concluded that this process can extract >95% of P from digested sludge and produce 6-8 g/L of fertilizer product with 1.5% P. This product also contains a significant amount of metals, therefore, further study is needed to remove these metals and produce a high-quality phosphate product.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

“Safe and Sustainable by Design” as a regulatory approach for a more sustainable biobased circular economy in the European Union

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Keywords: Safe and Sustainable by Design; Circular Economy; Biotechnology

Content:

Biotechnology has large potential in enhancing sustainability and plays a key role in establishing a biobased circular economy in the EU. This is also recognized in the European Green Deal, the European Union’s Circular Economy Action Plan and the Union’s Bioeconomy Strategy which set the aim to render the EU circular economy more biobased. Novel biotechnologies, such as biocontrol agents against plant pests, microbial food production and genetic engineering of crops, are developing at a quick pace; however, risks related to human or animal health and the environment arise along with these technologies. Therefore, regulation to minimize these biotechnology related risks is paramount. One way to regulate Biotechnology and its risks is by the “Safe and Sustainable by Design” concept. Also known as prevention by design, the concept is a precautionary and preventative measure that is implemented in early stages of design of the (bio)technology itself. It is hence a tool to lower the risks related to and enhance the creation of a more circular biobased economy. In this paper we will explore the benefits and disadvantages of integrating the Safe and Sustainable by Design concept in Biotechnology as a form of regulation to enhance sustainability and therefore reach towards a more sustainable biobased circular economy. More precisely, we will firstly describe the origins of the concept and its current use, as well as its relation to the precaution and prevention principle, to then analyse what it could mean for the establishment of a more circular biobased economy.



Topic groups: Sustainable Co-management of Water Resources and Aquatic Environments (WATER)

On thin ice: Are lakes feeling the heat?

Sharma, Sapna: York University, United Kingdom

Keywords: Climate change; lake ice; winter biology

Content:

Our planet is experiencing accelerated climate warming, with dramatic consequences not only on lake ecology, but also on the ecosystem services we rely on from our freshwater resources. Lakes with seasonal ice cover, which represent more than half of the world's lakes, are especially sensitive to a changing climate, as ice cover is a strong determinant of lake ecosystem functioning. Lakes are losing ice cover at unprecedented rates. On average, ice duration is shorter by 17 days/century. However, in the past 25 years, lake ice loss is 6 times faster, with some lakes not freezing every winter. By the end of the century, over 200,000 lakes may no longer regularly freeze and almost 6,000 lakes may permanently lose ice cover with climate warming. With reduced ice cover, lakes may stratify earlier which can lead to elevated water temperatures, primary production, and likelihood of algal blooms, some of which may be toxic. Mitigation of greenhouse gases is essential to preserving this ecological, cultural, and economically important resource.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Legal Risks of Extended Producer Responsibility Adoption

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Keywords: circular economy; extended producer responsibility; legal risks; scoping review

Content:

Transitions towards a circular economy necessitates a myriad of tools; there is no silver bullet for a circular economy. Numerous legal tools can promote circular economies, including bans, standards, targets, labels, certifications, charges, environmental taxation, and container deposit schemes. This paper focuses on one such tool: extended producer responsibility. Extended producer responsibility is based on the polluter-pays principle where the producer or seller of a product retains responsibility of some form (i.e. physical responsibility, economic responsibility, informative responsibility, liability) for the product throughout its life cycle, including when it becomes waste. The allocation of such responsibility is intended to promote ecodesign of products by incentivising the improvement of product reusability and recyclability, reduction of raw virgin material use, and engagement in other environmental design activities. This paper presents the results of a scoping review of literature on legal risks of extended producer responsibility. The contributions of the review are two-fold: (1) identification of legal risks of producer responsibility within the context of circular economy transitions and implementations (i.e. what are the legal risks), and (2) identification of the allocation of these legal risks (i.e. who bears these risks). These findings inform a wider analysis on the extent to which circularity affects the legal distributions of risks in supply chains and whether circular supply chains call for new liability standards and new collaborative contract models.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

It's not "one size fits all": Why size matters in organizational sustainability transformation

Strunk, Kim: University of Passau, Germany

Keywords: Organizational transformation, organizational sustainability, sustainability transformations, employee engagement, sustainability strategy

Content:

Progressing climate change urges organizations to become more sustainable. While scholars recognized the importance of employee engagement for organizational sustainability and that there is no “one size fits all” approach to sustainability, research has particularly emphasized large organizations. However, considering the wide economic and societal transformation necessary, scholarly attention increasingly shifts to small and medium organizations; yet differences in employee engagement for sustainability due to organizational size remain widely unexplored. We add to this stream by analyzing differences in employees’ sustainability engagement in a comparative case study of two Germany based organizations. Contrasting a large multinational with a start-up, now being a successful medium sized organization, we show that while both organizations implemented measures for sustainability and attempt for reducing resource consumption, the role of employees in the small organizations was distinctly different. While the multinational’s management created a strategic vision for sustainability, that employees adapted and operationalized in the day-to-day activities, in the start-up, employees were decisively involved in developing a sustainability vision and strategy. Given the need to perform in the market, the founders – initially highly engaged in sustainability – lost track of sustainability as they were challenged by establishing functioning and effective business processes to allow for scaling their operations. However, the employees used their relatively prominent position and close connections with the founders to rally for sustainability and put it back on the organizational agenda. Our studies show that while employees matter greatly for sustainability transformations, smaller organizations may benefit from very early participation whereas established and large organizations need the management to initially set the stage for sustainability.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Circular economy sharing platforms - Customer value and active value creation

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Keywords: circular economy, sustainability, sharing platforms, customer value, customer value creation

Content:

This qualitative multiple-case study is looking into circular economy (CE) companies operating on sharing platforms and the customer value and the value that they are creating as customers for three pre-selected CE companies. CE has gathered more and more interest from various instances in the past years and is seen a more sustainable alternative for linear economy. CE businesses are aiming to extend or close the material flow loops with different business models (BM). Yet, online customers are operating in a role that is heightened to do with the typical BMs on platforms. Therefore, the customer is an active stakeholder producing value. The literature has strongly looked into CE companies leaving aside the customer value research subject that has looked at the customer not just as a value receiver party but also a producer. This is the gap that this research is shedding light on. This study is the first article in a series of four that is viewing the customers' role within platform CE companies holistically and gaining an understanding of the value gained and produced by customer with a 360-angle. This first study is started with a deductive approach on literature and data is collected with customer stories from the customers of these pre-selected companies. The customer stories are analyzed with inductive content analysis. The research question in this study is: "What is the customer value that CE companies' sharing platforms offer, what is the value that customer is creating for the platform and how are these related?" The results will be helping online CE ventures in planning and operating as well as in developing phase. Also, results will be giving knowledge for any company, academic or political instance that is aiming to further CE development, entrepreneurship, and business on platforms.



Topic groups: Sustainable Co-management of Water Resources and Aquatic Environments (WATER)

Recycling of sediment phosphorus from eutrophic Finnish and Estonian lakes in agriculture

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Keywords: lake sediments; phosphorus; recycling to agriculture; sustainable lake restoration

Content:

The role of lake sediments as a phosphorus (P) fertilizer has been questioned. While sediments with the iron to P ratio (Fe/P) around ten can likely be applied directly in agriculture, additional measures may be needed to increase the availability of P for plants in case of the sediments with the higher Fe/P ratio. Here, we studied fertilizing ability of the sediments from four Finnish (Päijät-Häme) and two Estonian lakes with contrasting Fe/P conditions in a greenhouse experiment with ryegrass. Additionally, we tested the potential of lime, biochar and arbuscular mycorrhiza to increase availability of sediment P for plants. The experiment lasted from December 2021 to May 2022, during this time, four yields of ryegrass were cut. Next, P uptake by plants was determined and growing medium analyzed for P fractions. Sediments of all lakes studied showed a good potential to be used as a P fertilizer, as the biomass of ryegrass grown on sediments was higher than the biomass of the controls (without sediments). Moreover, the growth of the plants on the sediment-P was much better than in the treatment with mineral P fertilizer, indicating additional benefits of sediments (e.g., source of organic carbon, nitrogen, microelements). Biochar and lime improved the plant growth on the sediments from Lake Kymijärvi. Highest growth of plants occurred on sediments from Lake Kutajärvi and Lake Matjärvi (with the highest content of organic matter) treated with lime, though the lime itself did not affect the plant growth. Hence, the results of the current study showed that lake restoration by sediment removal will provide certain co-benefits addressing e.g. scarcity of mineral P sources.



Topic groups: Carbon cycle in surface waters (Limnological Division of Water Association Finland)

Browning of boreal lakes: do public perceptions and governance meet the biological foundations?

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Keywords: brownification, ecosystem-based management, recreation, regulation, tourism, water quality

Content:

Browning of surface waters, also known as brownification, is an environmental issue particularly in boreal lakes surrounded by intensively managed forests and wetlands. In this paper, we review the ecological consequences and ecosystem-based management of browning by using a systematic review approach and adopt an interdisciplinary approach to build new governance on this complex phenomenon. To support the study on the impacts of browning on lake ecosystem functioning, we present primary survey data on public perceptions of water quality in Finland. We identify a need to develop ecosystem-based management beyond the EU's Water Framework Directive (WFD) to fully account for the extensive implications of browning. We also detect a need for a better understanding of the biogeochemical processes related to browning to manage the greenhouse gas balances related to lake metabolism. Public perceptions of the quality of waterbodies in Finland were largely in agreement with the general proportion of waterbodies classified as meeting a good or excellent ecological status, but recreational fishers may value different aspects of water quality. Consequently, we suggest that the ecosystem-based management of inland waters should improve the utilization of information on not only biogeochemical processes but also users' perspectives on aquatic ecosystems beyond the EU WFD.



Topic groups: Forests and Bioeconomy (FOBI)

Thermal sum drives abundance and distribution range shift of *Panolis flammea* in Finland

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Keywords: Climate warming; pine beauty moth; forest insect pest; pheromone traps; population levels; forest health

Content:

Climate change has assisted the northward range expansion of various forest insect pests, increasing the risk of forest damage in Northern Europe. The pine beauty moth, *Panolis flammea*, is common in European pine stands with cyclical outbreaks that have damaged thousands of hectares. In the 1970s, its Finnish northern distribution limit was reported to be around 64°N. We re-evaluated the northernmost distribution limit of *P. flammea* in Finland and studied the effect of temperature sum on its abundance. We used pheromone-based traps throughout Finland in 2019–2020. The number of individuals caught in each trap was coupled with the previous year's thermal sums from the same location, and the relationship between them was analysed using a generalised linear mixed model. *P. flammea* had spread into northern Finland to 68°51'N, at .10.2 km/year, 50 years ahead of earlier predictions. We found a non-linear correlation between thermal sums and *P. flammea* abundance, increasing from cold to warm areas. Given the climate change scenarios for Fennoscandia, its range and population could continue to increase, allowing it to become another widespread coniferous-forest insect pest. Understanding the effects of temperature on its populations will allow us to model their probable future distribution and population dynamics.



Topic groups: Sustainable Co-management of Water Resources and Aquatic Environments (WATER)

Companion planting enhances the plant production in aquaponics system

Atique, Faiqa: University of Jyväskylä, Finland

Keywords: Aquaponics, hydroponics, companion planting, sustainable food

Content:

Due to increasing demands for the sustainable food production and environmental regulations for agriculture and aquaculture it is needed to develop environmentally friendly food farming methods. Aquaponics is an integrated farming of fish and plants where two techniques hydroponics and recirculating aquaculture (RAS) are combined to grow fish and plants for human consumption. We investigated if the growth of lettuce is increased when grown with a companion herb on RAS effluents and how the companion plants affected the microbial community of the lettuce. The companion herbs, especially mint, enhanced the growth of lettuce. We detected evidence of transfer of bacteria between the companion plants and lettuce and were able to link specific bacteria to increased growth of lettuce. In concern to consumer acceptability for aquaponically grown food, it is important to investigate if the RAS effluents could be a potential source of pathogens for the aquaponic plants. The present study revealed that the transfer of bacteria from RAS water to lettuce was negligible. Companion planting in aquaponics could be a useful technique to enhance the production of plants in a sustainable and environmentally friendly way.



Topic groups: Sustainable Co-management of Water Resources and Aquatic Environments (WATER)

Legal deadlock in the catchments: Three ways to reconcile hydropower generation with environmental objectives

Belinskij, Antti: University of Eastern Finland / Finnish Environment Institute, SYKE

Keywords: environmental law, water law, hydropower generation, environmental objectives, license review

Content:

Finland has harnessed almost all its rivers for hydropower generation. While the role of hydropower in electricity generation has decreased and legal and ecological demands to improve aquatic biodiversity increased, the strong permanence of hydropower licenses has largely remained intact in Finland. To illustrate the point, a national permit authority has considered two applications to review hydropower licenses in two major rivers in Finland already for five years. Currently, EU and Finnish law include considerable legal drivers for greening hydropower. The EU Water Framework Directive, Environmental Liability Directive, Taxonomy Regulation, and proposed Nature Restoration Law all steer hydropower to more adaptive direction. In Finland, the constitutional responsibility for the environment and more environmentally oriented interpretation of the Water Act have gained prominence academically and societally. This presentation discusses three roles for legal research in reconciling hydropower generation with the environmental objectives. First, legal research can advise the permit and other processes by setting the scene through e.g., clarifying how EU and national law including the constitution support or impede the reconciliation of different objectives. Second, research can discuss different legal possibilities and limits for top-down regulation. For example, Sweden has thoroughly amended its legislation to set modern environmental requirements for hydropower installations. Third, research may consider what is the role of law in enhancing bottom-up solutions such as the Nousu-program that has been successful in removing small hydropower dams in Finnish rivers.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Improving the Sustainability of EV Battery Supply Chains: Prospects for sourcing, manufacturing, and end-of-life management

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Keywords: minerals, EVs, circular economy, batteries

Content:

As governments across the world decarbonize their economies, the shift toward clean energy is highlighting new geopolitical tensions, supply chain vulnerabilities, and sustainability challenges associated with raw material extraction. With electrification as the main pathway to achieving decarbonization, one key technology—the battery—plays an outsized role. As electric vehicle deployment accelerates, several factors—ranging from trade war-, pandemic-, and conflict-induced supply chain shocks to resource availability and investor-led ESG demands—have spurred national and regional efforts to protect supply chains. These efforts involve a combination of onshoring and regionalization, development of novel battery chemistries, and circular production processes. While a significant and growing body of research evaluates individual aspects of EV supply chains through the lens of resource scarcity, geopolitical conflict, and—in some cases—sustainability, very few studies provide a comprehensive overview of policy, corporate, and technological challenges to sustainability at all relevant nodes of EV supply chains. This research takes a holistic approach to EV battery chain sustainability, evaluating public sector policy proposals and strategic planning in relevant jurisdictions, corporate ESG bottlenecks and opportunities, and technological solutions. This paper uses the Supply Chain Operations (SCOR) model developed by the Supply-Chain Council as a guide for identifying and evaluating nodes of the supply chain. In the context of EV batteries, sourcing is interpreted as the sourcing of critical minerals; making as the material processing, cell component manufacturing, and battery cell and pack assembly; and returning as the recycling or upcycling of EV batteries. Three instruments are evaluated for their efficacy in enabling or impeding sustainable solutions at each stage: public policy, corporate governance, and technology. The paper concludes with a series of key recommendations relevant to all supply chain nodes, using each of the three instruments as avenues for improving life cycle sustainability.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Socio-political aspects of electric vehicle battery minerals supply chains

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Keywords: electric vehicle, critical minerals, energy transition, politics, social risk, lithium, cobalt

Content:

Global efforts to mitigate climate change will continue to see the demand for battery technologies and the necessary minerals soar (Wilson & Martinus 2020, IEA 2021). The energy transition will drive a shift from fuel- to materials-intensity in the energy system (IEA, 2021). The e-mobility solutions the world needs for this transition will significantly increase the demand for critical minerals such as lithium (Ballinger, et al. 2019, Lèbre, et al. 2020, IEA, 2021). Questions about mineral availability, geopolitics, social and environmental risk in the critical minerals supply chain abound. In addition, the current war in Eastern Europe has increased pressures to diversify the supply chains while raising questions on the harm new extraction sites might produce (Sharma, Lere & Loginova, 2022). Over the next two years, a post-doctoral research project will seek to contribute to an improved understanding of the socio-political risks, and associated governance and policy responses in the supply chain of electric vehicle battery minerals. The project will combine analysis of global trends, risk and policy mapping, with expert interviews and desk-top case studies. The presentation will be an opportunity to discuss the project design and identify linkages and collaboration opportunities.

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Topic groups: Sustainable Co-management of Water Resources and Aquatic Environments (WATER)

Are plastic additives a threat to aquatic ecosystems?

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Keywords: microplastics; chemicals; ecotoxicology; freshwater; risk assessment

Content:

Pollution of the water environment with plastic, in its macro- or micro- form, reflects the disproportionate use of plastic in our daily life. Plastic particles are far from being homogeneous particulates. For example, microplastic particles cannot solely be qualified as “polymeric particles smaller than 5mm in size”. They are very complex entities that among other characteristics, include thousands of chemicals like plasticizers, flame retardants and surfactants (generally tagged under the term “additives”) that may leach to water. Additives have been defined by the European Commission as substances intentionally added to provide a plastic with a physical or chemical effect during its manufacture or in the final product and they are intended to remain in the plastic. Plastic additives are an aspect of plastic pollution that surprisingly has been studied infrequently, possibly due to the assumption of an insignificant release from plastic matrices. As plastic additives are not covalently bound to polymers, they leach to water and have been found in marine, freshwater and terrestrial environments, and even concerns about their biomagnification and effects to higher levels have been raised. Also, additives leaching to the environment can be considered as a very complicated chemical mixture that may vary their composition depending on the environmental conditions and the plastic type present. In addition to presenting the latest findings in the literature regarding plastic additives, we will show our latest experimental results regarding the toxicity of tire rubber, PVC, PE and cellulose acetate leachates to model freshwater organisms at the organism and molecular level. While the chemicals that leached from PE did not harm any of the physiological endpoints of the organism tested, tire rubber and used cellulose acetate leachates presented the highest toxicity, inhibiting growth and causing substantial mortality. PVC only caused toxicity in extreme conditions. At the molecular level, tire rubber leachates altered the gene expression of the freshwater insect *Chironomus riparius*, likely as a response to the generation of oxidative and cellular stress provoked by the leached chemicals. Both our results and those found in the literature suggest to further investigate the effects of the chemicals present in plastic products as a potential threat to aquatic ecosystems.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Assessing the EU's evolving position in energy geopolitics under decarbonisation

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Keywords: European Union; critical raw materials; geopolitics; energy transition; climate change

Content:

As a large importer of fossil fuels, the EU's pursuit of carbon neutrality by 2050 promises to significantly affect its position in the geopolitics of energy. This article analyses the implications of the energy transition for the EU's role in energy geopolitics, looking at declining and emerging energy dependencies through the lenses of sensitivity and vulnerability. These analytical categories refer respectively to the EU's exposure to the material foundations of interdependence and to its ability to manage them. The EU generally finds itself in a more advantageous geopolitical position in a clean energy order compared to the current fossil fuel-based energy system. This is mostly due to the geological distribution and specific material features of clean energy materials and the ability to manage such interdependence. This result seems valid despite a high degree of uncertainty in the development of the technological and geopolitical landscape over the transition period.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Nature as a stakeholder: Typology

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Keywords: stakeholder, nonhuman, nature, sustainability

Content:

Stakeholder theory has considerably discussed the stakeholder status of nonhuman nature. Yet, it has not been able to fully explain how firms engage with nonhuman nature. Thus, the theory is limited in addressing the ways by which businesses can respond to sustainability challenges. Our aim in this article is to examine what types of nonhuman stakeholders there are when nature is considered as a stakeholder. We propose a typology presenting nonhuman stakeholders as context, resource, protegee and partner. We contribute to stakeholder theory by complementing the current anthropocentric understanding with a more particularized view of nonhuman nature as stakeholders.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

The role of institutional environment in catalysing circular entrepreneurship: cross-country comparison of CE ventures in Finland and Italy

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Keywords: circular economy, institutional environment, startups

Content:

The purpose of this paper is to explore sustainable startups business opportunity creation in different industries in Finland and in Italy and especially the role played by governmental agencies as potential innovation management catalysts in developing sustainable businesses. In particular, we focus our investigation on how start-ups create business opportunities in collaboration with governmental agencies, public institutions, and business development services. Our study contributes to applying the institutional perspective in circular economy research. The biggest body of knowledge on sustainable CE has so far come from the engineering and natural sciences (Broman and Robért, 2017) and business model perspectives. However, the institutional approach has not been very extensively used circular transition even if it offers a possibility to analyze the tradition in a holistic manner. Similarly, to Ranta et al. (2018) we also point out that regulative efforts are not enough to catalyze the change in norms, values, world views, visions, concepts (see Korhonen et al., 2018), but also cultural-cognitive and normative pillars have a significant role in catalyzing the circular transition. By analyzing the collaborations between ventures and public actors we also aim at bringing a new insight into the CE actors and their roles in the institutional change on how the CE actors influence each other.



Topic groups: Carbon cycle in surface waters (Limnological Division of Water Association Finland)

VEMALA TOC: towards better national scale carbon leaching estimates

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Keywords: total organic carbon, loading modelling, catchment scale, VEMALA

Content:

There is an urgent need to quantify carbon leaching from the catchments to the rivers/lakes and eventually to the Baltic Sea. The Finnish-scale nutrient loading modelling system VEMALA simulates nutrient leaching and transport on land and water for all watersheds (Huttunen et al., 2016, Korppoo et al., 2017). The total organic carbon (TOC) leaching component was incorporated into the VEMALA during the last five years. Carbon processes in the soils are based on INCA-C model. The new soil moisture and infiltration model was implemented into VEMALA for runoff simulation for different soils. In peat soils, water table is shallower than in mineral soils, and higher baseflow is produced from shallower soil layers, which have higher carbon content evenly spread throughout the soil profile. In contrast, in mineral soils, the main TOC leaching happens with subsurface runoff, because highest carbon content is in top-soil layer. The VEMALA modelling system gives the possibility in the future to apply the new version to all the Finnish watersheds and quantify the TOC loading and source division for all the inland waters and the Baltic Sea. Some parts of the Baltic Sea are considered a source of CO₂ to the atmosphere. For instance, Gulf of Bothnia, which productivity is low is highly influenced by terrestrial organic carbon water. Therefore, simulation of changes in terrestrial TOC loading estimates is important. The model will be applied using climate change and land use change scenarios for future TOC loading simulations. Moreover, this new VEMALA TOC model opens up the opportunity to develop the lake model to account for carbon emissions from the aquatic freshwater ecosystems in the whole country.



Topic groups: Carbon cycle in surface waters (Limnological Division of Water Association Finland)

Mitigating freshwater ecosystem browning calls for a systemic change in peatland forestry

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2. Natural Resources Institute Finland

Keywords: organic carbon, brownification, forest management, peat decomposition, water protection

Content:

Surface waters of the boreal region have experienced increased browning during the last decades. Browning is mostly driven by increased organic carbon (OC) and iron concentrations. It can cause detrimental changes in aquatic ecosystems through implications for both chemistry, physics, and ecology. In addition, browning can impact aquatic greenhouse gas emissions, increase the costs of drinking water treatment, and weaken the recreational value of waterbodies. All these impacts are calling for means to mitigate excess OC and iron transport to aquatic ecosystems. Browning has often been associated with decreased atmospheric sulphur deposition and climate change induced alterations in temperature, vegetation, and hydrological regime of the catchments. Lately, browning has also increasingly been attributed to changes in land use, especially peatland forestry. At the same time, conifer dominance together with increasing tree biomass have been assumed to increase OC export. In a review, we evaluated the impacts of peatland forestry operations on OC leaching and assessed possible mitigation measures. Our review revealed that traditional, even-aged peatland forest management with intense harvesting, soil preparation and ditch network maintenance not only create hot spots for excess OC leaching but also promote hot moments for OC transport via artificial, increased hydrological connectivity. Moreover, most water protection measures currently utilized in peatland forestry were discovered either inefficient or at best ambiguous in retaining OC especially in dissolved form. Consequently, a systemic change would be needed with a number of actions to prevent formation of loading and excess OC leaching, which is the most efficient way to diminish negative water quality impacts. Management practices that prevent future peat decomposition and diminish the hydrological connectivity especially during high runoff are essential. Means for mitigating excess loads should be integrated in future forest policies and revised forestry guidelines.



Topic groups: Sustainable Co-management of Water Resources and Aquatic Environments (WATER)

Rivers under pressure – interdisciplinary feasibility analysis of sustainable hydropower

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2. University of Eastern Finland
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Keywords: River biodiversity, Hydropower, Mitigation hierarchy, Dam removal

Content:

Global biodiversity loss is most severe in freshwaters, particularly in river ecosystems. Hydropower is one of the main culprits. While being promoted as a carbon free source of renewable energy, hydropower disrupts the flow, habitats, and biota of rivers. Environmental policies and programs seek to mitigate the damage hydropower causes. Any policy action aiming at making the utilization of our rivers more sustainable must be ecologically, economically, and legally feasible. We show that the interdisciplinary feasibility of mitigation measures divides existing facilities into three categories i) large facilities in which biodiversity mitigation measures are needed but electricity generation and balancing the electricity grid should remain as their main focus, ii) small facilities in which dam removal and full scale river restoration measures can be taken by assisting the facilities to seize operations, preferably just before their next big investments, and iii) medium facilities where benefits and trade-offs associated with alternative paths should be analyzed case-by-case to determine the most feasible path forward. Policy action is feasible in all three categories but in different ways: requiring fish passes in the case of large facilities, helping remove dams and restoring the rivers in the case of small facilities, and focusing cost-benefit analysis efforts on the non-trivial group of the medium sized facilities.



Topic groups: Forests and Bioeconomy (FOBI)

Wind Damage Risk Assessment Tool (prototype) with GIS software

Ikonen, Veli-Pekka: University of Eastern Finland

Keywords: Wind damage, risk assessment, stand, management unit, wind climate, topography

Content:

Our aim was to build a tool for wind damage risk estimations based on open-source forest, terrain and climate data and open-source platform QGIS. We used terrain data from National Land Survey of Finland (NLS), forest data from Finnish Forest Centre (FFC) and wind climate data from Finnish Meteorological Institute (FMI). The tool predicts critical wind speeds (CWS) needed for wind damage (uprooting) of trees at the edges of clear-cut areas. CWS for wind damage was calculated using regression model based on mechanistic HWIND model calculations. Stand boundaries that were considered to have a potential risk of wind damage (at-risk edges) were searched for in the landscape. These were expected to be in stands with a dominant tree height ≥ 16 m with at least 25% lower adjacent stand height at upwind direction. CWS predictions were based on the characteristics of both the subject stand (tree species, mean tree height, and diameter/height ratio) and the adjacent stand (mean height and area of the stand). The CWS predictions were compared to the wind speed predicted for the target at-risk edges based on wind speeds at a nearby weather station. The wind speed at the target at-risk edge was calculated using information on the topography of the terrain and the roughness of the tree canopy in the upwind direction. The tool is still a prototype and needs improvements, e.g., user-friendly interface and visualization of wind damage risk through gamified approaches. In this presentation it is demonstrated the performance of the prototype.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Food Waste in Indian Families: Status and Potential Solutions

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2. Häme University of Applied Sciences Ltd. (HAMK), Finland
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Keywords: Food waste; Indian families; Qualitative research; Phenomenology

Content:

India is the second largest country in terms of human population. The state of hunger is worrying in India. According to a FAO report, in terms of absolute terms, India had highest number of undernourished people in the World during 2020. The world hunger increased in 2020 in the shadow of COVID-19 pandemic. The Food Waste Index Report 2021, from the United Nations Environment Programme (UNEP) and WRAP observed that 931 million tonne of food waste was generated in 2019. The share of different sectors in the same was 61% from the household, 26% from food services, and 13% from the retail. Thus, the household sector is the most important source of generating food waste. The report further observed that the estimated food waste among Indian household is 50 kg per capita per year, or 68,760,163 tonne every year. The present study focusses on understanding the status of food waste generation by Indian families, explanatory reasons for generating this waste and potential solutions to minimize or control food waste. The findings of the study suggest that food waste is a common phenomenon in Indian households. All participants were concerned on the issue of food waste and had a bad to hurting kind of feeling associated with it. The reasons for food waste range from miscalculations in cooking, lack of appreciation, food preferences to facility to store etc. Finding alternative ways to consume food and improving family culture have emerged as master theme in controlling or eliminating food waste in Indian household. This study will provide a guidance to the planners and policy makers to design policies to tackle food waste problem among Indian households.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Reviving the Incentives for Eco-design in Extended Producer Responsibility: The Challenges for Eco-modulation

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2. Yale School of the Environment, USA
3. Finnish Environment Institute, SYKE

Keywords: Extended Producer Responsibility, EPR, eco-modulation

Content:

Extended producer responsibility (EPR) is an environmental policy strategy that makes producers of products and packages responsible for the waste management of their products. A key goal of EPR is to incentivize producers to (re)design their products and packages to improve their environmental performance, especially at end of life. However, because of how the financial structure of EPR has evolved, those incentives have largely been muted or made non-existent. Eco-modulation has emerged as an additional component in EPR to restore the missing incentives for eco-design. Eco-modulation operates through changes in the fees that producers pay to meet their EPR obligations. Eco-modulation includes both increased differentiation of types of products and associated fees, and additional bonuses and penalties—environmentally targeted discounts and surcharges on the fees that each producer pays. Eco-modulation faces challenges if it is to restore the incentives for eco-design. These include weak linkages to environmental outcomes, fees that may be too low to induce changes in materials or design, lack of adequate data for policy management, online sales that allow international producers to avoid EPR obligations, EPR and eco-modulation implementation that differs across jurisdictions reducing market signals for eco-design, and extensive lack of ex post policy evaluation. Opportunities to address these challenges include use of life cycle assessment to inform eco-modulation, increased eco-modulation fees, strategies to increase harmonization of eco-modulation implementation, mandated provision of data, and adoption of policy evaluation tools that establish the efficacy of different eco-modulation schemes. The overall lack of information about the efficacy of existing eco-modulation initiatives, the need to build capacity in data collection and management and in policy evaluation, and the complexity of establishing eco-modulation programs suggests that eco-modulation might best be treated as an experiment, or rather a series of experiments, building and evolving upon each other.



Topic groups: Sustainable Co-management of Water Resources and Aquatic Environments (WATER)

Presentation types: Oral presentation

Nitrogen and carbon dynamics and circulation in the aquaponic system followed using ^{13}C and ^{15}N isotopes

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2. Natural Resources Institute Finland (Luke)
3. Terhontammi Oy,

Keywords:

Content:

Aquaponic farming combines aquaculture of fish and cultivation of plants in closed systems that recirculate water and nutrients. Thus, aquaponic farming has lower environmental impacts compared with traditional separated aquaculture and plant production. In this experiment, whitefish (*Coregonus maraena*) and stinging nettle (*Urtica dioica*) were grown as model species in the aquaponic system constructed in UEF. The aim of this study was to estimate flow and recycle of carbon and nitrogen from fish feed to fish, to plants and respiration. We used ^{13}C and ^{15}N enriched fish feed. Since the total isotopic abundance is conserved in the system, the mass of ^{13}C and ^{15}N equals the mass in products and thus helps in estimating C and N retention in the system. Nutrient, pH and oxygen level in water was monitored online with Aquatroll-500 and water quality was adjusted when diverting from the optimum for fish or plants. The proportion of carbon and nitrogen accumulated to produced biomass fractions (e.g., fish, plants and solid waste material) and released from the systems was estimated by measuring amounts of C and N and their isotopic composition in each fraction. Besides this, also CO_2 and N_2O flux from the aquaponic system as well as inorganic carbon and nitrogen dissolved in water was estimated. This study show, that the combination of whitefish and stinging nettle was suitable for the aquaponic farming. Furthermore, stable isotopic analyses are a valuable tool when following dynamic biological processes.



Topic groups: Sustainable Co-management of Water Resources and Aquatic Environments (WATER)

Modelling the effects of different fishing methods on fish size structures

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2. Natural Resources Institute Finland (Luke), Paltamo, Finland
3. Natural Resources Institute Finland (Luke), Oulu, Finland

Keywords: Food web, selection curve, Allometric Trophic Network Model with Evolutionary Application, fishing, pikeperch, vendace

Content:

Fishing selects fish of certain sizes and therefore it could affect the size and growth of the individual fish in the fish populations. Here we studied the effects of different fishing methods on a theoretical lake food web simulation that was based on Lake Oulujärvi data. We used Allometric Trophic Network model with Evolutionary application (ATNE model) that has previously been used in a study of perch (*Perca fluviatilis*) trait evolution in Lake Constance. Here we have now two fish species, pikeperch (*Sander lucioperca*) and vendace (*Coregonus albula*) that evolve simultaneously. In the ATNE model the fish growth is modeled with von Bertalanffy equation and when the fish mature they also allocate part of their biomass into reproduction. The evolving fish species inherit their growth parameter traits; asymptotic length (L_{∞}) and Brody's growth constant (k), from their parents. We studied two different kind of fishing methods for pikeperch; gillnet (knot size 50 mm) and fykenet and they differed on the resulting development in the growth parameters. In addition, we studied a less selective curve of trawl and a normally distributed selection curve of trawl in vendace. There were differences in the Brody's growth constant with the two kinds of trawling selection tested.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Collaborating beyond the concession: moving towards water stewardship in mining

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2. The University of British Columbia, Canada

Keywords: Mining, water stewardship, collaboration

Content:

Poor water management practices in mines, such as the discharge of contaminated water into local waterways, acid rock drainage, and catastrophic failures of tailing storage dams have raised concerns and eroded public trust. Tailings management failures in Finland, Sweden and Canada show that mining can cause significant environmental damage even under the rule of modern environmental legislation and within the bounds of self-regulation regimes. In the mining sector, executives now rank a lack of trust with local communities as a significant business risk. Governmental authorities' ability to enforce and monitor the water use of the mining industry has been questioned together with their legitimacy. In consequence, any perceived threat to community water sources is a trigger for conflict. There have been attempts to address the water issues with regulation, technological solutions, and corporate social responsibility measures. However, many of these responses have been unsuccessful. This may be because traditional approaches to water tend to be based on unilateral assumptions about stakeholders' concerns and interests, and often exclude key rightsholders and stakeholders in the planning and implementation processes. Instead of focusing on bad cases, we investigate examples where mining companies have successfully addressed water-related concerns in different social contexts. These cases illustrate how the role of water can shift from that of environmental divider into a connector. We explore new approach to sustainable use of water – a move from classic water management, managing water considerations within the mine concession area, towards water stewardship. Meaningful water stewardship utilizes collaborative and participatory tools, relies less on corporate priorities, and instead recognizes local rightsholders and stakeholders as partners in water management, providing access and opportunities to influence knowledge production and interpretation.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Multi-level governance of recycling electric vehicles' battery metals

Sairinen, Rauno & Kotilainen, Juha: University of Eastern Finland

Keywords: Critical metals, governance, circular economy, electric vehicles, EU

Content:

Electric Vehicles (EV) will be vital in reducing air pollution and meeting climate change goals. Our paper aims at analysing the on-going multi-level governance for developing circular economy of EV battery metals. Present EV batteries are not designed to be easily and cost-effectively disassembled, reused or recycled (Mossali et al. 2020). Yet the challenge is not simple: drivers of recycling and absent recovery value itself depend on regulations, incentives, development of greater residue volumes and economic viability of recycling processes, and voluntary agreements (Mulvaney et al. 2021). In the analysis we are presenting a general picture of European Union level governance system which is influenced by the global activities of the industry and other major players of the field. The analysis identifies relevant policy actors, policy targets and regulatory systems, possible voluntary mechanisms and coordinating authorities and the relationships between policy-making and business development. In practice, the EU, global and national level governance and regulatory systems are under active development, and need improved understanding on multi-level interactions for the needed new technological steps.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Business and societal perspectives on circular plastics economy

Lehtimäki, Hanna¹; Sengupta, Subhanjan¹; Leppälä, Kristina¹; Piispanen, Ville-Veikko¹

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Keywords: Circular economy, plastics, economic, environmental, social, sustainability

Content:

The purpose of this paper is to present a comprehensive review of business and societal perspectives on circular plastics economy. The prevalent global understanding is that our current lifestyle produces too much plastic waste with respect to planetary boundaries. There are visions for circular economy for plastics that address ways in which the global society can reduce, reuse and recycle plastics in consumption (EllenMacarthur foundation). Academic research in business studies and social sciences on circular economy on plastics is emerging. Our research will contribute to this budding research area. We will provide an overview of up-to-date research on circular economy on plastics and evaluate the current development from economic, environmental and social sustainability perspectives. The review will be organized along the three dimensions of sustainability. First, in connection to economic sustainability we will bring together literature that examines value creation through more efficient use of material resources, for instance, elimination of unnecessary plastic packaging, or recycling of plastics. This is the most established stream of research. Second, we will review literature that examines environmental sustainability. This body of literature discusses, redesign the logic of value creation (products, packaging, business models) to reuse and replace plastics, health and safety issues, and decoupling plastic from infinite sources. This line of research is most dispersed across disciplines. Third, we will review literature on social sustainability of plastic circular economy. This is the most novel and emerging area of research that comprise issues such as households as consumers, the informal waste sector in the global South, social inclusions of marginalized and vulnerable and citizens/consumers values, beliefs, behaviours. We will conclude with suggestions for future research and outline research framework for circular plastic economy.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Social license to explore? Critical raw materials and social acceptance in the AGEMERA project

Lempinen, Hanna: University of Lapland

Keywords: critical raw materials; mineral exploration; social acceptance; social license to operate

Content:

Global demand for critical raw materials continues to grow rapidly. At the same time, the EU-level domestic supply of many primary critical raw materials (CRMs) is less than 3%, making the EU very dependent on imports from China, Russia and third countries. For this reason, mobilizing Europe's domestic CRM potential has become an essential part of the EU's transition to a low-carbon and digital economy. Successfully navigating this challenge calls for innovative methods, technologies and techniques to be developed and applied in mineral exploration. In addition, in order to be implemented in a socially sustainable and just manner, exploration – and potential later extraction – should unfold in a manner that is acceptable and sustainable from the viewpoints of those affected. In response to these demands, the Horizon-funded AGEMERA (Agile Exploration and Geo-Modelling for European Critical Raw Materials, 2022-2025; 7 494 662,50 euros; lead: University of Oulu) project aims both to quantify the CRM potential in the region and to promote its utilization in a manner that is socially acceptable and sustainable. The task of our work package in the overall project is to develop a survey for mapping community expectations and concerns related to mineral exploration based on our case study areas in Oikarainen and Petäjäinen, Rovaniemi to be later utilized as a tool for universally measuring the social acceptance of mineral exploration across different national and sociocultural settings. We wish to make use of this presentation as a platform for discussing the potential benefits and pitfalls of this approach.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Sustainability transition in higher education institutions: the role of formal university sustainability strategies

Liakh, Olena: University of Macerata, Italy

Keywords: sustainability strategy; universities

Content:

The growing seriousness and complexity of challenges attributed to sustainable development accentuated the key role of higher education institutions (HEIs) in contributing with novel solutions to societal well-being (including intellectual and cultural), calling for universities all around the world to intervene more effectively. Pressures coming from communities, regulators, scholar and pupils resulted in HEIs steadily prioritizing their involvement in advancing the global society towards new and established models of education, research, innovation and citizens' involvement. The initiation of a sustainability transition at university-level can be easily controlled for through the positioning of formal university sustainability strategies to ensure a more qualitative project management of sustainable activities. Adopting the sustainability criteria in the form of an aspirational and intentional strategy is, in fact, instrumental to properly integrating sustainable development goals within HEI macro-objectives, which can enable universities to drive positive societal changes. The paper aims at presenting the relevance of the role of a formal sustainability strategy within the context of a HEI. Considering sustainability strategy from the viewpoint of problem-solving for enabling change three essential elements have been commonly recognized as characteristic of a successful university change towards sustainability: (1) a formalized aim to dedicate some researching efforts to studying short-run local contexts to increase chances of learning-by-doing; (2) a stakeholder-involving mindset for speeding up the process of knowledge co-creation; (3) constant attention to the development of an organizational culture based on sustainability for transforming the knowledge into action.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Towards Just Transitions? Consultation, consent, and energy transitions in the Arctic region

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Keywords: Energy transitions, just transitions, consultation and consent, Arctic

Content:

The idea of a 'just transition' is being actively mobilised in debates about global energy transitions. As a principled framework, the idea suggests that in the pursuit of meeting ambitious climate targets, social justice and environmental integrity should not be compromised by the decisions and actions of state and non-state actors. It requires meaningful consultation and consent with rights holders, supported by international norms, national regulations, and customary laws and practices. Ambitious climate targets are driving heightened demand for energy transition minerals and metals (ETM) as inputs to renewable energy technologies. Meeting demand will require greater access to the land and seas where ETMs are located and renewable energy infrastructure is installed. Research confirms that a significant proportion of global ETM reserves and resources are located on or in close proximity to the lands of Indigenous peoples and other land- and sea-connected communities. This raises important questions about procedural justice and natural resources governance in remote territories – including the Arctic region. In this region, Indigenous peoples and local communities have long interfaced with mining and other large-scale development. While their insights and experiences have potential to inform decision-making processes, they are not always brought to the forefront of debate. In this paper, we amplify the perspectives of peoples from the Arctic, and those who work with them. We also identify gaps between international commitments, national regulations, and territorial and place-based practices. Our work aims to support Indigenous peoples and local communities to demand responsible action from governments and industry by exercising their rights to actively participate in decision-making about the global energy transition and the Arctic's future.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Leadership sensemaking – mining industry leadership interpreting their business environment

Mielonen, Nuppu: University of Eastern Finland

Keywords: senior management sensemaking, sustainability, mining, strategy

Content:

This paper explores how mining leadership in Finland make sense of their business environment. Research on leadership in mining is scarce, especially from the business and organizational studies perspective. As the strategic leaders of the companies doing the mining activities are the ones making decisions about the future direction of business, it is of interest and importance to see how they view and interpret the changing business environment they are in. The green transformation powered by actions of governments, NGOs, industries, and businesses is changing the way we live, and the way business is done. In the context of electric mobility and the increased investments on renewable energy, there is an increase in demand for materials required for batteries. These materials are acquired through mining which is, on one hand, a central industry in green transition, but, on the other hand, a publicly criticized industry for harming the environment. This qualitative research paper discusses the views and interpretations of seven industry leaders of Finnish mining companies. The data comprises open, thematic, semi-structured interviews of the leaders. Qualitative content analysis was performed with sensemaking as theoretical lens. The findings show what leaders consider as important for the Finnish mining industry, and how the identity and image of mining industry are constituted in the leaders' sensemaking. The sensemaking emphasizes national geological resources and Finnish mining industry know-how as assets in European and global competition. The sensemaking considers the negative reputations of mining industry being based on people not considering the whole story. Finally, circular economy in the mining industry raised conflicting thoughts among the leaders. The paper will conclude with a discussion on senior management sensemaking on justifications of mining industry in Finland. As a managerial implication, we will outline recommendations for strategy communications.



Topic groups: Forests and Bioeconomy (FOBI)

Strip harvesting in drained boreal peatlands when water quality matters

Miettinen, Jenni: University of Helsinki

Keywords: peatland forestry, strip harvesting, water table, even-aged management, ditch network maintenance, nutrient loads, sediment loads

Content:

Pristine boreal peatlands are wet forest sites, where high ground water table limits tree growth. Over time, peatlands have been widely drained for forestry purposes in the boreal zone. Traditional forest management with clear-cuts and ditch network maintenance on drained boreal peatland forests causes nutrient and sediment loads from peat soils. There is a need to reduce water quality externalities this causes to society. This paper examines the economics of strip harvesting on drained boreal peatlands as an alternative to traditional even-aged management that causes negative externalities due to nutrient and sediment loads from peat soils. Strip harvesting avoids large clear-cuts, eliminates the need to conduct ditch network maintenance and facilitates maintaining water table at the environmentally beneficial level, thus reducing negative externalities. A forest manager maximizes present value of net harvest revenue subject to a constraint on the water table. The optimal harvesting program consists of a transition period and steady state period. In the transition period, the initial stand area is allocated between strips to be harvested in a row and rotation ages in the strips are simultaneously determined. In the steady state, only the rotation ages are chosen. The model is applied numerically to the Finnish peatland forestry. The results show that strip harvesting is an economically feasible option that effectively reduces negative water quality externalities. It may reduce private harvest revenue relative to the traditional even-aged management but reduces negative environmental externalities to society. The water table constraint plays important role in designing the optimal solution. A tight constraint decreases the share of firstly harvested stand volume relative to the laxer water table constraint.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Achieving Greenhouse Gas Emissions through the Utilization of Hydrogen: Case Study of the EU Renewable Energy Directive Differentiating Renewable and Fossil-Based Hydrogen

Noël, Sébastien: University of Eastern Finland

Keywords: European Union, hydrogen, process and production methods, World Trade Organization law

Content:

This article addresses how the European Union's (EU) renewable energy directive (RED) implements the carbon neutrality objective of the Paris Agreement, and affect the World Trade Organization (WTO) rules, by differentiating renewable and fossil-based hydrogen. Hydrogen, essentially, is a liquid or gaseous fuel that emits no greenhouse gases (GHG) emissions, and could be utilized to decarbonize heavy industries (refineries, chemicals, iron and steelmaking) and transport (long-haul road transport, aviation, and maritime) sectors. These "hard-to-electrify" sectors are located remotely from electricity grids and require high density of energy, which currently originates from petroleum oil, coal, and natural gas. Currently, these fossil fuels sources constitute the main hydrogen productions, which significantly generate more GHG emissions than renewable energy ("bioenergy, solar, wind-power"). RED essentially implements the Paris Agreement by requiring that renewable hydrogen is used to decarbonize the transport sector; which is further complemented by the consortium CertifHy issuing renewable and low-carbon certificates. Hydrogen fundamentally questions whether its renewable and fossil-based productions are in a competitive relationship, or "like" products under the WTO non-discrimination obligations of most-favored-nation and national treatment. Such a competitive relationship can be challenged by "process and production methods", which are regulations differentiating "like" products based on characteristics physically-related thereto (PR-PPMs) or otherwise related to their production processes (NPR-PPMs). The legal dogmatic method ascertains whether the said GHG-related NPR-PPM can differentiate hydrogen and be justified on environmental protection grounds. This article, consequently, places this PPM within the legal debate occurring at the WTO, where non-product PPMs remain controversial. Controversy entails that the predominant scholarship considers them as extra-judicial protectionist measures, while other scholars deem they address Multilateral Environmental Agreements and WTO Multilateral Agreements shortcomings, alike. This article, consequently, claims that the above GHG-related PPM lawfully differentiates hydrogen and affords no such a protection to domestic hydrogen productions.



Topic groups: Forests and Bioeconomy (FOBI)

How to fight against biodiversity loss - actions by the biodiversity education network

Oksanen, Elina: University of Eastern Finland

Keywords: Biodiversity, sustainable development, education

Content:

Biodiversity is a prerequisite for the well-being of the planet and people, as well as for sustainable development. However, biodiversity is declining at an exponential rate and human actions now threaten more species with global extinction than ever before. An average of ca. 25% of species in assessed animal and plant groups are threatened and 75% of the land surface area has been significantly altered. It has been estimated that around 1 million species already face extinction unless rapid action is taken to reduce the intensity of drivers of biodiversity loss. Rapid decline in biodiversity and ecosystem services mean that most international societal and environmental goals, e.g. those in the 2030 Agenda for Sustainable Development, will not be achieved. We essentially need transformative changes in production and consumption of food, feed, energy, fibre and water as defined in the European Green Deal and new European Biodiversity strategies. Biodiversity must be included in all decision-making and actions of all sectors of society in the same way as climate issues are done. Therefore, new forms of multidisciplinary education and co-operation is urgently needed to promote the development of sustainable society and new solutions for tackle this crisis, including technological development. In this presentation we introduce the achievements of new nationwide Biodiversity education network where collaboration in biodiversity related education has been launched in collaboration with UEF, UHEL, OU, UTU and JyU, funded by the Ministry of Education and Culture (<https://www.biodiversityeducation.fi>). In this effort, experts from the participating universities are creating joint online and multimodal courses and teaching materials, sharing their special expertise in different biodiversity fields (e.g. birds, forest, peatland and tropical ecology fish biology, species identification, genetics and planetary wellbeing). As an example, we will introduce the new Biodiversity.now online course, which is being produced with Climate university and Una Europa. We also shortly present our new project targeted to forest owners to increase their knowledge about biodiversity issues, to be realized together with JOK (Centre for continuous learning, UEF). We highlight the importance of interdisciplinary understanding and actions in the fight against biodiversity loss. At the end, we aim to raise discussion about widening the collaboration among the participants from different fields of science.



Topic groups: Carbon cycle in surface waters (Limnological Division of Water Association Finland)

Winter nitrogen cycling in sediments of boreal lakes affected by browning and mining

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Keywords: Browning, Nitrogen cycle, denitrification, DNRA, N₂O, winter limnology, sediment microbiome

Content:

Ice-covered period of boreal lakes has contrasting environmental conditions respect to the ice-free, with cold temperatures, absence of light, and minor gas exchange between water and atmosphere. Focusing on the nitrogen (N) cycle, winter seems a suitable period for N-transforming prokaryotes with a high availability of reactive N due to minor assimilation by photoautotrophs. However, there is limited data about winter N cycling rates and the microbes involved on, and about the role of organic matter quality on N cycling processes. We studied two oligotrophic big boreal lakes in North Karelia, Finland, Lake Viinijärvi and Lake Höytiäinen, each lake with clear-water and brown-water sides. Viinijärvi has an additional side affected by mining activities in the catchment showing higher nitrate and sulphate levels in the hypolimnion. During winter of 2021 we sampled two times these five sites, at the beginning (January-February) and at the end (March-April) of the ice-covered period. Using the Isotope Pairing Technique we incubated sediment cores with ¹⁵NO₃⁻ and quantified the products of 1) complete denitrification (N₂), 2) truncated denitrification (N₂O), and 3) dissimilatory nitrate reduction to ammonium (DNRA, NH₄⁺) to infer the process rates. In addition, to see the role of organic matter, we perform anoxic slurry incubations of the top sediment layer with ¹⁵NO₃⁻ and 1) lake water, 2) miliQ water, 3) algal dissolved organic matter (DOM) extract, or 4) peatland DOM extract. We characterized the DOM using FT-ICR MS. We also explore the genetic potential (DNA) of the sediment microbiome by using several sequencing techniques: 1) amplicon (16S rRNA), 2) captured, capturing the main N and CH₄ functional genes, and 3) shotgun. Preliminary results identify the N-transforming microbes and point to changing nitrate consuming activities and N genetic potentials between the clear-water, the brown-water, and the mining affected sites.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Innovation in an ecosystem: Making sense of sustainability transition

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Keywords: innovation, ecosystem, prospective sensemaking

Content:

This presentation explores dynamics that shape the development of new and eagerly anticipated innovations in a sustainability transition ecosystem. As we face the need of reframing and reimagining organizing in modern societies, the presentation discusses stakeholder innovation and highlights the relational view in exploring value creation. I consider innovation as a shared, continuous, dynamic, and emerging phenomenon in a system with distributed agency. Interdependent ecosystem actors gather around an overarching issue of designing and implementing sustainable future. Divergent actors share similar hopes for the future development and expect to achieve benefits for different economic sectors. To analyze innovation in sustainability transition, I suggest the framework of prospective sensemaking. Prospective sensemaking entails bets on the future that refer to fragmented pieces of stories about future potentialities unfolding based on past experiences, present dynamics and future expectations. I offer prospective sensemaking as an approach to address ambiguity, uncertainty, and speculation of what is going to happen. In addition to the future orientation, prospective sensemaking highlights the nascent character of the innovation ecosystem in which multiple actors construct an actionable and plausible future in collaboration. This research will set out to highlight a business science perspective on the sustainability transition that is a current issue entailing numerous bets on the future. This perspective allows us to make sense of business renewal and the related business opportunities. The presentation concludes that prospective development of various sustainability transition initiatives unfolds in stakeholder relations and takes shape as fragments of stories.



Topic groups: Forests and Bioeconomy (FOBI)

Climate Smart Forestry

Peltola, Heli: Itä-Suomen yliopisto

Keywords: Forestry, Boreal forests, Forest Ecosystem services, Adaptation, Risk Management, Climate change mitigation

Content:

Finland is the most forested country in the EU. Increasing carbon sequestration from the atmosphere, and its storage in forests (trees and soil) will be one important part of the climate smart forestry strategy in Finland. Although maximizing the carbon storage of forests may provide the best climate-cooling benefits in the short term, it may not be the best option in the long term. This is because the increasing risks of large-scale natural disturbances associated to climate change may turn forests, at least partially, into carbon sources. Therefore, adaptation to and mitigation of climate change need to be considered simultaneously in forest management and forestry. Different adaptation and risk management actions may also be needed to increase forest resilience to multiple damage risks such as caused by wind storms, snow extremes, forest fires, European spruce bark beetle outbreaks and wood decay (e.g. by *Heterobasidion* species). They may also vary largely depending on the geographical region and the projected severity of climate change. In climate smart forestry strategy, it should also be harvested wood for wood-based products that could act as longer term carbon storage and/or substitute for more greenhouse gases -emission-intensive materials and energy. However, at the same it should be enhanced forest resilience and ensured sustainable provisioning of multiple ecosystem services for the society.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Understanding Societal Acceptability of Mining - Emergent legitimacy and the control of legitimation resources

Peltonen, Lasse: University of Eastern Finland

Keywords: mining, legitimacy, legitimation, social acceptance

Content:

At general level, various concepts of social acceptability, social license, and legitimacy share the idea that any organization or institution needs the approval of its operating environment; the viability of the organization is linked to evaluations regarding the acceptability of its performance. At a more fine-grained level, the way these relationships are understood and conceptualized is relevant for how we understand acceptability. How does acceptability emerge from a network of actors and interactions? How is 'social licence' granted or revoked? How can controversies and contestation over mining be understood through these interactions? This presentation seeks to refine the dynamics of acceptability by expanding the focus towards a differentiated and networked conceptualization of societal acceptability. It links the notion of legitimacy with stakeholder theory, with a particular focus on legitimation processes and legitimation resources. Building on Hybels' s (1995) framework of organizations' legitimacy and legitimation, acceptability is understood through the lens of control of legitimation resources by stakeholders, directly or indirectly affecting the goals and actions of an organization or industrial sectors.



Topic groups: Sustainable Co-management of Water Resources and Aquatic Environments (WATER)

Adaptive Baltic Sea eutrophication governance: lessons from the implementation of Water Framework Directive and Marine Strategy Framework Directive in Finland and Sweden

Pihlajamäki, Mia: Aalto University

Keywords: learning, policy cycles, governing catchments, experimentation, participation

Content:

Adaptive governance is considered essential for managing complex socio-ecological problems such as Baltic Sea eutrophication. Over the past decade, the EU Water Framework Directive (WFD) and the Marine Strategy Framework Directive (MSFD) have become the backbone of eutrophication management. The directives entail that the EU member states prepare river basin management plans (RBMPs) and national marine strategies (MSs) for their established river basin districts and marine areas. The RBMPs and MSs go through an extensive revision process every six years, thereby facilitating learning that is a key characteristic to adaptive governance. In 2021, the third RBMPs and the second MSs were adopted. This study presents an on-going analysis related to adaptive governance of Baltic Sea eutrophication. The aim of the analysis is to explore how WFD- and MSFD-related eutrophication governance in Finland and Sweden has adapted between the river basin and marine management cycles. We use selected adaptive governance criteria, namely i) collaboration in a polycentric governance system, ii) public participation, iii) an experimental approach to resource management, and iv) management at the bioregional scale, to analyse the planning processes and policy outcomes related to eutrophication as well as possible changes in them between the management cycles. We derive data from policy documents, mainly legislation, RBMPs, and MSs, and complement these with expert interviews. The results provide insight on the changes that have been made for adaptation in the two EU member states as well as the related benefits and challenges.



Topic groups: Forests and Bioeconomy (FOBI)

Effect of prior tree marking on cutting productivity and quality of remaining stand in thinnings

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Keywords: thinning; time study; machine operator; driver assistance system (DAS); cut-to-length (CTL) method.

Content:

Advanced driver assistance systems (ADASs) are becoming more common in vehicles and heavy machinery. These systems scan the machine's surroundings with different perception sensor technologies using for instance lidars, radars, and cameras. Developing the ADASs has a great potential for more precise forest management, improved harvesting productivity and possible relief on operators' workload. However, the effect of ADAS on cutting productivity, quality and operator's workload is unknown. The first study of the PhD thesis aimed to simulate and investigate the effect of a tree selection system on cutting productivity and the quality of remaining stands by applying conventional prior tree marking. The comparative time study was conducted with four experienced and skilful harvester operators. The operators thinned 4825 stems with the cut-to-length (CTL) logging method in eight thinning stands. Prior tree marking increased the effective cutting productivity, on average, in first thinning by 2.8% and in later thinning by 2.7%, reducing the time consumption of boom-out (positioning the harvester head for cut) and moving. Consequently, the operator effect was notable, even if only experienced operators participated in the study. Although prior tree marking increased productivity only marginally, the prior tree marking produced a more proper density of remaining trees after the cutting operation. These findings lay the foundation for the use of ADASs in forest machines. In the future studies, the harvester will be equipped with a mobile laser scanner (MLS) which will be integrated into the display of the harvester by the research collaboration company of Ponsse Plc. This ADAS can detect the trees guiding the operator in tree selection and managing better thinning intensity at cutting work. The future studies attempt to determine the effect of ADAS on cutting productivity, quality and operator's workload with several harvesters and harvester operators in time and long-term follow-up studies.



Topic groups: Sustainable Co-management of Water Resources and Aquatic Environments (WATER)

Mix & match for transformative wetland restoration governance

Santaoja, Minna: University of Eastern Finland

Keywords: wetlands, restoration, transformative governance, transdisciplinarity

Content:

The United Nations General Assembly proclaimed the years 2021-2030 as the UN Decade on Ecosystem Restoration, aiming to halt the degradation of ecosystems all around the world. The EU Biodiversity Strategy for 2030 also emphasizes restoration. The EU restoration plan entails concrete commitments and actions by the Member States. In June 2022, the Commission proposed the EU's first ever Nature Restoration Law, with binding restoration targets. Finland would be one of the most impacted countries of the new law, due to large peatland areas drained for forestry. The restoration of wetlands is becoming a priority on the international conservation agenda as the importance of wetlands has become understood. Wetlands retain and purify water, remove pollutants and excess nutrients, store atmospheric carbon, moderate flooding and coastal storms, support a great variety of wildlife, and offer recreational, well-being and economic benefits to surrounding communities. At the same time, wetlands are the most degraded habitats, facing numerous pressures. Wetland restoration has been local and fragmented, and both scaling up and speeding up the restoration effort are needed. However, one size does not fit all – local good practices cannot be simply scaled up to broader landscapes, as the ecological, social, and cultural contexts are different. What can be scaled up, then, in wetland restoration governance? Transformative governance calls for systems thinking and understanding eco-social interdependencies. Successful governance requires a diversity of stakeholders, stewardship that navigates complexity, and niche-level innovations and experiments that may allow new configurations to break through. Current approaches to restoration have been called technical and bureaucratic - new human-nature connections are called for. This talk discusses emerging ideas for restoration governance, such as vitality and relational ethics, and how these can act as leverage points for transformation.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

Management accounting and control systems in circular economy

Teittinen, Henri: University of Eastern Finland

Keywords: management accounting, management control, circular economy

Content:

Maas and Boons (2010) argue that measurement and monitoring systems are prerequisites for integrating sustainability into organizational strategies and efficiency. Although the current literature argues that management accounting and control systems need to adapt to the strategies and business models of the circular economy, only a few studies have explored the topic (Svensson and Funck, 2019; Barletta et al., 2018; Crutzen et al., 2017). This research project investigates the forms of management accounting and control systems (MACS) in the circular economy. The data has been collected from 40 circular economy forerunner companies in Finland. Theoretically, this study contributes to the integration of environmental and economic concerns in accounting and management control for sustainability (see, e.g., Maas et al., 2016) and to accounting and organizational change from an environmental perspective (see, e.g., Contrafatto and Burns, 2013; Epstein and Roy, 2007; Bebbington et al., 2014; Bennett et al., 2013; Epstein and Roy, 2001).



Topic groups: Sustainable Co-management of Water Resources and Aquatic Environments (WATER)

On-Site Measurement of Heavy Metals in Environmental Waters with a Portable Multielement Water Analysis System

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Keywords: Heavy metals, Adsorption, X-ray fluorescence, Water monitoring

Content:

With the current laboratory techniques, it takes time and money to measure heavy metal concentrations in environmental waters. This is due to the equipment needed such as inductively coupled plasma mass spectrometry (ICP-MS) or optical emission spectrometry (ICP-OES). These devices also require trained personnel to run them. The laboratory facilities are not available in every part of the world and the lack of monitoring can lead to health risks for the people using the water for daily activities. Because it can take weeks to get the results from the laboratory, it is impossible to react fast to sudden changes. To solve this problem, a portable measuring system was developed, which anyone with little experience can measure heavy metal concentrations in water on-site and get the results within 15 minutes. The system concentrates the dissolved metals into a tailored adsorbent filter and the metals are quantified with a portable X-ray fluorescence (pXRF) device directly from the filter. The current system can measure cationic metals such as Mn, Ni, Cu, Zn, Pb, Co and U and more metals will be added later in the portfolio. The system fits into a backpack and is easy to carry in to hard-to-reach locations and provides a smart way to monitor metals in waters in areas where laboratory infrastructure is scarce or there is a need for quick on-site assessment. One of the current development goals is to make the system feasible for arsenic analysis as chronic arsenic poisoning is a severe problem in certain parts of the world like in Nepal and India.



Topic groups: Sustainable Co-management of Water Resources and Aquatic Environments (WATER)

Numerical methods towards quantitative and predictive management of inland fisheries

Vainikka, Anssi: University of Eastern Finland

Keywords: fisheries, management, boreal, lake, ecosystem-based, modelling

Content:

Sustainability of inland fisheries is based on the self-regulation paradigm and minimum allowable sizes set for certain large-bodied, long-lived fishes. However, to optimize societal benefits, fish catches or biodiversity goals, more knowledge-based management would be needed. Management of any harvested animal population should be based on solid understanding of population dynamics, often using ecologically relevant population models that can describe the past, replicate the present and predict the future. The necessary input data include information on catches and particularly catch-per-unit-effort (CPUE) and size structure of the catches. Such data could be easily collected using mobile applications or through other online solutions. I present an example how size-structured population models can be used to estimate the total fish production of small boreal lakes. Fisheries-independent collection of CPUE and individual data was used to parametrize a model for each lake, and the model was simulated to predict catches at different harvest intensities and size selectivities. Lakes managed for recreational purposes need different management from commercially harvested lakes, and the optimal management is dependent on water quality. The model-based management could be commercialized and used both locally or through cloud-based services, but fisheries economies tend to be underdeveloped and the fishers show increased willingness to pay only when they target iconic large salmonids such as salmon or brown trout. Openly available information on fish stock status would also create an apparent tragedy of the commons in open access fisheries with freely moving participants creating value for secrecy. As a whole, inland fisheries represent examples where most development is not pending better science but a better use of the current knowledge. This presents a challenge for academic research as the gap between high-impact research and practise may often be too large for feasible applications.



Topic groups: Carbon cycle in surface waters (Limnological Division of Water Association Finland)

Diversity of lake plankton and its responses to brownification

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3. University of Jyväskylä, Finland
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Keywords: Phytoplankton, diversity, browning, lakes

Content:

In Finland, and the boreal zone in general, water bodies are naturally subject to a high load of dissolved organic matter/carbon (DOM/DOC) coming from the surrounding coniferous forest and peatland areas. Climate change is expected to increase DOM load, leading to intensified browning of lake waters, which in turn causes changes e.g. in the light climate and, temperature conditions of lakes. As a result, the composition and diversity of the phytoplankton community changes. In clear, nutrient poor lakes, the phytoplankton community is typically characterized by golden algae, while browning decreases their proportion. On the other hand, diatoms *Aulacoseira*, *Urosolenia*, and *Tabellaria* are often abundant in brown-water lakes. Browning also favours phycoerythrin-rich cryptomonads (*Cryptomonas* and *Rhodomonas*). A particularly visible consequence of the browning is the higher abundance of the slimy raphidophyte alga *Gonyostomum semen*. Weaker light availability limits the photosynthesis (autotrophy) and changes the metabolism of phytoplankton towards mixotrophy. Mixotrophic phytoplankton can utilize organic nutrients (heterotrophy) by grazing bacterioplankton or small eukaryotic plankton (phagotrophy). Changes in phytoplankton community composition, due to browning, reduces the production of essential fatty acids, downgrading their transfer in aquatic food webs up to fish. Currently, a thorough understanding on the effects of browning and climate change on phytoplankton is still missing. Based on the Finnish lake data, the previously rather uniform phytoplankton communities have experienced significant spatio-temporal changes during the last 40 years, especially in phytoplankton functionality rather than in total species diversity.



Topic groups: Forests and Bioeconomy (FOBI)

Towards more accurate forest information with the joint use of operational harvester and remote sensing data

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Keywords: Reliability, Airborne laser scanning, Smartphone, Operational forestry, Harvester

Content:

Airborne laser scanning (ALS) is increasingly used to predict the stand attributes of boreal forests. Also, smartphones are increasingly used in wood purchasing operations and forest mensuration. In my PhD work I'm studying both ALS and smartphone mensuration and I'm comparing the predictions produced by both ALS and Smartphone to actual harvester data. Previous studies on the accuracy of ALS inventory have usually compared ALS-based stand attribute estimates with field measurements and the use of harvester data in forest inventory purposes has so far been minor because the collection and combining harvester data with remote sensing information is tedious. In the first article of my PhD work, I compared ALS estimations produced by Finnish Forest Centre to actual logging data and in the second article I did the same with the Smartphone estimations. In third article I will try to include the quality estimation in ALS predictions. Precise information about the trees is needed, in order to optimize the wood supply of wanted timber assortment and allocate the loggings to the most suitable harvesting sites. With more precise information wood procurement can be intensified remarkably at both strategic and operative level. With more effective planning also the greenhouse gas emissions of wood procurement are decreasing, which is very important nowadays. With changing climate there is more uncertainty about forest resources because it affects for example the growth and increases forest damages. This will affect the amount of growing timber and especially the quality of sawn goods.



Topic groups: Sustainable Resource Society: Circular Economy, Energy and Raw Materials (RESOURCE)

What kind of social innovations appear in for-profit social enterprises?

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Keywords: case study, Finland, for-profit social enterprise, social practice, social innovation, typology

Content:

Traditionally, innovation studies have focused on the business companies. Value that has been the aim in this context is economic value. Yet, recently, we have seen a rising interest in social innovation to advance the sustainability of organizations, societies and environment. The focus here is social innovation. It refers to the creation and implementation of new solutions to social problems so that the benefits of these solutions do not come only to the innovating organizations but they are shared beyond the confines of the organizations. We advance the understanding of social innovation by developing a framework of different types of social innovation. Qualitative case study was conducted. 45 open-ended interviews were done in six for-profit social enterprises in Finland. The enterprises operate in the intersection of economic and social aims. These organizations are intended for businesses that invest the majority of their profits in promoting their social aims. Exploratory content analysis was used to analyze the data. The idea of social practices was the crucial focus in the analysis of the types. The proposed framework consists of three types. Drawing on the empirical data several criteria were defined to produce the types: objective, level, key actors, scaling potential and social result. The first type is everyday innovation. It is produced at a micro level in personal relationships solve problems in people's life. The second type is companionship innovation. It refers to producing innovation in cooperation between a social enterprise and its stakeholder organization. It is a meso level innovation produced between organizations. The third type is transformational innovation that refers to a wide social transformation at a societal level. Although the developed typology is limited to its specific focus, it offers an empirically proven insight to the topic.



Topic groups: Carbon cycle in surface waters (Limnological Division of Water Association Finland)

KEYNOTE

Lake brownification: effects and relationship to ecological state classification

Horppila, Jukka: University of Helsinki

Keywords: lakes, brownification, background water colour, sensitivity, ecological state classification

Content:

Brownification of surface waters is a widely recognized phenomenon that is caused mainly by the increasing load of dissolved organic matter and iron from the catchments. Brownification is driven by several factors, the importance of which varies regionally (climate change, decreased sulphur deposition, catchment land use). Compared with eutrophication, brownification has not been given the same attention in water protection, although many stakeholders see it as a severe problem. This is probably due to several reasons. Brownification is difficult to control, because it is largely caused by dissolved substances and the effects of brownification are often not considered significant, when the recipient waters have a high background water colour. However, several studies have suggested that lake ecosystem functions (e.g. primary production, foraging by fish) can be substantially disturbed with increasing water colour, when the background colour is high. Additionally, the ecological state classification of lakes does not well account for the effects of brownification. The presently used indicators may suggest that the ecological state of a lake is changing towards the natural state, although it is changing to another direction via brownification. Ecological state classification should be developed to reveal the effects of brownification.



Topic groups: Carbon cycle in surface waters (Limnological Division of Water Association Finland)

Browning impacts on fish communities and the nutritional value of fish for human consumption

Taipale, Sami¹; Järvinen, Marko²; Vuorio, Kristiina²; Olin, Mikko³; Rask, Martti³; Ruuhijärvi, Jukka³; Kankaala, Paula⁴; Strandberg, Ursula⁴; Tuomainen, Tomi-Pekka⁴; Nurmi, Tarja⁴; Kahilainen, Kimmo⁵; Peltomaa, Elina⁵; Keva, Ossi¹; Kiljunen, Mikko¹; Hämäläinen, Heikki¹; Jones, Roger I.¹

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Keywords: Browning, fish, phytoplankton, essential fatty acids

Content:

Browning influences light attenuation, temperature, pH, and stratification, which influence the structure of phytoplankton, zooplankton, and fish communities. A slight increase in water color can increase species diversity and the somatic growth of fish, but a continued increase in water color usually has a negative impact on species diversity and growth. Intensified browning decreases the abundance of salmonids, and low pH has a negative effect on cyprinids. Percids are known to tolerate best these harsh conditions. Long-chain omega-3 polyunsaturated fatty acids, eicosapentaenoic (EPA), and docosahexaenoic acid (DHA), are physiologically essential biomolecules for fish and are also beneficial for human health. EPA and DHA are produced by dinoflagellates, cryptophytes, and golden algae, but also a certain extent, by nuisance algal *Gonyostomum semen*. Browning inhibits the growth of golden algae and enhances the growth of *G. semen*. Previous studies have shown decreased transfer of EPA and DHA from phytoplankton to large perch, which are commonly used for human consumption. Moreover, the high total mercury content in fish reduces the nutritional value of fish for human consumption. Previous studies have shown that an increase of peatland in lake catchment areas decreases perch muscle EPA and DHA content but increases the amount of mercury. Recently, the reduced nutritional value of perch muscle was positively related to catchment forest coverage and negatively to lake pH, potentially mediated by increasing allochthony.



Topic groups: Sustainable Co-management of Water Resources and Aquatic Environments (WATER)

Lake restoration based on the optimization of inter-basin water transfer using a cost-efficient climate-neutral-energy model in the context of urban hydrology

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2. City of Oulu, Finland

Keywords:

Content:

Finland is known for clear and high-quality lakes, however, the coastal zones and small lakes have less than satisfactory ecological status. The small urban lakes in North Ostrobothnia are a good example of water bodies that could not reach good ecological status. Ditches' erosion, organic enrichment, and increased external load led to eutrophication, resulting in reduced dissolved oxygen in winter and fish deaths in the past. In a shallow lake with a small catchment area, eutrophication can trigger abrupt shifts from a clear and desired state to a turbid and less preferred state. The lakes Kuivasjärvi and Pyykösjärvi are surrounded by residential areas. According to a preliminary survey conducted in the study area, excess algal growth and reduced clarity of water decrease the recreational and aesthetic benefits of the lakes, which are reflected in the social and economic value of the region. The prioritization model initiated by the city of Oulu shows that out of 52 water systems in the Oulu Region, the lakes Kuivasjärvi and Pyykösjärvi need rehabilitation in the first place. The Oulu City has equipped lakes with aeration pumps, but the effect was locally limited. Therefore, the City of Oulu has decided to dilute nutrient-rich lake water with river water. The oxygen content of the Oulujoki water in winter is high, so the oxidizing effect of additional water on Lake Pyykösjärvi is significant. Considering increasing energy prices, we propose optimizing current remediation activities to improve lakes' water quality by maximizing the interbasin water transfer from Oulujoki to Pyykösjärvi Lake and minimizing energy cost and the impact on Merikoski hydropower plant performance by developing the scenario-based cost-efficient climate-neutral-energy model.



Topic groups: Sustainable Co-management of Water Resources and Aquatic Environments (WATER)

High performance functionalized metal organic framework for selective recovery of Nd and Dy from aqueous medium

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Keywords: recovery, metal organic framework, rare earth metals, hybrids

Content:

The recovery of critical metals from secondary sources is becoming increasingly relevant because of the growing demand for these metals in a wide range of high-tech applications. The functionalized hybrid metal-organic frameworks are expected to have extraordinary performance in adsorptive removal and extraction processes. This work explores the potential of functionalized hybrid metal organic frameworks with incorporated chelating characters. To evidence the successful fabrication of these functionalized hybrid metal-organic frameworks, a variety of characterization methods, such as Fourier transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), transmission electron microscope (TEM), scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), thermogravimetric analysis (TGA), surface area analysis and X-ray photoelectron spectroscopy (XPS), was used to measure the chemical structure, compositions, and thermal stability. Furthermore, a series of adsorption experiments were implemented to explore the influence of contact time, temperature, initial concentration, and pH on adsorption behavior. The results demonstrated that the method described is a facile and effective tool for synthesizing functionalized metal-organic frameworks, which possess promising prospects for environmental adsorption applications. Recyclability and selectivity tests further proved that the sorbent is highly effective for the enrichment of Nd and Dy from an aqueous solution. More importantly, the prepared material can also be used for various applications, such as selective detection of metals from an aqueous medium.



Topic groups: Carbon cycle in surface waters (Limnological Division of Water Association Finland)

Freshwater blue carbon: carbon accumulation in Finnish lake sediments

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Keywords: bluecarbon, carbon, sediment, lake

Content:

Lake sediments provide natural sinks for organic carbon accumulation on timescales of thousands of years. This way a part of the carbon is permanently removed from active biogeochemical cycling, making lake sediments potentially important nature-based solutions for carbon drawdown, and thus provide opportunities for climate change mitigation. To protect and better manage these natural carbon sinks, however, it is critical to understand the factors that control their formation. Simultaneously there is a need to open a dialogue with decision makers and water management authorities to ensure that the blue carbon is considered in national and regional climate and water management plans and strategies, which to date have largely overlooked the potentially important store of carbon. A holistic approach that considers carbon flows at the catchment level and between different ecosystems and environments should be considered in future. Here we present previously unpublished sediment data on modern carbon accumulation rates in over 200 lakes from Finland, covering range of lake types and sizes, and give future perspectives on how blue carbon can contribute toward climate mitigation on regional and national level.



Topic groups: Sustainable Co-management of Water Resources and Aquatic Environments (WATER)

Does food supplementation by *Hermetia illucens* larvae affect overwinter survival and spleen size in the brown trout (*Salmo trutta*)?

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Keywords: Conservation aquaculture, edible insects, feed supplementation, *Salmo trutta*, hatchery

Content:

Hatchery-reared fish are released in to wild to support threatened salmonid populations in many countries globally. However, survival and general performance of hatchery-reared released fish have often been documented as considerably lower than those of wild individuals. Recently, various enriched rearing methods have been promoted as a possible cost-efficient way to produce fish stockings that show increased survival in the wild. We reared brown trout juveniles in enriched and conventional tanks, provided them novel food supplementation (*Hermetia illucens* larvae), and finally studied their overwinter survival and relative spleen size. We did not find difference in overwintering survival between the trout that received *H. illucens* food supplementation and the trout that were not food-supplemented. However, the trout reared under early enriched conditions showed higher feeding performance to forage on these novel prey items, and they had also relatively larger spleens than trout reared in conventional environment. Our results suggest that early enriched rearing provides beneficial and long-lasting effects, but that possible beneficial effects of *H. illucens* food supplementation remain unclear. Enriched rearing can be recommended especially when fish stockings are produced for conservation purposes.



Topic groups: Carbon cycle in surface waters (Limnological Division of Water Association Finland)

Transfer of sedimentary carbon into benthic organisms: Implications for disposal of radioactive waste

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Keywords: radioactive waste, radioecology, radiocarbon, benthic animals, ^{14}C , peat

Content:

Radiocarbon (^{14}C) is known as one of the important radionuclides that can be released into the biosphere from nuclear fuel cycle and radioactive waste repositories and thus can be readily taken up by organisms. It has long half-life (5730 years) and can distribute in forms of dissolved and gaseous species at global scale. In the present work, we investigated the proportion of sedimentary C (from field-collected peat and sediment) in benthic animals, chironomid larvae (*Chironomus riparius*) and blackworms (*Lumbriculus variegatus*), in a microcosm study. There was a large difference in ^{14}C /total C ratio between the atmosphere and up to 8000-year leftover peat after peat extraction. Two-pool isotope mixing model was used to estimate the contribution of sedimentary C in the selected animals. The isotopic abundance of ^{15}N was also used to further investigate the incorporation of the substrates (peat and sediment) in the selected animals. The findings revealed insignificant contribution of sedimentary C in the organisms, despite positive incorporation of the substrate into the animals as shown by the ^{15}N values. Such a minimum/zero contribution of C could be attributed to availability and preference of the fish food and other microorganisms with more enriched C, over the recalcitrant peat or the sediment with lower nutritional value. Other parameters such as assimilation efficiency, elimination rate, gut passage time and C turnover rate are important in the rate of uptake. These findings indicated that transfer of sedimentary C in the animals is relative to availability of old vs. modern sources of C as it was observed by the selective diets of the organisms. Further studies with a greater number of samples and species as well as sediment types are recommended for the future work.



Topic groups: Carbon cycle in surface waters (Limnological Division of Water Association Finland)

Controls on aquatic CH₄ and CO₂ emissions from Canadian Arctic tundra

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Keywords: arctic, permafrost, lake, stream, carbon, methane, carbon dioxide, dissolved organic matter

Content:

Northern permafrost soils contain one of the largest carbon (C) pools on Earth. Increasing attention has been drawn to how these C stocks may be mobilized and converted to greenhouse gases in a changing climate. Recent studies have revealed a strong influence of thawing permafrost on northern freshwaters, with a shift toward increasing dominance of terrestrial dissolved organic matter (DOM). This shift might alter the pathways of aquatic microbial metabolism, with likely consequences on the production and release of the potent greenhouse gases methane (CH₄) and carbon dioxide (CO₂). Unravelling the key environmental factors regulating CH₄ and CO₂ emissions from northern freshwaters and their link to DOM quality and quantity is highly relevant to predicting the magnitude of the permafrost C feedback to the global climate. Here we aim to study how seasonality, landcover and permafrost thaw regulate CH₄ and CO₂ emissions from northern freshwaters by conducting floating chamber flux measurements and water sampling in five lakes and two streams in the continuous permafrost zone of the Northwest Territories, Canada. The study site, Trail Valley Creek (68°44' N, 133°29' W), is a heterogenous upland tundra site located east of the Mackenzie Delta, ca. 50 km north of Inuvik, NT. The measurements were done in 2019 and 2021 on four occasions. We found that streams were hotspots of CO₂ emissions due to fresh DOM exported in spring freshet, while in lakes CH₄ fluxes peaked during the ice-melt period. We observed a strong positive correlation between C gas fluxes and SUVA (specific ultraviolet absorbance at 254 nm), suggesting higher CH₄ and CO₂ fluxes from waterbodies with higher DOM aromaticity. During mid- and late-summer, lake sites near retrogressive thaw slumps showed higher CH₄ fluxes compared to other lake sites, while thaw slump development had no effect on lake CO₂ fluxes.



Topic groups: Carbon cycle in surface waters (Limnological Division of Water Association Finland)

Persistent hot spots of CO₂ and CH₄ emissions in coastal nearshore environments

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Keywords: greenhouse gas emissions; coastal ecosystem; allochthonous loading; eutrophication; carbon biogeochemistry

Content:

Nearshore environments are typically supersaturated with the potent greenhouse gases methane and carbon dioxide, due to intense respiration of the elevated supply of organic carbon in these systems. These environments are characterized by overlapping biogeochemical gradients and heterogeneous morphology, from which follows that the overall spatial variability in nearshore greenhouse gas fluxes remains unclear. We measured surface water concentrations of carbon dioxide and methane synoptically with water quality parameters – applying very high spatial resolution over an unprecedentedly vast area in coastal Baltic Sea, covering two ice-free seasons. The extensive high-frequency data revealed sites with recurring very high atmospheric emissions of carbon dioxide and methane (i.e., hot spots) scattered around the study area, exceeding overall emission averages by 0.8 mmol m⁻² d⁻¹ (CH₄) and 63 mmol m⁻² d⁻¹ (CO₂). The emissions were linked with elevated inputs of allo- and autochthonous organic matter, underpinning the major role of organic enrichment of both freshwater and marine nearshore environments in global carbon cycling.



Topic groups: Sustainable Co-management of Water Resources and Aquatic Environments (WATER)

Effective adsorption of pharmaceuticals by plant based-activated biochar

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Keywords: Water treatment; Biochar Modification; Adsorption mechanisms; Fixed-bed-column studies; Tetracycline; Ciprofloxacin.

Content:

Pharmaceuticals are used massively for human wellbeing and animals' welfare. Moreover, wastewater treatment plants have low efficiency in removing these which has led to classification of the pharmaceuticals as emerging environmental contaminants. This study presents results on the ability of *Anthriscus sylvestris*-derived activated biochar (ACTI-BC) to adsorb tetracycline (TET) and ciprofloxacin (CIPF) from aqueous solution in both batch and column mode. The effect of several batch parameters (pH, biochar dosage, time, initial concentrations of pharmaceuticals and coexisting ions) on the removal of TET and CIPF using ACTI-BC was investigated. The optimal pH for removal of both TET and CIPF was pH 5.17. Equilibrium was reached at c.a. 1400 and 380 min for TET and CIPF, respectively. The experimental isotherm data for the adsorption of TET and CIPF by ACTI-BC were analyzed using different isotherm models. From Langmuir model the maximum adsorption capacity for TET and CIPF was 402.75 and 582.18 mg g⁻¹, respectively. The kinetic data had the best correlation with the pseudo-second-order model. Several chemical interactions regulate the adsorption of TET and CIPF by ACTI-BC such as π - π EDA interaction, cation- π bond and H-bonding. Moreover, to examine the applicability of removal of TET and CIPF by ACTI-BC in real scale, column studies were conducted in specific adsorbates concentrations and flow rates. As a result, the present study presents a practical approach to produce an adsorbent capable of reducing pharmaceuticals contamination in aqueous solutions.



Topic groups: Sustainable Co-management of Water Resources and Aquatic Environments (WATER)

Photocatalytic activity of iron oxide and graphitic carbon nitride films in water under UVA and visible light

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Keywords: Water treatment, photocatalysis, nanomaterials

Content:

Photocatalysis is eco-friendly and economically viable technology applicable for air or water remediation and purification. It is based on irradiation of material (photocatalyst) by source of irradiation (sun, lamp) leading to photon energy conversion and formation of reactive species on photocatalyst surface. These reactive species are able to decompose various pollutants such as organic impurities (e.g., pharmaceuticals), bacteria, or viruses. In our work, we prepared coatings based on iron oxide nanoparticles, graphitic carbon nitride 2D sheets and organo-silica binder in a common laboratory condition (room temperature, atmospheric pressure) by spin-coating method. The chemical and morphological parameters of the coatings have been studied by alteration of various parameters as ratio of nanomaterials and binder, duration of milling the nanomaterials, and time of plasma post-treatment performed by Diffuse Coplanar Surface Barrier Discharge (DCSBD) in ambient air atmosphere. The surface structure of the coatings was studied using Scanning Electron Microscopy (SEM) and the chemical composition by X-Ray Diffraction (XRD). The photocatalytic activity of prepared materials in water was studied under visible light and UV irradiation. Formic acid was used as a test compound. The decomposition of formic acid in water was monitored Ion Chromatography (IC). The chemical stability of photocatalysts corresponding to leakage of carbon and nitrogen from coatings to water was checked by Total Organic Carbon (TOC) and Total Nitrogen (TN) measurements. Possible leakage of metals from prepared materials was tested using inductive coupled plasma mass spectrometry (ICP-MS).



Topic groups: Carbon cycle in surface waters (Limnological Division of Water Association Finland)

Is browning of Finnish water bodies progressing? Long-term changes in streams, lakes and coastal waters

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Keywords: brownification, organic carbon, long-term data, surface waters, trend analyses

Content:

First signs of browning were reported in Sweden in early 1990s, where a large-scale increase in the discharge of humic material in rivers, as well as a darkening of lakes were detected (Forsberg 1992). Thereafter numerous studies have shown that increases in organic carbon concentrations have been detected widely across North America and Europe. However, recent studies indicate that browning may have slowed down (Eklöf et al. 2021). Organic carbon leaching, while still dependent on rates of acidic deposition, is becoming increasingly sensitive to changes in climate (de Wit et al. 2020; Lepistö et al. 2021). What is the situation in Finland? To answer that question, we selected 746 monitoring station covering whole Finland and various water bodies (streams, rivers, lakes, and coastal waters). Trend analyses from 1990 to 2021 showed that browning is still ongoing in all types of waterbodies, even though at some monitoring stations it has levelled off. Beside linear trend analyses, we also tested non-linear behaviour of changes in TOC concentrations, which revealed big interannual variation in trends mainly caused by variation in climate. In addition, we linked detected changes in OC concentrations to different driving factors, e.g., catchment characteristics, hydro-meteorology, land-use, and sulfate deposition. What became evident was, that multiple drivers are affecting changes in TOC concentrations, but their quantification requires more work.

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Topic groups: Carbon cycle in surface waters (Limnological Division of Water Association Finland)

Observing brownification from space - the benefits of using satellite observations

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Keywords: earth observations, surface waters, CDOM, bio-optical modelling

Content:

Satellite observations are visually impressive overviews of the color of the water and its changes. The spatial resolution of these observations (10-60m) is well suited for observing water quality in lakes, like in Finland via SYKE's open service TARKKA. During spring, when the melting of snow, ice and frost colors the water areas, satellite observations provide relevant information for brownification. In spring, part of Finland's lakes, rivers and coastal waters turn noticeably brown at the latest stage of melting, when the frost on the ground melts. Satellite observations can be used to estimate the amount of Coloured Dissolved Organic Matter (CDOM) via bio-optical modelling (e.g. Attila et al., 2013). The added value in utilizing satellite observations is that the observations can be made at times and in areas that are not covered by station sampling. Modern high resolution (60m) satellite observations have been collected for the seventh year already, thus their compatibility with station sampling measurements can be analysed. In evaluating the brownification of waters, it is relevant to evaluate whether longer-term changes can be identified. Over a longer period than the past seven years, medium resolution satellite observations (300m) can be used to define the amount of humus and seasonal variations in it in open sea areas, large coastal estuaries and the largest lakes since 2003.



Topic groups: Carbon cycle in surface waters (Limnological Division of Water Association Finland)

Browning alters food-webs and leads to biodiversity loss in riverine ecosystems

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Keywords: dissolved organic carbon, drainage, nutritional quality, mesocosm, field data

Content:

Concentrations of terrestrial-derived dissolved organic carbon (DOC) in freshwater ecosystems have increased consistently, causing freshwater browning. The mechanisms behind browning are complex, but in forestry-intensive regions browning is accelerated by land drainage. Here, I will introduce the results of our recent studies, which are based on both well-replicated manipulative browning experiments and extensive field data encompassing a wide browning gradient. Based on experimental and field observations, browning reduced dramatically the periphytic algal biomass, suppressed the availability of nutritionally essential polyunsaturated fatty acids, but increased the availability of terrestrial-derived and nutritionally poor-quality long-chain saturated fatty acids (LSAFA). The ongoing browning process is inevitably inducing a dramatic reduction in the nutritional quality of the stream biofilm, potentially causing biological degradation in algal-consuming communities, such as benthic macroinvertebrates. The field data from boreal forest streams suggest that invertebrate assemblages in brownified streams are less diverse and compositionally altered compared to those in non-humic, clear-water streams. A distinct invertebrate community change along the browning gradient was observed at around 12-13 mg DOC L⁻¹. Only four taxa increased along the gradient, while 13 taxa showed a decreasing response. Our findings of both a gradual biodiversity loss and an abrupt biodiversity change along a browning gradient provide a benchmark against which forthcoming changes to stream biodiversity relative to the predicted browning trend can be gauged. With DOC levels in boreal freshwaters set to increase further in the future, the loss of invertebrate biodiversity in boreal streams seems inevitable. Restoration of drained peatlands as a means of reducing terrestrial biodiversity loss has shown some promise but responses of freshwater biodiversity and ecosystem functions to restoration of adjacent peatlands remain largely unknown.



Topic groups: Carbon cycle in surface waters (Limnological Division of Water Association Finland)

HUMI project - Lake Browning Indicators

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Keywords: organic matter, water quality, Water Framework Directive, biological quality elements, field data

Content:

Many boreal and temperate lakes are currently increasing in water colour due to increased run-off of organic matter. Human activities in the catchment (peat mining, forestry) have also a strong effect on this brownification process. This is also reflected in the water quality of Finnish lakes. Lakes in Finland often have naturally brown water, but numerous lakes have darkened even more in the last couple of decades. However, the current water quality indicators in accordance with the Water Framework Directive do not reflect the browning of lakes sufficiently. Consequently, further research is needed to develop new methods in lake monitoring. Humic load indicators (HUMI) is a 10-year (2018-2027) research project (funded by R. Erik and Bror Serlachius Foundation) coordinated by the Ecosystems and Environmental Research Program of the University of Helsinki. The aim of the project is to provide new insights into the meters that act as indicators of the humus load in lakes. During the first years of the project (2019-2020), we collected comprehensive field data of over 100 lakes, from which both physico-chemical and biological variables were studied. Later, we focused on the most promising variables that reflected the browning of lakes. Here, we present the latest results of the HUMI project, focusing on biological indicators.



Topic groups: Carbon cycle in surface waters (Limnological Division of Water Association Finland)

Connecting silvan and lacustrine ecosystems – two decades in Finnish forests and on numerous lakes

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Keywords: long-term data, continuous measuring systems, lateral carbon transport, carbon cycling, net ecosystem exchange

Content:

Here we present our 20 years' experience in aquatic studies in connection with boreal forests and forestry. We started our line of research at the beginning of the 21st century by initiating collaboration with atmospheric physicist and forest scientists and applying the state-of-the-art techniques of terrestrial ecosystem ecology in aquatic research. This meant a transition from discrete less frequent manual sampling to continuous measuring systems running over several years. With this approach and by combining research in pristine as well as in managed ecosystems we have been able to figure out e.g., the importance of lateral carbon transport to net ecosystem carbon balance (NECB) in forested catchments, i.e., roughly 10 % of NEE (net ecosystem exchange) of forests can escape via lateral routes. Thus, due to the silvan-lacustrine -connection, our forests may be somewhat smaller carbon sinks than assumed. The research has also highlighted the utmost importance of hydrology for carbon cycling in the forest-stream-lake -continua. Recently, we have expanded our research to effects of forest management practices on water quality, especially biodegradability of DOC, in streams. For comparison, we have also studied some pristine streams in subarctic Finland. We are focusing on continuous cover forestry (CCF) in drained peatlands which is a peculiarity of Finnish forest management. The results from this line of research are now emerging and we will present the recent findings.



Topic groups: Carbon cycle in surface waters (Limnological Division of Water Association Finland)

Chemical precipitation of phosphorus with polyaluminium chloride: water quality development five and twenty years after treatment in two eutrophicated lakes

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Keywords: Lake restoration, shallow lakes, chemical treatment, polyaluminium chloride

Content:

To improve water quality in two badly eutrophicated shallow Finnish lakes, Kirkkojärvi and Littoistenjärvi, phosphorus in water and surface sediment was precipitated with polyaluminium chloride, in Kirkkojärvi in May 2002, in Littoistenjärvi in May 2017. Water became clear in hours. All plankton disappeared, but phytoplankton recovered in four weeks and crustacean zooplankton in two months. In Kirkkojärvi the treatment killed all fish. In Littoistenjärvi, pH was tuned so that most fish survived. In Kirkkojärvi, the average summer phosphorus (TP) and chlorophyll (Chl) levels dropped from >400 and >350 $\mu\text{g l}^{-1}$ in 2000-2001 to 60 and 40 $\mu\text{g l}^{-1}$ in 2003-2005. Despite occasional cyanobacterial blooms in two years, the average TP and Chl of 89 and 55 $\mu\text{g l}^{-1}$ in 2006-2020 indicated substantial improvement in the ecological state of Kirkkojärvi to “satisfactory” instead of earlier “bad” rating. In Littoistenjärvi, TP and Chl decreased from 76-106 and 26-86 $\mu\text{g l}^{-1}$ in 2011-2016 to 22-38 and 4-15 $\mu\text{g l}^{-1}$ in 2018-2020, respectively. Most importantly, July-August biomass of cyanobacteria declined from 11-24 to 0.01-1.5 mg l^{-1} . In spite of clear water, mass occurrences of submerged macrophytes did not appear. In 2019 and 2020 hot weather spells in June-July induced short-term increases of TP and Chl, and in the particularly hot summer 2021 high levels prevailed until September. From 2011-2016 to 2017-2020 the internal loading of phosphorus declined from 131 to 12 $\text{mg m}^{-2} \text{a}^{-1}$ but increased to 99 $\text{mg m}^{-2} \text{a}^{-1}$ in 2021. Warming climate seems to reduce the longevity of chemical treatment.



Topic groups: Carbon cycle in surface waters (Limnological Division of Water Association Finland)

Response of aquatic invertebrates to browning of surface water in lakes, beaver ponds and temporary wetlands

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Content:

Water browning affects many lakes in the Northern Hemisphere. This phenomenon is exacerbating as the result of global changes. Browning of surface water is expected to hinder key ecosystem processes, as a result of lower primary productivity and loss of biodiversity. Ecological consequences of water browning on aquatic food webs, focusing on invertebrate abundance, was studied in Evo Natura 2000 area, Southern Finland (61°20N, 25°109E). First, the link between water colour and aquatic invertebrate abundance was tested in lakes with long-term datasets. Water colour has increased in many lakes over the past three decades with subsequent negative impact on aquatic invertebrate abundance. Aquatic invertebrates are key components of the aquatic food webs raising concerns of their consumers, such as fish and waterbirds, status. Second, in the pilot study carried out in 2022 the link between water colour and invertebrate abundance in different habitat types, i.e. lakes, beaver ponds and temporary wetlands, was tested. Results showed that invertebrate abundance linked to brownification differs according to habitat types. In particular, brown temporary ponds hosted a higher macroinvertebrate abundance as compared to clear ones due to high numbers of mosquito larvae (Culicidae). These larvae might have benefited from the absence of fish and the low UV radiation in the water column due to high concentration of DOM, which is known to facilitate their survival. In respect to the results, better consideration of different habitat types in browning studies is much needed. Especially, browning of small temporary wetlands should be integrated in biodiversity studies.



Topic groups: Carbon cycle in surface waters (Limnological Division of Water Association Finland)

Browning of a small humic boreal lake – Effect of beaver floods over forestry practices at a catchment scale

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Keywords:

Content:

The browning or brownification of boreal and temperate freshwaters has been occurring over the past decades. Further research and especially long-term studies are needed to understand the abiotic and biotic factors driving the browning of freshwaters at the catchment and global scales. In this study we aimed at studying the drivers of the long-term browning of a small humic lake from 1993 to 2018. We investigated the impacts of forestry practices (clearcutting, thinning, preparation practices) and beaver activities on changes of the lake water color. Our results highlighted that beaver floods can be the dominant control factor of changes of water color; the lake color was browner under flood events. In contrast, forestry practices did not significantly contribute to the browning of the lake. Beavers are known as ecological engineers, and they have a major influence on riparian dynamics. We suggest that the strong influence of beaver floods may hide the effect of forestry practices on water color, at a catchment scale. We thus present here for the first time the contribution of beaver floods to water browning and propose to include beavers as drivers of browning in further studies in the boreal and temperate regions in particular.



NOTES:





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