TERRA
ENVISION

8-11 July, 2024
Valencia, Spain

Nature-based Solutions to Facilitate the Transition for Living within the Planetary Boundaries



TerraEnVision 2024

Nature-based Solutions to Facilitate the Transitions for living within the Planetary Boundaries

Valencia, Spain, 8-11 July, 2024

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The Mission of TerraEnVision 2024

Our Planet suffers from human activities. Scientists know more and more about our environment, about processes, rates of change, new threats and risks. However, the challenges seem to grow quicker than the solutions that can be created. To find the right, feasible and viable solutions to make the transition towards a society that stays within the planetary boundaries, it is needed that scientists, policy makers and to join forces with industry.

This conference aims to focus on finding solutions for the societal issues of our time. TERRAenVISION promotes to exchange scientific research, solutions from industry and insights from policy for interdisciplinary collaboration and networking. To bring scientists and stakeholders that have the same goal, work on the same societal issue, but have different backgrounds. By bringing the people and their knowledge together, we may be able to take the steps towards solutions that can bring our society to a more sustainable situation. In this conference, we want to link to International policies such as the Sustainable Development Goals, the UN Climate conventions, the Green Deal, COP and CAP.

This conference is framed around themes which are connected to the big transitions of our time. Each theme is kicked off by two plenary keynote speeches of 20 min, followed by a discussion. After the plenary session, a range of different parallel sessions will be organised.

We want to stress that this conference is not only for scientists, but also for those people from outside the scientific world working on transitions towards climate mitigation and adaptation, sustainable cities and agriculture and a circular economy with a focus on the sustainable use and management of the natural system.

The Chair of the TerraEnVision Organizing Committee,

Saskia Keesstra

Senior researcher, Sustainable Land and Water Management at Climate-Kic, The Netherlands

Scientific Committee

1. Saskia Visser, Wageningen University and Research, The Netherlands
2. Zahra Kalatari, Stockholm University, Sweden
3. Rolf Becker, Hoch Schuele Rhein Wahl, Germany
4. Artemi Cerda, University of Valencia, Spain
5. Jesus Rodrigo-Comino, University of Granada, Spain
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7. Claire Chenu, INRAE, France
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20. María Pilar Penyarrubia, University of Valencia, Spain

Organizing Committee

1. ARTEMI CERDA, Professor in Physical Geography, University of Valencia, Spain
2. MARGOT DE CLEEN, Senior Advisor, Soil and Water Ministry of Infrastructure and Water Management, The Netherlands
3. SASKIA KEESSTRA, Senior researcher, Sustainable Land and Water Management at Climate-Kic, The Netherlands
4. SASKIA VISSER, Land use, agri-food and sustainable bio-economy Orchester, Climate-KIC, the Netherlands
5. IOANNIS DALIAKOPOULOS, Assistant Professor, Hellenic Mediterranean University, Greece

Keynote speakers

Emilio Barba

Professor of Ecology, University of Valencia



Emilio Barba is Professor of Ecology at the University of Valencia. He currently serves as Head of Initiatives for the Office of the Vice-Rector for Sustainability, Cooperation, and Healthy Living, and Co-director of the Valencian Agenda for Anti-Depopulation (AVANT) Chair. His research activities are conducted at the Cavanilles Institute of Biodiversity and Evolutionary Biology at the University of Valencia, where he leads the Terrestrial Vertebrate Ecology Research Group. His research focuses on behavioural ecology and bird population ecology, including the impacts of human activities and climate change on bird populations. Currently, he is leading a research project on the suitability of urban green infrastructure to promote biodiversity. Additionally, as Head of Initiatives for the Office of the Vice-Rector for Sustainability, he addresses issues related to carbon footprint reduction, energy efficiency, and sustainable mobility.

Giuseppe Grezzi

Deputy Mayor, Councilor for Sustainable Mobility and Public Space, Valencia



Giuseppe Grezzi is italian born. Since 2000 he has lived in València in Spain. He worked as a translator and founded Coop Ecovida, dedicated to environmental services. Specializing in mobility and transport, he was assistant to the region and the municipality. Elected city councilor in 2015, he was appointed Deputy Mayor, Councilor for Sustainable Mobility and Public Space and President of the EMT Public Transport Company. In 8 years of management, València has become a symbol of cities in transition towards sustainable mobility, the recovery of quality public spaces and the push for cycling. EMT was awarded as the best urban transport company of 2018. València has 198km of cycle paths, of which 75km created in the last 8 years. València was named European Green Capital 2024. In May 2023 there was a change of government, and Giuseppe Grezzi is currently a municipal councilor of the ‘Compromís’ party (in english 'commitment’).

Natxo Lacomba

Head of the Parks and Gardens Service, Valencia City



Doctor in Biology and career civil servant, he is currently Head of the Parks and Gardens Service of the Valencia City Council, where he arrived in 2018 to take charge of the Climate Change Service. He has previously developed a three-decade professional career in the Ministry of the Environment (Generalitat Valenciana), always dedicated to the conservation and management of protected areas and wildlife.

Heleen van den Hombergh

Senior Expert, Agro-Commodities



Heleen van den Hombergh, PhD, is IUCN NL's lead on responsible value chains and good governance of agrocommodities. She advises government, companies and financial institutions on measures to achieve responsible conversion-free soy and palm oil, which are both important for the global transition towards sustainable proteins and vegetable oils. In the Forests for a Just Future programme, she works with CSOs in countries such as Indonesia and Colombia and advocates for biodiversity-proof trade and commodity policies. Passionate about knowledge-based bridge building for impact, Heleen is convener of the multi-stakeholder Dutch Soy Platform, collaborates with other commodity platforms in Europe and is promotor of the global Collaborative Soy Initiative, striving towards 100 % conversion free responsible soy. She also works with Dutch business and Argentinean NGOs to achieve positive impact in agrocommodity production landscapes in the Chaco. Heleen chairs the informal NGO palm oil platform in the Netherlands, is member of the IUCN Oil Palm/ Vegetable Oils Task Force, as well as Steering Group member of the Edible Oils and Fats Collaboration hosted by Forum for the Future. For and with IUCN she furthermore takes part in EU dialogues and consultations to achieve policy and legislation for forest protection, and with the Transition Coalition Food she advises government to promote future-proof protein consumption and production.

Wouter Vanneuville

Expert on Climate Change Adaptation, European Environment Agency



Wouter is a MSc. In Geography with a focus on landscape sciences. He worked for almost 15 years on water resource management topics, and in particular on the EU Floods Directive from an academic perspective, as a Member State representative and from a European perspective while being seconded to the European Environment Agency. After a short period back at the Flemish Ministry of Mobility and Public Works, he returned to the European Environment Agency's group on Climate change impacts, vulnerability and adaptation 8 years ago. There his focus is on national adaptation policies, adaptation reporting and economics of adaptation.

Stephan Ourevitch

Co-founder and Partner, ALSO Space



Stephane Ourevitch received the M.B.A. degree from INSEAD and the master's degree in law, political science/int'l affairs (Sciences Po). He is currently a Partner at SpaceTec Partners, with over 30 years of professional experience. He is also the Project Director for several DG GROW service contracts related to Communication regarding applications of Space Data (Copernicus and European Space Expo.). He acts as an expert on Copernicus and Space Policy on several study contracts, with his excellent knowledge of the space industry in a very international context. He held top management positions at Becker Avionics (including, managing a 300-people group of companies across three continents), Dassault Electronique, and ABB. In addition Stephane is the co-founder of ALSO Consulting. ALSO Space is a consultancy specialising in Earth Observation (EO).

Gemma García Blanco

Senior researcher, TECNALIA Research & Innovation



Researcher in the energy, climate and urban transition department. Climate change adaptation team-– Tecnalia research & innovation. Geographer (University of Oviedo) MSc in Environmental Sciences (University of East Anglia UK) currently PhD student in the doctoral programme in Social, Political and Cultural studies (University of the Basque Country). Research experience on the fields of sustainable spatial and urban planning, environmental assessment, strengthening initiatives for public administrations. Current research interests: Nature positive and climate resilient planning, climate adaptation strategies, and synergies between adaptation and mitigation from an innovative planning perspective.

Danush Dinesh

Head of Partnerships and Outreach, Wageningen University & Research



Dhanush is the Founder and Chief Climate Catalyst of Clim-Eat, the 'think and do tank' for food and climate which he established in 2021 at COP26. Clim-Eat focuses on bridging science and policy on food and climate issues by synthesizing knowledge, convening stakeholders, providing strategic advice, and strategic policy engagement. His previous work experience includes roles within the private sector, NGOs, and the UN and CGIAR systems, in China, India, Thailand, The Netherlands and the UK. He has worked on a range of issues including forestry, environmental policy, climate change adaptation, and advocacy, at the national, regional, and global levels. Dhanush has an interdisciplinary academic background, combining an MBA, MSc in Carbon management, and a PhD in Environmental Governance. He is a member of the Advisory Boards of the EAT Foundation. ClieNFarms and the Global Food and Environment Institute at the University of Leeds.

Fernando Valladares

Research Professor, Spanish Council for Scientific Research



Fernando Valladares holds a PhD in Biological Sciences and is a research professor at the Spanish Council for Scientific Research (CSIC), where he directs the Ecology and Global Change group at the National Museum of Natural Sciences. He is also an associate professor at the Universidad Rey Juan Carlos in Madrid. He has published more than 450 scientific articles and books in ecology and plant biology being a highly cited scientist in the area of Ecology and Environment (he is since 2016 among the 1% most cited scientists in the world with an H-index of 85). He is currently vice-president of the Iberian Society of Ecology. His research has focused on the impacts of global change on terrestrial ecosystems. He contributes weekly to numerous media outlets and performs daily active scientific dissemination in his channels "The health of humankind" on Youtube, Twitter, Instagram and Facebook. In 2020 he received the Information Transparency Award from the Association of Environmental Information Journalists (APIA), the Luis Balaguer Ecosystems Distinction from the Spanish Association of Terrestrial Ecology (AEET), and the Climate Leader Award in the Research and Education category granted by the Climate Reality Project-Spain. Complete information on his research and his outreach program as well as detailed CVs can be found at www.valladares.info

Robert B. Zougmoré

Principal Scientist, Alliance Bioversity International & CIAT



Robert Zougmoré works as Principal Scientist with the Alliance of Bioversity International & CIAT where he leads the West and Central Africa Climate Action and the West Africa cluster of AICCRA (Accelerating-Impacts-of-CGIAR-Climate-Research-for-Africa). From 2010 to 2021, he was the Africa Program leader of the CGIAR Research Program on Climate Change-Agriculture-and-Food-Security (CCAFS), at ICRISAT Bamako, Mali, where he led research initiatives and fostered partnerships to address pressing climate challenges. Agronomist and soil scientist with a PhD in Production Ecology & Resources Conservation - Wageningen University, he is Director of Research (equivalent to University Professor) under CAMES cadre. His career is spanning over 30 years dedicated to tackling critical issues such as climate change adaptation, soil fertility management, and rural development across Africa. His impactful work has significantly advanced agricultural practices and sustainability in the region. Through rigorous research, effective leadership, and passionate advocacy, Robert continues to play a pivotal role in enhancing the resilience and development of agricultural systems in West and Central Africa. As the coordinator of the AICCRA, Robert brings a wealth of experience in climate change adaptation and mitigation solutions, biodiversity conservation, agriculture, forest ecosystems management, water science, stakeholders' engagement and science-policy interfacing. His leadership ensures strategic programming actions that harness climate science for actionable outcomes, impacting over 30 countries across Africa and beyond. Robert has published widely with more than 100 papers and book chapters on soil erosion, integrated soil, water and nutrient management options and their economic benefits, and climate-smart agriculture.

Conference Program

Program for TERRAenVISION 4 in València

Preconference excursions	
6th July	The lagoon of Prat de Cabanes Torreblanca. The challenges of a coast under the pressure of Turism
7th July	Due to rough sea the boat trip is cancelled. We are now planning an alternative trip. Soon to be updated here.

Monday 8th of July:		
11.00-13.00	City walk for NBS in Valencia city. Departing from the NORD train station.	
13.00-14.00	Registration	
14.00-14.30	Opening by UVEG	
14.30-15.00	Opening keynote: Fernando Valladares (CSIC)	
15.30-17.00	Plenary session NATURE BASED SOLUTIONS FOR AGRICULTURE AND NATURE AREAS (SOIL, WATER AND LANDSCAPE) (Aula) Keynote 1: Robert Zougmore (AICCRA West Africa Lead, CGIAR) Keynote 2: Dinesh Dhanush (Clim-Eat) Discussion between keynotes and audience	
17.00-17.30	Coffee/tea/orxata break	
17.30-19.00 Parallel Session	AN Land management and carbon sequestration in agricultural soils (Aula)	AN Microorganisms in Agriculture: Direct Application or Management (room 2)
19.00-20.30	Poster session	

Tuesday 9th July			
8.00-9.00	Registration		
9.00-10.30	Plenary session theme Methodologies: how to measure processes and impact of Nature-based solutions (Aula) chair: Keynote 1: Gemma Garcia Blanca (Technalia) Keynote 2: Stéphane Ourevitch (**EUSSO**) Discussion between keynotes and audience		
10.30-11.00	Coffee/tea/orxata break		
11.00-12.30 Parallel session	NH: Nature based solutions for increasing resilience to water-related hazards (Aula)	MET: Advances in land ecosystem restoration monitoring using remote sensing and machine learning (room 2)	Workshop: Synergies and trade-offs of carbon sequestration as a climate mitigation solution (room 3)
12.30-14.00	Lunch break		
14.00-15.30	Plenary session theme: Nature-based solutions for natural hazards (Fire, Floods and Droughts) (Aula) chair: Keynote 1: Heleen van den Hombergh (IUCN) Keynote 2: Celia Gouveia (University of Lisbon) Discussion between keynotes and audience		
15.30-16.00	Coffee/tea/orxata break		
16.00-17.30 Parallel session	AN: Nature-based solutions for agriculture and natural areas (soil, water and landscape)(Aula)	NH: NBS for landscape resilience (fire, droughts and extreme events)(room 2)	MET: **NBS for sustainable soil management and biodiversity. (room 3)**
17.30-19.00	Poster session with refreshments		
21.00-	Conference dinner in DON PELAYO RESTAURANT Address restaurant: Carrer d'Antonio Sacramento, 17, Quatre Carreres, 46013 València		

Wednesday 10th July			
8.00-9.00	**Registration**		
9.00-10.30	**Plenary session theme: SCIENCE BROKERS FOR TRANSITIONING TO A CLIMATE RESILIENT AND CIRCULAR SOCIETY (Aula) chair: Margot De Cleen** **Keynote 1: Wouter Vanneuville (European Environment Agency)** **Keynote 2: Pablo Modernel, (Friesland Campina)** **Discussion between keynotes and audience**		
10.30-11.00	**Coffee/tea/orxata break**		
11.00-12.30 Parallel session 2	**SB: Science brokers for transitioning to a climate resilient and circular society (Aula)**	**Workshop** Workshop: Realising carbon neutrality across scales from farm level to landscapes **(room 3)**	**Workshop Humus (room 2)**
12.30-14.00	**Lunch break**		
14.00-15.30	**Plenary session theme: Theme Nature-based solutions for urban and industrial areas (soil, water and spatial planning). Sustainable solutions for the València City. (Aula) chair: Artemi Cerdà** **Keynote 1: Guiseppe Grezzi (Mobility plans in València city)** **Keynote 2: Natxo Lacomba (European Green Capital Valencia)** **Keynote 3: Emilio Barba (Universitat de València)** **Discussion between keynotes and audience**		
15.30-16.00	**Coffee/tea/orxata break**		
16.00-17.30 Parallel session	**Nature based solutions in urban areas (Aula)**	**Workshop Transition towards Circular Land and Soil Management; Building networks, bringing together interests and coping with friction in regulation (Room 3)**	
17.30-19.30	**Poster session with refreshments and closing of indoor event**		

11th July: Conference excursion	
11th July	NBS in coastal wetlands in Valencia. Nature and agriculture. The Natural Park of L'Albufera. A Geographical Approach.

Post-conference excursions

12th July	Drip and flood irrigation systems in La Costera and La Safor districts. Water and Soil under the commercial agriculture. Problems and solutions.
13th July	Rainfed vineyards and olives in Moixent and Font de la Figuera. Quality of agriculture products and landscapes. There is a future for traditional rainfed agriculture?

Conference Abstracts

Session AN1: Microorganisms in Agriculture: Direct Application or Management

Session organisers

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Application of Mycorrhizal Fungi Inoculants in Grapevines: Successes and Failures

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[1]*Grupo de Investigación en Biología de la Plantas en Condiciones Mediterráneas (PlantMed), Departamento de Biología, Universitat de les Illes Balears (UIB) – Instituto de Economía Agroambiental y del Agua (INAGEA). Carretera de Valldemossa Km 7.5, 07122 Palma, Islas Baleares, España.*
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Abstract

Mycorrhizae, particularly arbuscular mycorrhizae, represent a symbiotic relationship between fungi and roots found in numerous plant species of agricultural and industrial significance. This symbiosis enhances the plant's nutritional and physiological well-being while bolstering its resistance to pathogens and soil-borne diseases. The beneficial impact of this symbiosis has been recognized and researched since the 1960s, and today, its integration into agricultural practices is widespread, including viticulture. A bibliographic review of 30 scientific articles comparing the growth of *Vitis* sp. plants inoculated with mycorrhizal fungi (MF) versus control plants reflected that positive effects of inoculation are not always found. Greater growth of inoculated plants was conditioned by numerous factors, such as plant variety, soil type, or fungus species. Despite variability, some generalizations can be drawn, such as the effect being more positive when plants grow under stress conditions, when comparison is with control plants in sterile conditions or when the assay is carried out in controlled conditions (Baraza et al., 2023). This leads us to think that the use of commercial inoculants based on mycorrhizae applied in the field has a wide margin of uncertainty regarding their final effect on the vineyard. In fact, we tested in field conditions a commercial inoculum based on *Rhizophagus irregularis* with no positive effects on vine plants in two occasions. The first experiment was carried on plants inoculated at the time of plantation. After 177 days after the inoculated plants presented significant less photosynthetic rate and height than control ones, however these differences disappear one year after plantation. In the other assay, the inoculation was made in a 5 years old vineyard in the spring of two consecutive years. The first year after 2 months of inoculation, no effects on the plant photosynthetic rate was found, although inoculated plants presented significant higher somatic conductance. The second year, no significant effect of inoculation was found on physiological parameters. Moreover, no effect on yield was observed. However, in both experiments, the characteristics of the grapes (Ph, Birx, acidity) seem to indicate that the inoculation with AMH can delay the ripening of the grapes. Considering that climate change, one of the negative effects it has on wine grape production, is the shortening of the ripening period, inoculation with MA seems to help minimize this impact.

Keywords: Vineyard, Biofertilizers, Photosynthesis, Grape quality

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Land use effects on soil microalgae and cyanobacteria communities

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Abstract

In the current global context, with the increase of food demand due to the growing population, there is an urgent need to search for agricultural nature-based solutions as alternative to the conventional practices generating several environmental negative effects, exacerbated also by the pressing climate changes. Soil microalgal and cyanobacterial (SM&C) communities show biofertilizer, biostimulant and biopesticide properties, providing several beneficial ecological functions potentially exploitable in agrosystems. Being photosynthetic primary producers, they can enrich the soil in organic carbon and biomass; they can produce bioactive compounds making more hospitable the microenvironment for plants development; they can improve the physical properties of the soil, such as promoting the soil particles aggregation; the cyanobacteria, in particular, can fix the atmospheric nitrogen, crucial for plant growth (Ramakrishnan et al., 2023; Kalyanasundaram et al. 2020). The aim of this work was to characterize SM&C communities in a Mediterranean olive orchard, located in Ferrandina (Basilicata, southern Italy), managed with sustainable (S_{mng}; drip-irrigated with treated urban wastewater, light pruning, soil permanently covered by spontaneously vegetation, mowing and pruning residuals left as mulch) and conventional (C_{mng}; severe pruning and soil tillage, chemical fertilization) practices for 22 years. After soil sampling in the surface layer (0-3 cm) of the soil, SM&C were cultivated using two selective liquid media: one containing N, for isolating the entire photosynthetic consortium, and one without N, for the nitrogen-fixer cyanobacteria. By the most probable number (MPN; FAO, 1967) method, we assessed their amount: both microalgal and cyanobacterial groups had significantly higher abundance in the S_{mng} soils ($2.210 \cdot 10^4$ g^{-1} and $0.408 \cdot 10^2$ g^{-1}, respectively) compared to the C_{mng} ones ($0.872 \cdot 10^4$ g^{-1} and $0.240 \cdot 10^2$ g^{-1}, respectively). Biodiversity were evaluated through light microscopy and 16S/18S/ITS rDNA metagenomics. *Anabaena* cyanobacterial genus, *Oedogonium* and *Scenedesmus* green algae and the diatoms *Navicula* and *Pinnularia* were detected in the S_{mng} soils, whereas *Trebouxia*, *Euglena*, *Chaetophora* green algae genuses and the diatom *Cymbella* were dominant in the C_{mng} soils. Metabolomic analysis were performed on lysed cells and supernatant, detecting 1888 features for microalgae and 494 for cyanobacteria, and

highlighting distinctive metabolic profiles based on the different land use and two matrices analyzed. Metabolic pathways related to the biosynthesis of the secondary metabolites, hormones, amine, fatty acids and lipid showed an up-modulation in the S_{mng} soils. In particular, the secondary metabolites more accumulated were the N-containing organic compounds, the phytoalexins, the phenylpropanoids and the terpens, that are elicitors molecules, able to activate a plant defense response, with antibiotic properties and with growth-promoting properties for plants. In light of these results, we can affirm that the sustainable agricultural practices can positively affect the soil phototrophic communities, both quantitatively in their abundance and qualitatively in their diversity and metabolic profiles, strengthening crucial ecological processes mediated by them, improving the soil heath and supporting the native microbial diversity.

Keywords: phototrophic microorganisms, soil microalgae, soil cyanobacteria, soil health, sustainable land use

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Contrasting fertilization and phenological stages shape microbial-mediated phosphorus cycling in maize agroecosystem

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CEBAS-CSIC

Abstract

The recycling of waste such as sludge and struvite as phosphorus-rich fertilisers is a promising strategy to address the shortage of conventional fertilisers. Their production and improvement are crucial due to their potential to increase phosphorus availability and influence microbial diversity and function. Bioinformatics techniques have been essential in exploring soil microbial communities, particularly in agroecosystems. Here, we investigate the soil metagenome and metaproteome to understand microbial responses to alternative phosphorus-rich fertilisation. We conducted a field experiment to evaluate how different fertilisation types affected key phosphorus cycle genes in soil microbial communities. Treatments included conventional NPK, struvite, sludge, and organomineral fertilisation (sludge plus struvite). We also assessed the influence of phenological stages, collecting rhizosphere soil samples during germination and flowering. This trial took place in a Mediterranean maize field in Murcia, Spain. DNA was extracted and sequenced using Illumina technology. Metagenomic analysis involved quality assessment with FastQC, assembly with MEGAHIT, gene prediction with FragGeneScan, sequence alignment with Bowtie2, and annotation with JGI and NCBI. Metaproteomic analysis identified the most active soil proteins, grouping phosphorus cycle genes into three categories: organic phosphorus mineralisation, inorganic phosphorus solubilisation, and phosphorus starvation response. Our metagenomic results showed that the bacterial community was dominated by Actinobacteria, Proteobacteria, and Acidobacteria. *Luteitalea*, *Nocardioides*, and *Solirubrobacter* were the predominant genera. *Nocardioides* increased in the sludge and struvite treatment, especially during flowering. The archaeal community was dominated by Thaumarchaeota, Euryarchaeota, and Crenarchaeota. Metaproteomic results highlighted the activity of *Skernella* and *Phytohabitans*, despite their lower abundance in the metagenome, showing that less abundant microorganisms can be highly active. Our analysis indicated that, in the bacterial community, genes for organic phosphorus mineralisation and phosphorus starvation response were significant in the fertiliser and phenological stage combination. In the archaeal community, organic phosphorus mineralisation genes were significant among the fertilisers used. At the metaproteome level, alkaline phosphatase *phoX* was the most active but not the most abundant, highlighting that abundance does not correlate with activity. The fertilisation strategy and phenology affected phosphorus cycle

gene abundance, modulating microbial activity. Phenology had a more significant influence on microbial functionality than fertilisers regarding inorganic phosphorus solubilisation genes. Bioinformatics, metagenomics, and metaproteomics tools are essential to understand microbial function in soil phosphorus availability. Alternative fertilisers like struvite or sludge offer a comprehensive strategy to address phosphorus deficiencies in agroecosystems. Our findings emphasise the importance of considering plant-soil-microbiota interactions to optimise fertilisation for better agricultural sustainability and productivity.

Keywords: soil,agricultural,phosphorus,microbes,metagenome,metaproteome,bioinformatics

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Effects of sustainable management strategies on soil microbial activity and grapevine performance

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Abstract

Vineyards management has been changing over time and according to the specific region in which is grown. In semiarid areas such as the Mediterranean basin, one of the main axes of management is related to nutrition and water. In recent years, the implementation of green covers (GC) has intensified despite in semi-arid areas the scarcity of water and nutrients can reduce their benefit on the soil and the crop. Furthermore, little is known about the effect of the different management techniques on the microbial community and its activity, and how soil microbial activity can affect grape production and quality. This study evaluated the effect of GC and water management on soil microbial functional diversity, soil water content (SWC), soil organic carbon (SOC) cycling, and soil respiration during the vine-growing season. At harvest, the yield components and quality of grapes were determined. The results reveal that both phenology and irrigation treatment significantly affected soil microbial communities' carbon source utilization patterns. Soil under GC treatment showed higher soil microbiota carbon metabolism specificity and higher soil respiration rate compared to tillage treatment. Moreover, the SOC analysis determined a higher carbon decomposition rate but also greater organic carbon accumulation by an increase of organic matter stability in the GC system. Regarding plant performance, higher total sugars and anthocyanin concentrations were found in grapes under GC treatment. In conclusion, using sustainable management in grapevines improved grape quality by increasing carbon cycling and accumulating and selecting the specific microbiota functionality.

Keywords: sustainable agriculture, ecological intensification, ecosystem services soil management, bacterial functionality, carbon sequestration

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BENEFITS ON THE EX VITRO PLANT PERFORMANCE OF THE EARLY ARBUSCULAR SYMBIOSIS ESTABLISHMENT IN ROOTING PROCESS OF PRUNUS ROOTSTOCKS

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Abstract

In vitro is a mainstream and successful plant production method, providing homogeneity, high survival, and disease-free plantlets. However, the controlled and aseptic conditions during plant propagation do not provide the plantlets with beneficial microbiota to enhance their development and responses to cope with soil stress. Those characteristics become crucial when those plantlets are established as a crop. In natural conditions, seedlings are directly exposed to soil microbiota, potential disease promotors, plant-promoting growth bacteria, and potential symbionts, among others. Arbuscular mycorrhiza (AM) symbiosis was described as the mother of the symbiosis, being the most widespread symbiosis in terrestrial plants. Indeed, nowadays the utilization of inoculum of AM as a biofertilizer during the biofortification period in nursery conditions is increasing. Nonetheless, at the tree level, arbuscular mycorrhizal colonization showed low levels, and frequently the symbiosis is unsuccessfully established. The main objective of the present work was to perform the symbiosis establishment of two AM fungi species, Clareidoglomus clareidum (obtained from Chilean soils) and Rhizophagus intraradices (widespread fungus in plant AM symbiosis) during the ex vitro rooting process, just after finishing the in vitro shoot development. Plant survival and biomass production of symbiotic plantlets with each AM fungus were compared with plantlets rooted without symbiosis. Plantlets used were two Prunus rootstocks, ‘Adara’ and ‘Maxma 14’, which are highly produced under in vitro process. Survival during the rooting process of non-symbiotic plantlets was 100% in both rootstocks, while symbiotic ‘Adara’ plantlets of C. clareidum presented 20% losses and 100% survival with R. intraradices symbiosis. ‘Maxma 14’ showed more survival with C. clareidum, but the differences with R. intraradices were not significant. Regarding plant fitness, both symbiont rootstocks were significantly higher in total biomass, increasing root and shoot development.

Keywords: in vitro plantlet production, AMF symbiosis, Prunus rootstock, plant fitness

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Influence of Rhizophagus irregularis and natural inoculum on soil microbial community and early growth of Vitis vinifera cv. Merlot

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Abstract

Soil microbial communities play a key role in aspects such as plant nutrition, health, productivity, and crop quality. In this context, arbuscular mycorrhizal fungi (AMF) are fundamental components in agroecosystems, forming symbioses with most crop species, including grapevines. However, in some situations, the application of commercial AMF inoculants under field conditions has not produced the expected benefits. This could be due to competition with the established natural soil microbiota. The aim of this study was to determine the effect of inoculating *Rhizophagus irregularis* (*R*) and a natural inoculum (extraction of AMF from soil) separately, together at the same time, or sequentially in different orders of inoculation under controlled greenhouse conditions. Rooted cuttings of the Merlot cultivar were planted in 2 L pots with a 3:1 ratio of sterile soil to sand. They were divided into six treatments: sterile control, pure *R. irregularis*, natural inoculum (Nat), Mix (*R* + Nat simultaneous), *R* + Nat (the latter 35 days later), and Nat + *R* (the latter 35 days later). Physiological measurements included photosynthesis and stomatal conductance were measured using a portable gas exchange system. After three months, dry biomass of the plants (roots, stems, and leaves) was taken. To study the microbial diversity of the rhizospheric soil, the Biolog EcoPlates™ method was used, which employs 31 substrates to assess bacterial functional diversity. The control treatment showed a lower photosynthetic rate and reduced growth. The rest of the treatments didn't show statistically significant differences from each other, except for the dry weight of the stems, which was significantly lower in the Nat + *R* treatment compared to the *R* + Nat. Regarding the diversity of substrates utilized by the microbial communities, it was lower in the control but similar among the other treatments. Principal component analysis of the intensity of use of the 31 substrates didn't show differences between the microbial communities of the different treatments. These results indicate that grapevine cultivation relies on the presence of AMF for its favorable growth, and that in the presence of natural AMF, inoculation with *R. irregularis* didn't confer an advantage in the early growth stages of *V. vinifera* regardless of the timing of inoculation. Furthermore, the interaction between AMF and the bacterial community is not altered by the introduction of a foreign cultivated fungi species. Inoculation with *R. irregularis* could stimulate the common soil bacteria, and improve vine growth, even in the presence of some local species.

Keywords: arbuscular mycorrhiza, Vitis vinifera, rhizosphere soil, microbial diversity, competition.

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Evaluation of Field Inoculation of Kocuria rhizophila and Streptomyces violaceoruber as Biostimulants in Two Grapevine Rootstocks

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Abstract

Agricultural productivity must promote management systems that incorporate sustainability principles, and viticulture is no exception. In this regard, several studies have shown that certain symbiotic microorganisms, such as mycorrhizae and rhizobacteria, can enhance plant development and growth. Growth-promoting rhizobacteria (PGPR) are naturally occurring soil bacteria that have the ability to stimulate vegetative growth and development, as well as enhance resistance to stress. The aim of this experiment was to assess the effects of the growth-promoting rhizobacteria *Kocuria rhizophila* and *Streptomyces violaceoruber* on the vegetative development and physiology of Merlot vine cultivar onto two rootstocks (SO4 and R110) in the field. The planting was designed in blocks with a total of 30 plants per treatment (control, *Kocuria*, and *Streptomyces*). The Merlot cultivar was grafted onto two rootstocks: one considered more tolerant to water stress (R110) and one more sensitive (SO4). For inoculation, the roots were immersed in the bacterial suspension of $1x10^7$ CFU/ml for *K. rhizophila* and $1x10^6$ CFU/ml for *S. violaceoruber* for 60 minutes. The control plants were treated with plain water. At the time of planting, the inoculation was reinforced by watering each plant with 500 ml of bacterial suspensions at same concentration. At three and six months, growth measurements (maximum height) and gas exchange parameters were taken using an infrared gas exchange system with an integrated fluorescence chamber. To study the microbial diversity of the rhizospheric soil, the Biolog EcoPlates™ method was used, which employs 31 substrates to assess bacterial functional diversity. Three months after inoculation, a significant increase in growth of the R110 rootstock was observed for *Kocuria*. A slight increase in the photosynthesis rate of plants inoculated with *Streptomyces* was also detected after three months for both rootstocks. Despite the growth differences suggesting the stimulating effect of the bacteria on plant development, no differences were observed in the rest of the evaluated parameters. Regarding the α diversity of substrates utilized by the microbial communities, there were no differences between treatments. However, in the principal component analysis of the intensity of use of the 31 substrates, there were differences between the microbial communities of the different treatments, *Kocuria* distinguished itself from the control and *Streptomyces*, degrading different substrates. These results suggest that it is crucial to consider other factors that might have

influenced field conditions, such as root colonization once the root system is developed or competition with other microorganisms in the rhizosphere.

Keywords: Growth-promoting rhizobacteria, Kocuria rhizophila, Streptomyces violaceoruber, rootstocks, rhizospheric diversity

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Phenomic and genomic characterization of pre-market bioproduct: insights on multifunctionality.

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Abstract

Bioproducts are formulated products containing beneficial microorganisms which can be released in the environment to promote plant growth by means of their biostimulant, biopesticide, and/or biofertilizer properties. Their use is a widely adopted practice world-wide and a valid and cost efficient alternative to chemicals. Despite, we need to increase our knowledge on the biological processes determining their efficacy in the field, to further promote their use. A deep characterization of microbial based bioproducts can nowadays be straightforwardly obtained by genome sequencing, to assess the potential functionality encoded in the genome, later supported with in-depth phenotipic characterization to confirm the inferred potential features. In this work we explored the biofertilizer and biopesticide potential of the *Paenibacillus polymyxa* K16 strain, isolated from tomato roots, for its pre-market characterization as a novel bioproduct. We aimed at coupling an in-depth genomic mining evaluation of potential functions, with phenotype microarray confirmation of expressed functions, to underline the strain multifunctionality
The genome was sequenced using NovaSeq followed by assembly and genes annotation. Metabolic and phenotypic characterization were performed with standard plate methods and with phenotype microarray analysis of multiple plates in the BIOLOG system.
Results showed that the *Paenibacillus polymyxa* K16 strain has different biofertilizer (conversion of nitrate in ammonia; phosphorous solubilization; siderophore production) and biopesticide (plate antagonism; FusaricidinB and PolymyxinB gene; production of pyrazine volatile compound) functions, and low presence of antibiotic resistance genes. As experimental confirmation, the observed genes were connected to measured metabolic activity trough metabolic pathways reconstruction for nitrogen and sulphur metabolism.
Overall, different approaches were used to explore properties that a novel bioproduct should possess to survive the soil conditions and the resident (micro)biota competition, prerequisites for exerting a beneficial action on plant growth. Moreover, this combined approach can highlight a bioproduct inherent multifunctionality with different possible stimulatory, fertilizing and biopesticide features.

Keywords: Bioproduct, genome, phenotypic characterization, Paenibacillus polymyxa, multifunctionality

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Soil amendment with biochar at agronomic rates improves borrowing conditions for grounddwelling communities: case study in biodiverse pastures

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Abstract

Unsustainable soil management in intensive pastures has led to a well-documented loss of habitat use by soil invertebrates and ground-nesting pollinator communities,which are key to soil functioning and delivery of ecosystem services. Soil compaction and increased resistance to penetration are among the main drivers hindering ground borrowing and nesting activity by such communities. Biochar (pyrolyzed biomass) application to soil was shown to improve soil structure and soil water retention, while reducing compaction, even though effects are dependent on soil and biochar characteristics as well as site-specific soil-biota-climate combinations. Integrated in ongoing projects POLLINATE, SOILCOMBAT and TRUESOIL, the present case study aimed at evaluatingthe effect of biochar on soil penetration resistance (PR; N/cm^2) at the field scale, at relevant soil depths for representative faunal groups.Other factors that affect soil hardness and ground burrowingand nesting (e.g. bulk density, rooting, soil moisture and temperature) are also being monitored in the scope of ongoing projects. The study area is a sown biodiverse pasture in Central Portugal, with a hard-setting,sandy loam Cambisol and temperate Atlantic climate.In September 2022, pine wood biochar was incorporated in the topsoil (0-20 cm) in10 rainfed plots (and 10 un-amended controls) of 9 m^2 (3x3 m) each, and in rainfall exclusion(50% by rainout shelters) plots- 5 controls and 5 biochar-amendedat an application rate of 4% (w/w).The plots were sown with a legume-rich biodiverse seed mixture. After the vegetation was established in February 2023, soil PR was measured monthly at 3 replicate measurements per plot, measuring the force needed to penetrate the soil from the surface to 40cm depth, in 10cm depth intervals. The first 10 cm of topsoil often had similar PR values between biochar and control plots, depending on soil moisture and vegetation growth. Below the 10 cm depth, biochar plots showed significantly lower PR values inall treatment plots, particularly at deeper soil

depths. While this effect appears to have been the most pronouncedin the drier periods, the full length of correlations with soil moisture and soil temperature is still being investigated.Our results suggest that biochar reduces soil compaction,at depths that are relevant toground dwelling invertebrates and pollinators, with stronger benefits during the drier months, particularly for faunal groups that borrow below 10 cm.

Keywords: soil-biochar-biota interactions, soil functioning, soil compaction, soil resistance to penetration

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Ecotoxicological bioassays essential tools to improve knowledge about the quality of biochars

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Abstract

The intensification of irrigated olive crops leads to the use of agricultural practices that are aggressive to soil health, contributing to soil degradation and desertification. One of the possibilities for recovering these soils is the use of materials to improve their chemical properties, such as biochars.To comprehensively evaluate the quality of these materials, the physicochemical characterization must be complemented by an ecotoxicological assessment, serving as an indicator of potential (eco)toxic effects that may undermine the balance of ecosystems and their associated services. This study aimed to improve Tier 1 risk assessment of biochars by conducting acute ecotoxicological bioassays. These tests were carried out to determine the (eco)toxic concentrations of 9 biochars: vineyard wastes in various proportions (“P” pruning; “E” stalk): 100P, 100E, 50E, 25E, olive pomaces (Co, B1, B2), and forestry residues (I and C). We tested 9 pure biochar, 1 pure olive orchard soil and 27 soil-biochar mixtures at 1.5%, 3%, and 5% totalling 37 treatments. The ecotoxicological evaluation included acute morality assays using the crustaceans *Thamnocephalus platyurus* and *Daphnia magna*. The acute assays indicated that the crustacean *T. platyurus* was the one that showed the highest sensitivity to the samples, and only 2 biochars, 100P, and C did not induce toxicity to this species.The biocharsthat induced high toxicity to *T. platyurus*were B1 with a 24h-$EC_{50}$of 14% (v/v), followed by B2 with a 24h-$EC_{50}$of 15% (v/v). Concerning *D. magna*, three of the nine biochars (50E, C, and I) did not show signs of inducing acute toxicity in this species. On the contrary, B2 (48h-EC_{50}=20%(v/v)), 100E (48h-EC_{50}=24%(v/v)), and Co (48h-EC_{50}=24%(v/v)) exhibited the highest toxicity levels for this species. These results have enabled the identification of biochar concentrations potentially hazardous to ecosystem species and the establishment of a concentration range for further analysis in the

subsequent phase of the risk assessment process, involving bioassays to evaluate sublethal properties and life cycle parameters. Overall, the findings suggest that biochars derived from forest residues may offer greater advantages for application in agricultural soils compared to those produced from agricultural residues.

Keywords: Biochar, ecotoxicological evaluation, Tier 1 assessment, D. magna, T. platyrus

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Spontaneous cover crops enhances soil water storage in olive groves after natural rainfalls

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Abstract

Cover crops in woody crops are promoted by the Common Agricultural Policy but in Spain, almost the 50% of the olive grove surface is tilled (MAPA, 2022). In Central Spain, farmers are reluctant to change from traditional tillage to cover crops due to the risk of competition for water and nutrient resources (Sastre et al., 2017). There is a believe among farmers that the tillage increase soil infiltration capacity after a rainfall, and this can be true just after the tilling but this effect is not permanent. The aim of this work is to compare the effect on soil water storage after natural rainfalls of two soil management in an olive grove in Madrid Region (UTM 30N, ETRS89: X=455,654, Y=4,435,959). The soil is classified as Haplic Gypsisol (IUSS Working Group WRB, 2014), with a xeric moisture regime, under a Mediterranean semiarid climate. The soil management were 1) a spontaneous cover crop (SPO) since 2014 mowed 2-3 times per year and 2) a conventional tillage (TIL) consisted on 3 chisel cultivator passes per year, in a randomized block design with 4 repetitions. Soil volumetric water content (θ) was measured in the inter-rows employing EC-5® soil moisture sensors at 10, 20 and 30 cm depth. In the autumn and winter of 2023/2024 season, 13 rainfall events were recorded in an automatic weather station (11.7 mm/event on average, [5.0-33.2]). After the end of the rainfall, the increase of the θ was used to evaluate the capacity of the soil to storage water. Furthermore, steady state infiltration with a 12cm single ring (USDA, 2001) was determined. The ANOVA shows that SPO increases θ regarding TIL ($p=0.041$), and that there are differences between depths ($p=0.006$), mainly at 10 cm depth. There is an important effect on rainfall depth ($p<0.001$) working as covariable. The LS mean of the θ increase are 0,033 and 0,044 m3/m3 in TIL and SPO, respectively; and 0.050, 0.030 and 0.034 m3/m3 at 10, 20 and 30 cm depth, respectively. The interaction of these factors was not statistically significant. There were no differences among soil management regarding steady state infiltration, with 41.6 mm/h in TIL and 51.8 mm/h in SPO. The spontaneous cover crop had enhanced soil structure, and thanks to this, soil increased its capacity to infiltrate and storage water. If the cover crops is appropriate managed (mowed at the right time), its influence on soil water balance is positive.

Keywords: soil moisture, volumetric water content, groundcovers

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Enhancing MRV Frameworks for Afforestation: A Path to Credible Carbon Markets

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Abstract

Nature-based solutions are vital for achieving Europe's 2050 climate neutrality goals in combating climate change. To promote such solutions, it is crucial to develop a robust and transparent voluntary carbon market ensuring the environmental and financial integrity of carbon credits. Monitoring, Reporting, and Verification (MRV) processes are extensively employed to authenticate the impact of various climate mitigation efforts, including energy-use reduction, reforestation, and direct air capture. However, in afforestation as a nature-based technology, there is a notable lack of standardized MRV methodologies, which is essential for increasing market credibility. Global Factor conducted a comprehensive literature review and analysis of twelve MRV frameworks for afforestation projects targeting carbon removal. This review encompasses those frameworks that collectively account for about 80% of the global CO2 credits generated in the voluntary carbon market. The findings demonstrate significant alignment among these frameworks in critical aspects such as quality requirements for data collection and general MRV processes. A robust MRV system's foundation lies in the accuracy and sustainability of its underlying data and models. Ensuring proper data acquisition and establishing universally applicable requirements for data handling and processing are crucial to maintaining system quality over time. Despite these commonalities, some MRV systems exhibit significant weaknesses in meeting quality criteria, often due to a lack of transparency or high uncertainty in data. This study identifies traceability, accuracy, coherence, and consistency of data as the primary challenges facing MRV frameworks. Addressing these challenges is imperative for enhancing the reliability and credibility of afforestation projects within the voluntary carbon market, which plays a substantial role in global carbon credit generation. To maximize the impact of knowledge derived from analyzing current MRV frameworks for afforestation projects, several enabling conditions are necessary. These include fostering international collaboration for knowledge sharing, establishing transparent and standardized global MRV standards, addressing technological challenges, integrating insights into regulatory frameworks, and promoting awareness. MRV methodologies have been found to be sometimes outdated and based on tedious and error-prone methods. The introduction of digitalisation in MRV processes, although mentioned by some accreditation bodies, has not yet reached its full potential. Platforms are beginning to emerge, offering solutions to directly store data and improve efficiency in data collection and management. Digital innovations are therefore seen as key to improving the reliability and efficiency of MRV, although there is still work to be done in their widespread application. Policymakers should incorporate analysis insights

into frameworks to ensure alignment with international standards.

Keywords: Voluntary carbon market, Monitoring Reporting, and Verification, Afforestation

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Influence of the use of cover crops on the enzymatic activity of olive grove soils - SANCHOSTHIRST Project

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Abstract

The EJP-SOIL SANCHOSTHIRST project [Cover crops (CC) ANd soil health and climAte CHaNge adaptation in Semiarid woody crops. The RemOte SensIng and furTHer scenaRIoS projecTions] has as one of its objectives to establish an inventory of vineyards and olive groves with cover crops and tillage to monitor soil health. This work presents the first results of the study of enzymatic activities in the olive grove soils sampled in this project. A total of five locations in Spain were sampled: 1) Los Aires (Toledo, Castilla-La Mancha), 2) Alcocer (Guadalajara, Castilla-La Mancha), 3) Al Alma del Olivo (Toledo), 4) Gálvez (Toledo) and 5) Finca Experimental La Chimenea (Comunidad de Madrid). In each of these locations, olive groves with vegetation cover and in nearby tilled olive groves were sampled, being taken three composite samples at two depths (0-10 cm and 10-30 cm). The samples were kept refrigerated from collection, subsequently sieved (<2 mm) and refrigerated until analysis. In each sample, β-glucosidase, arylsulfatase, urease and phosphatase activities were determined following ISO 20130, and dehydrogenase activity was determined following Schaefer (1963). The initial hypothesis was that the use of cover crops would favor greater enzymatic activity in the soils due to the greater presence of plant remains, a favoring of microbial activity due to the action exerted by the rhizospheres of the covers and the less disturbance of the structure of the soil. In the results obtained, the enzymatic activity of the soils with cover crops was equal to or higher than the activity of the tilled soils, with the exception of: i) the soils of La Chimenea in which the dehydrogenase, β-glucosidase and arylsulfatase was higher in tilled soils at a depth of 10-30 cm while phosphatase activity was higher under 10-30 cm with CC, and ii) urease in Los Aires which was higher in tilled soils at the two depths sampled. These differences in these two soils may be due to their own intrinsic characteristics in terms of nutrient content, which are currently being analyzed. These results, taking into account the exceptions mentioned, seem to indicate a better enzymatic activity in the soils with cover crops, however, a deeper study is necessary in each case taking into account other biological, physical or chemical soil properties.

Keywords: Semi-arid, biological activity, soil management, soil enzyme

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Evaluation framework to predict the fate of organic materials

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WUR

Abstract

In transition towards a circular economy, new organic fertilisation products will become available. The nitrogen and carbon dynamics of these products is not yet evaluated and suitable tools are not available. To fill this gap, Wageningen Research developed a toolbox that can be used to easily assess the carbon decomposition and nitrogen mineralisation of these products. The framework is currently being developed further. The model RothC has been used to assess C mineralisation and sequestration from farm management. The C/N ratio of the individual organic pools of RothC was used to assess the N-mineralisation and immobilisation. The model was calibrated based on incubation studies in which C and N mineralisation of 16 different organic materials was measured, both in a sandy soil and a clay soil. The measured C-mineralisation was used to determine in each fertilising product the fraction of easily decomposable plant material (fDPM) and the complementary fraction of recalcitrant plant material (fRPM = 1 - fDPM). Furthermore, the influence of soil type on mineralisation/immobilisation was quantified. With regression analysis, a connection was made between the fraction of easily decomposable plant material and a large palette of laboratory analyses performed on the organic materials. Five additional organic materials were used to validate the model. A new simplified innovative methodology has been developed to predict the C- and N-mineralisation and immobilisation of organic products. Simple laboratory analyses (total nitrogen content, a pyrolysis parameter and a MicroResp. parameter) could predict the size of the RothC parameter for the easily decomposable fraction of carbon (fDPM) of an organic fertilising product, enabling the prediction of carbon dynamics. The model results were quite similar to what was measured with incubation experiments. However, the MicroResp. parameter is not considered reliable during the validation phase. The use of other parameters, such as COD, BOD or HWC, will now be explored. For N mineralisation, an overestimation was found, meaning that just using a fixed C/N-ratio of each of organic pools in RothC is a too simple approach. However, this approach is a first step from the conventional long-term and costly incubation experiments or field studies that are typically required to assess the impact of organic materials, at least for carbon turnover. The model assessment of N mineralisation will be further investigated. The tool is a simplified method, and can help to predict the effects of an organic material on carbon storage in soils and in the future possibly nitrogen mineralisation as well.

Keywords: Carbon decomposition, nitrogen mineralisation, framework

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Influence of Cover Crops on Soil Water Retention and Bulk Density in Diverse Agricultural Semi-Arid Soils

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Abstract

Preliminary results are presented from a project studying a dozen vineyards and olive groves managed with cover crops. All of these are located in semi-arid territories in Spain, with annual rainfall below 400 mm. The duration for which cover crops have been used varies, ranging from 2 to more than 20 years. In this range of soils with different characteristics, the objective is to observe the effect of the cover crops on the first 30 cm of soil. Soil moisture content and bulk density are being studied. For this purpose, in each location, the plot with cover crops is compared to a similar plot managed with traditional tillage. The textures of these soils range from sandy to clay-loam, with pH values from 4.3 to 8.9, carbonate content from non-existent to 70%, and electrical conductivity from 25 to 1964 µS/cm. Sandy soils have a total available water content from less than 4% in sandy soils to more than 20% in clay-loam soils. In general, no significant differences have been observed between tillage and cover crop treatments if the cover crops have been in use for less than 5 years. However, after 10 years of cover crop use, there is a tendency for tilled soils to have less water at the 30 cm depth. Nevertheless, soil texture is a determining factor and can introduce biases in these results which will be discussed in the presentation. One of the most mentioned effects of using cover crops is the increase in soil bulk density. In this study, after 5 years, we have not found significant differences in bulk density. In the most superficial layer of 0 to 10 cm, bulk density ranges between 1.2 and 1.6 g/cm^3, and in the subsurface layer of 10 to 30 cm, it varies between 1.4 and 1.8 g/cm^3. Given the significant influence of the specific conditions of each soil, the differences in the site-specific cases studied in this project will be presented. The importance of these results in the application of cover crops is based on providing concrete answers to farmers to determine whether the use of cover crops improves or harms concerning competition for water.

Keywords: Sustainable agriculture, ground covers, soil management, water conservation

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CARBON STOCK IN TILLED AND COVER CROPPED OLIVE GROVES AND VINEYARDS IN SARDINIA

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Abstract

In Italy, an area of over 1.1 million hectares is devoted to olive cultivation, while abot 700,000 hectares are cultivated with vines, of which 40,327 hectares of olive groves and 26,709 hectares of vineyards are located in Sardinia (ISTAT, 2024). Tillage is the traditional soil management of these woody crops, with the main goal of contrasting weed competition for water and nutrients. The use of alternative soil management to conventional tillage, such as cover cropping, improves the physico-chemical properties of the soil, preventing erosion and improving soil structure, due to the higher levels of organic matter in the soil, thus also enhancing other ecosystem services such as carbon sequestration, contributing to climate change mitigation, the productivity of the woody crops and the biodiversity of the soil and the agro-ecosystem. The aim of this work is to compare the effect of soil management with traditional tillage versus management with spontaneous vegetation cover on the soil physico-chemical properties of Sardinian olive groves and vineyards. Four vineyards in central and eastern Sardinia and four olive groves in north-western Sardinia were analysed. Half of the study plots for each woody crop are managed with spontaneous vegetation cover and the other half with traditional tillage. In each plot, three sampling points were identified where composite soil samples were taken at two depths (0-10 cm and 10-30 cm) and unaltered soil samples were taken in the centre of the two soil layers. Different physico-chemical properties of the soil were determined, of which we highlight for this work: pH, EC, total carbon and nitrogen, soil carbonate content and bulk density. An analysis of variance was performed with a general linear model (Statgraphics Centurion XVIII) taking into account soil management and depth as factors. Significantly higher values of soil orcanic carbon (SOC) stock were found in Sardinian olive groves compared to vineyards with a total of 79 $t \cdot ha^{-1}$ and 30 $t \cdot ha^{-1}$ respectively in the 0-30 cm layer. The Dorgali vineyard managed with spontaneous vegetation cover SOC stock increases significantly by 24.4 $t \cdot ha^{-1}$ compared to the plot managed with conventional tillage. On the other hand, the tilled olive grove in Alghero significantly improves the carbon stock by 16.5 $t \cdot ha^{-1}$ compared to the covered plot. In conclusion, soil management affects soil carbon storage, however factors such as soil type, soil physico-chemical characteristics and plant cover characteristics have to be taken into account to explain the differences.

Keywords: woody crop, soil management, biodiversity, SOC stock

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Comparative Study of Soil Management Techniques and Their Effects on Soil Carbon and Water Availability in Vineyards

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Abstract

This study examines the effect of soil management on four dry-farmed vineyards in two semi-arid locations in central Spain. Two vineyards are in Mota del Cuervo, Cuenca. The other two are in Fuentenebro, Burgos. Their soils are similar in texture (all sandy loam), pH (8.4 ± 0.35), Calcium carbonate content (30 ± 3.7%), and bulk density (1.33 ± 0.17 g/cm³). However, they show significant differences in organic carbon content and total available water due to different management practices and climate. The goal is to understand the factors influencing these differences. In each location, one vineyard uses sustainable management with cover crops, which are maintained unless there is a riskMa of prolonged drought or frost, in which case the farmer removes the cover crop with shallow tillage. The other vineyard in each location is managed traditionally with 3 or 4 tillages per year, typically to a depth of 15-20 cm. The highest soil organic carbon (SOC) content was found in the vineyard that is tilled and regularly fertilized with sheep manure (SOC 1.7±0.4%). This is followed by the vineyard with cover crops for more than 20 years (1.5±0.5%), the vineyard with tillage (1.1±0.1%), and finally the organic vineyard with recent cover crops (0.5±0.1%). The degree of humification of organic matter in these vineyards was estimated by studying the E4/E6 ratio (absorbance at 465 to 665 nm, respectively). Lower values, around 4, indicate greater stability and aromaticity, which are associated with better soil resilience to drought and temperature fluctuations. A direct relationship was established between carbon content and water retention capacity in soils with cover crops ($R=0.79$; $p=0.003$). A negative correlation was found between the E4/E6 index and available water in these soils ($R=0.8$; $p<0.001$; $n=24$), indicating that greater aromaticity and complexity of organic matter lead to higher water retention capacity. Vineyards with the most available water had an E4/E6 ratio below 5. It is important to note that all vineyards are dry-farmed, making soil water retention capacity crucial. This capacity is associated with complex, stable organic matter, which is influenced by soil management practices.

Keywords: rainfed agriculture, ground covers, humification, resilience,

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Effects of straw-biochar mulchingon soil runoff-erosion, organic matter and CO2 balance in a vineyard in Alentejo (southern Portugal)

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Abstract

Soil erosion is one of the main environmental challengesin European Mediterranean agroforestry systems, becoming increasingly more wickeddue to the intensification of agriculture. Erosion andwater runoff reducessoil water storage capacity, along with organic matter contents, nutrients and valuable biota.Nature based solutions, such asorganic mulching, reduce runoff, erosion and increase soil organic matter. Biochar can be combined with mulch, resulting in a positive impact in the recovery of degraded soils.Compared with mulch, biochar`s organic matter is much more stable, allowing it to remainstored in the soil for longer periods. Due to its high cation exchange capacity, biocharcan also positively contribute to nutrient retention. In addition, it has a porous structure and can easily absorb water, increasing soil water storage capacity. The main objective of this paper,within the scope of the first author's master's thesis,is to verify the effects of a mulch-biochar combined treatmenton the improvementof a sandy loam soil of a vineyard in Alentejo,the Portuguese region with a most marked Mediterranean climate. More specifically, we intended to verify the effects of the surface application of these products on:(a) soil water balances, (b) rainsplash and inter-rill soil erosion, (c) soil organic matter, (d) germination and plant growth and (e) CO2 flows and balances. Lab-basedrainfall simulations and field trials were combined to assess soil runoff, erosion and

infiltration after applying mulch(2Mg.ha-1 straw) and mulch+biochar (2Mg.ha-1 straw+10 Mg.ha-1biochar). Non-treated soil was used as control. Tests were made in the leaching water collected from the rainfall simulations to check ongermination, root and shoot growth, using Lactuca sativa L. seeds. Organic matter determinations were made oversoil samples collected in the field. These were conducted usingindirect gravimetry, weighing 1 to 2g of sample, previously dried at 105ºC.Soil samples had been collected in three different microenvironmentsfrom eachtreatment,at a depth of 0 to 2 cm.CO2 flows and balanceswere measured in the field, using a LI-7810Trace Gas Analyzer. Results indicate that applying a mulch+biocharlayer to the soil surface is potentially effective in reducing runoff and erosion. The mulch+biochar treatment was most effective inincreasingsoil organic matter and plant growth. Soil was detected to store CO2 in all three treatments at around the same rate.Underneath the trees showed the lowest organic matter contents and was the only microenvironment losing CO2.

Keywords: sustainability, agriculture, agricultural waste, soil fertility, carbon

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Assessing biochar ecototoxicity upon soil application: Implications for lettuce (Lactuca sativa L.) germination and Daphnia magna behavior

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Abstract

Soils play a fundamental role in carbon storage and climate change mitigation. However, intensified agricultural activities have led to soil degradation, erosion, and thus favoring desertification. Enhancing soil organic matter is crucial for soil conservation. Biochar amendments are a potential solution, improving soil physical and chemical properties, water retention, and microbial diversity, while promoting a circular economy. Despite these benefits, the ecotoxicological impact of biochar on terrestrial ecosystems remains underexplored. To answer this question, 9 types of biochar were assessed: vineyard wastes in various proportions (“P” pruning; “E” stalk): 100P, 100E, 50E, 25E, olive pomaces (Co, B1, B2), and forestry residues (I and C). We tested 9 pure biochar, 1 pure olive orchard soil and 27 soil-biochar mixtures at 1.5%, 3%, and 5% totalling 37 treatments. Water-saturated soil-biochar mixtures were distributed in Petri dishes covered with filter paper for Lactuca sativa L. phytotoxicity tests (dark incubation chambers, 25°C, 72 h). Germination percentage, germination index, root growth, and total growth were determined. Feeding rate assessment trials were performed with Daphnia magna. Additionally, polycyclic aromatic hydrocarbon (PAH) contents, pH, and

organic matter content were assessed for each biochar, soil-biochar mixture, and soil. Our results showed that pure biochar prevented germination and consequently, seedling growth. When compared with soil from olive groves, the effect was observed in soil-biochar mixtures, at concentrations of 1.5% and 3%, leading to a significant increase in germination rates and promoting root and shoot growth. Conversely, a concentration of 5% biochar reduced seedling growth, in relation to the soil under study. The behavioral test with D. magna showed that the percentages of biochar used (up to 5%) do not induce sublethal toxicity and can be subsequently tested in agricultural soil. The application of biochar to soils contributed to an increase in organic matter content, but the optimum application for having low phyto and ecotoxicity effects happened in the mixture's biochar-soil of 1.5-3%. Furthermore, biochar with low PAH contents demonstrated higher germination and greater root growth. Our results also showed that each biochar exhibits its unique optimal application rate. Further research is needed to develop our understanding of the effects of biochar application on soil properties.

Keywords: phytotoxicity, behavior ecotoxicity, sustainability, agriculture, soil restoration

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Biochar application to soil improves aboveground biomass in a sown biodiverse annual pasture, without trade-offs on community composition and structure

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Abstract

Biochar application to soil has been shown to have a positive impact on multiple soil functions, while increasing plant productivity. Increases in crop yield in biochar-amended soils have been long recognized, however, its effectoncommunity composition ofgrasslands is yet to be studied in detail. Soil management strategies that aim to increase productivity in grasslands often lead to trade-offs between yield improvement and composition of local plant communities. These negative effects mainly include decrease in abundance of local species andshifts in diversity. For instance, application of N-containing fertilizers in species-rich grasslands inevitably decreases the species richness, whileliming of acidic soils can reduce Al and Mn toxicity at the expense of local acidophilus species.In turn, biochar has the potential to affect both physical (e.g. increased water retention, reduced bulk density) and chemical (e.g. increased pH and nutrient status) soil properties, but the trade-off between yield-improvement and changes in local communities' composition remain largely unexplored. We assessed plant community changes in an annual biodiverse pasture in Central Portugal at field-plot scale, in the first growing season after soil (sandy loam texture Cambisol) amendment with a woody biochar at 4% w/w. Biochar was incorporated in the topsoil (0-20cm) in 20 rainfed plots (10 un-amended controls + 10 biochar-amended) of 9 m2 (3x3 m) each, after which the plots were sown with a legume-rich biodiverse seed mixture. Our results indicate that while biochar increased total aboveground biomass by 2–3 t/ha compared to control soils, as well as total grass and total legume biomass, it did not exhibit significant negative effects on abundance and biomass of local species. Biochar addition increased the biomass and abundance of grasses and legumes from the seedmixture, while decreasingthat of competing grass *Vulpia bromoides*, but not that of *Agrostis sp.* Aboveground biomass of local forbs was not significantly decreased by biochar application. This indicates that compared to other measures aiming to improve

productivity, biochar has the potential to preserve soil functions locally and increase grassland productivity,without compromising the local community composition. Ongoing work is focused on quantifying the relationships between soil temperature and moisture dynamics with the observed increases in grassland productivity, as well as the biochar-induced changes in soil chemical properties and nutritional properties of pasture species.

Keywords: Biochar, aboveground biomass, community composition and structure

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Impact of biochar amendment on the soil sponge function of a sandy loam Portuguese pasture soil

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Abstract

Increasingly drier springs result in decreased aboveground biomass for livestock, cork production and overall functional biodiversity loss. Climate change models indicate that pastoral land use in southern Iberia will no longer be feasible from 2050 due to rainfall decreases and desertification, thereby negatively affecting soil functioning, food security and rural livelihoods. Amending agricultural soils with biochar (carbon-based product of biomass pyrolysis) has been shown to increase crop yield, mainly by improving soil pH, soil structure, water storage and exchange. Such potential benefits to overall pastoral ecosystem health remain unexplored. The collaborative work between ongoing projects SOILCOMBAT, POLLINATEand TRUESOIL, aims tosustainably engineer the soil-water regulation function of Portuguese pasture soils, while minimizing detrimental effects on other soil quality parameters, including soil organic matter, erosionand soil-biota dynamics, through the use of biochar for soil amendment. Our approach combines three scales: i)laboratory for sustainable optimization screening, ii) lysimeter for determining the involved processes and mechanisms and iii)on-going field-trials in a real-world scenarioat the Quinta da França farm (Portugal). There, in the pasture land soils described as aEutric cambisol, the experimental set-up is composed by four treatments:control natural rainfall; control 50% rain exclusion;biochar (4% gravimetric) natural rainfall; biochar (4% gravimetric) 50% rain exclusion; N=20). Treatments were appliedat 0-20 cm depth and five times replicated. Plotswere equipped with green-house-gas chambers (N=24), soil microclimate sensors (N=20), together with soil climate sensors (volumetric moisture and temperature) recording at six depths (N=120). The on-going field trial at Quinta da França (experimental farm of Terraprima) based on soil moisture sensors(0-20 cm depth) for one year, showed that with 50% rainfall exclusion, the biochar plots kept 15% more moisture than the control ones, while for natural rainfall conditions, biochar plots kept 23% more moisture. Seasonal effects and deeper soil water storage (20-60 cm depth) will be explored next. At laboratory and lysimeters scales, results showed that the optimal biochar application concentration was 4% (gravimetric), while runoff and erosion were reduced by 19% and 63%, respectively, promising the use of biochar-amended soils as a useful tool to engineer soil-water relationships in pasture

lands. We conclude that biochar amendments improve the soil-water regulation functions of this pasture. The results are expected to contribute to the UN Sustainable Development Goals (SDG) #13 and #15, namely sustainable food production and climate adaptation of pastoral ecosystems, while combating desertification.

Keywords: Biochar amendment, soil-water function, pasture lands

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Assessment of the Effect of No-Tillage and Weed Cover on Soil Erosion in a Rainfed Olive Plantations in Sierra de Enguera, Spain

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Abstract

Soil and water losses resulted from conventional citrus plantations are often considered non-sustainable due to the high rates of soil degradation. To achieve sustainability and land degradation neutrality in citrus production new strategies should be developed to avoid non-sustainable soil and water losses. The use of chipped pruned branches as a mulch is evaluate here as an alternative option to the traditional burning. We selected two paired plots under Glyphosate treatment for 30 years, with bare soils (no weeds or catch crops), in the control plot the branches were burnt (CON), meanwhile on the chipped pruned branches plot were chopped as a mulch (BRA). The pruning was done on March 15th 2022, collected and chopped in a nearby field. After July 21st a set of 25 paired plots (50 plots) were stablished in the field with plots covered with chopped pruned branches (CON) and bare (CON). The amount of mulch applied, and his moisture characteristics were measured. We used a rainfall simulator at 55 mm h^{-1} rainfall intensity during one hour on a 0.25 m^2 plots to properly determine time to ponding, time to runoff, runoff and sediment discharge. The results show that the soils of the Control (CON) and chipped pruned branches mulch covered ones (BRA) are similar in grain size, organic matter and bulk density. However, the cover increased in the BRA ones due to the mulch created by the chopped branches. The soil water content was also higher in the BRA (7.55 %) than in the CON (3,8 %) plots. The ponding, runoff initiation and runoff outlet was faster in the CON plots (59 min; 106 min; 183 min) than on the BRA plots (94 min; 202 min; 418 min), respectively. Runoff discharge also found large differences: 82% versus 54 % for the CON and Bra plots, in average. Runoff concentration was 9.4 and 5.2 g l^{-1}, Sediment delivery 105 and 39 g, and soil erosion 4.22 and 1.55 Mg ha^{-1} h^{-1}, respectively for CON and BRA plots. The use of chipped pruned branches as a mulch caused a sudden decrease in runoff and soil losses, increase the soil moisture, and reduced the soil erodibility due to the cover of the litter. The immediate effect in soil and water losses reduction was due to the mulch effect. The soil characteristics remained

without changes.

Keywords: soil erosion, rainfall simulation, weeds, runoff, soil, water, plants, cover

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The potential of straw mulch as a nature-based solution in olive groves. A biophysical and socio-economic assessment

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Abstract

Olive groves are characterised by intense herbicide use to avoid weeds in the fields. Bare soils result in high and non-sustainable soil and water losses, and in the end in soil degradation. There is a need to find proper management strategies to reach sustainability; and Nature-Base Solutions (NBSs) are the most appropriate options. The use of straw as a mulch can be a good option to reduce soil losses, but there is no sufficient information about how to apply a mulch cover from a biophysical, economic and perception point of view to reach a sustainable situation. Fifty paired plots under simulated rainfall showed that the use of a cover of straw mulch of 50 % (1 Mg ha^{-1}) in olive plantations results in a delay in ponding (from 34 to 61 s) and runoff initiation (from 61 to 148 s), and a reduction in total runoff (from 50 to 38 %), sediment concentration (from 15.6 to 2.09 gr l^{-1}) and sediment yield (from 3 to 0.3 gr m^2 h^{-1}). On the other hand, an economic survey based on interviews show that the use of straw mulch in olive groves will cost 174.7 € ha^{-1}, from which 54.7 € ha^{-1} is needed for the application work, 52.3 € ha^{-1} for the purchase cost and 67.7 € ha^{-1} for the transport of 20 Kg bales that allow easy spreading and management by the farmers. The 43 interviewed farmers produce an average of 1,864 Kg ha^{-1} of olives, oil richness is 18.64 %, and the final average income is 777 € ha^{-1}. Therefore the cost of the straw is 22.5 % of the total income of the farmers. The farmer's perception was surveyed by means of interviews, and we found that their perception was negative about the use of the straw mulch, as the tradition in the fields is to avoid any weed or cover, except the crop. However, farmers would use straw mulch if they would be subsidized with a minimum of 267 € ha^{-1}, 92 € ha^{-1} more than the costs estimated on the basis of the surveys. We conclude that soil erosion can be controlled by the use of straw mulches, and that there is a need to subsidize this management due to

the extra cost for the farmers. However, the negative perception of the farmers about the use of straw can only be solved with information, training and tutoring. There is a need of an extension service to update, instruct and coach farmers in the use of sustainable management such as the use of straw mulch.

Keywords: Economy, perception, soil erosion, rainfall simulation, interviews, agricultural sustainability

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Assessment of soil management practices in Vineyards using Sentinel-2: Challenges in enhancing soil organic carbon content prediction

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Abstract

Vineyard management practices influence soil surface characteristics, which in turn affect the accuracy of models used to predict soil organic carbon (SOC) content via satellite remote sensing (Marques *et al.*, 2010; Ruiz-Colmenero *et al.*, 2013; Vaudour *et al.*, 2022). It is crucial to identify such viticultural management practices to further assess their impact on carbon storage in viticultural soils. This study evaluates the ability of Sentinel-2 data time series to detect soil surface conditions associated with two soil management practices, cover crop (CC) and tillage (Till), in Spanish vineyards. Two plots were studied: the first (Aranda_Burgos) in the north, located in Aranda de Duero, covering an area of about 82 ha, and the second (Toledo_Bergonza) in the centre, located in Toledo, covering an area of about 180 ha. Both vineyards are trellis-trained with an inter-row spacing around 3m. In order to consider soil surface condition aside from vine canopy vegetation, our methodology relies on a time series of Sentinel-2 data collected between January 2023 and February 2024. It involves using spectral indices (NDVI, IB, SI, NBR2, NSSI, RedI and Fe2) calculated from this time series within a 30-meter buffer around 60 points sampled on each plot in October 2023 and January 2024 and observed for their soil surface condition each. An analysis of the time series of these indices, as well as principal component analyses (PCA), were carried out to differentiate soil surface conditions according to CC or Till. Preliminary results show that the Toledo_Bergonza plot has greater variability in NDVI compared to the Aranda_Burgos plot, likely due to the diversity of agricultural practices. In addition, the Toledo_Bergonza plot shows a higher average NDVI, probably due to the specific characteristics of the vineyards for both CC and Till. The NSSI showed correlations with the percentage of coarse elements on the surface, and its PCA identified clusters of points that require further study. For the Aranda_Burgos plot, only the IB, NSSI and Fe2 indices identified clusters of points, while for the Toledo_Bergonza plot, all seven indices revealed distinct clusters. These

preliminary results highlight the significant variability in soil surface condition, raising additional challenges, in addition to the presence of grapevines, for the prediction of SOC content using satellite remote sensing.

Keywords: remote sensing, Sentinel-2, cover crop, tillage, soil

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Session AN3: Nature-based solutions for agriculture and natural areas (soil, water and landscape)

Session organisers

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Natural-based solutions for agriculture: Insights from the literature

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Abstract

Current times open up new opportunities for populations and socioeconomic activity, but they also bring new challenges and new concerns to which we need to find answers. Climate change, the increasing scarcity of some resources, the need for new ones and population growth (with the inherent demands) are an example of current transformations that require adequate and rapid responses. Natural-based solutions can make an important contribution in these contexts. Taking these motivations into account, we intend to highlight the main contributions of scientific literature to a better understanding of natural-based solutions for agriculture. To this end, systematic review and bibliometric analysis methodologies were followed, considering topics such as "natural based solutions" and "agriculture", for example. The results obtained show interesting examples of the adoption of these solutions for a more sustainable development of the agricultural sector worldwide and allow us to identify gaps that can be considered in future investigations. These results also allow us to identify relevant networking between the most productive authors and institutions on these topics that could be considered as a benchmark for future partnerships.

Keywords: Systematic review, bibliometric assessment, natural areas

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Defining Nature Positive Food System

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Wageningen Research

Abstract

The idea of a nature-positive food system is gaining attention. It is linked to the objective of becoming nature-positive, as a response to rapidly declining biodiversity, with a paradigm shift from reducing biodiversity loss towards enhancing biodiversity. Nature-positive thinking is especially relevant for food systems, which not only greatly benefit from biodiversity but are also a key driver of biodiversity loss, both close to where food is produced and consumed, and further away. Such links between nature and food systems have long been acknowledged, and with it the need for sustainable food production. At the least, this entails sustaining food production by protecting and sustainably using the natural resources on which it is based. A nature-positive approach goes beyond this protecting and sustaining, i.e. “doing no harm”, by signalling the urgency to increase biodiversity. However, while signalling a positive approach, the phrase “nature-positive food systems” leaves ample room for interpretation. This holds the risk of reporting good progress in cases where net positive effects on nature can actually be disputed. Therefore, we reviewed and searched how "nature-positive food systems" could be defined in such a way that is most beneficial for nature-positive transitions. To do so, we formulated a working definition based on literature and internal discussions: food systems that have nature at the heart of decision-making and that will lead to increased biodiversity and improved ecosystem functioning through collective understanding and action. This working definition reflects five building blocks that feature different elements in the term “nature-positive food systems” and existing definitions: “nature”, “positive”, “food systems”, “nature at the heart” and “collective understanding and action”. The working definition will contribute to creating a shared understanding what a nature positive transition is about in practice. We further help guide this transition by exploring perceptions of nature-positive food systems in case-studies in Kenya and India, and developing a set of indicators. These indicators are used in the communication with stakeholders and help to define the direction of nature-positive change.

Keywords: Nature positive, indicator, definition, food system, biodiversity

Acknowledgments: The study has been funded by Wagneingen Knowledge Based program Food Security and the Value of Water.

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nature-based solution choices: the role of vegetation and terracing in ecosystem restoration in fragile mountains of China

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Abstract

Vegetation and terracing are key nature-based measures for ecological restoration and water erosion control in the dryland mountainous regions. Due to the diversity of vegetation types and terrace structures and their spatiotemporal patterns, their coupling effects on eco-hydrological mechanisms need further studies. This project focuses on typical small watersheds in the Loess Plateau of China. Based on multi-point positioning observation, remote sensing image interpretation, model simulation combined with long-term system accumulation, historical data integration, and detailed investigation of the entire watershed, the ecological hydrological mechanism of vegetation restoration and slope-to-terrace engineering coupling was studied over time and space. The main findings are as follows. (1) At the basin scale, based on long-term positioning monitoring and simulation experiments, the eco-hydrological mechanism of slope alteration and ladder engineering and vegetation coupling was systematically quantified. Based on land use data and the SWAT model, it is found that land use change in the Zuli River Basin generally decreased the surface runoff and water yield in the basin, and climate change increased runoff while terrace change decreased runoff, and the contribution of terrace change was greater than that of climate change. The interaction between terrace factors and other factors improved the explanatory power of RSEI, indicating that terrace construction played a positive role in improving habitat quality. (2) At the regional scale, combined with the decision tree model of DEM and land use data on the Loess Plateau, the distribution pattern of long-term terraces on the Loess Plateau was simulated, and an effective method for simulating the distribution of large-scale terraces under multiple time series was established, which provided the possibility for quantifying the ecosystem services of large-scale terraces. The terraced fields in Gansu have increased significantly, with an average annual water saving of 7.60×10^{8} m^3 and an average annual soil conservation of 5.86×10^{7} t. After the implementation of the project of returning farmland to forest, the vegetation coverage rate has improved significantly, and the average annual growth rate of NDVI was 0.0086/a. The sensitivity of transpiration rate to the environment was different in different growth periods, and solar radiation, air temperature, and relative humidity were the main factors affecting vegetation transpiration in a short period. (3) At the national scale, the area of paddy terraces decreased by 40% from 2018 to 2020, and most of them were converted to dry farming terraces. The area of dryland terraces increased by 10%, and some of them were

converted to grasslands and woodlands. The ecosystem service function of terraced fields in China showed an increasing trend, and the spatial pattern showed a changing pattern of high in the south and low in the north, and decreasing from southeast to northwest. The trade-off between different ecosystem services was greater than the synergy, and the regional differences were significant. The results of this project can provide a scientific basis for optimizing vegetation configuration and the comprehensive layout of slope to ladder in the underlying surface of the watershed, curbing land degradation and promoting ecological restoration with nature-based solutions.

Keywords: ecosystem restoration, land degradation neutrality, nature-based measures, vegetation, terrace

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Assessing Cd and Zn accumulation in the rocket biomonitor Eruca vesicaria in inter- and rotational cropping with hyperaccumulator Noccaea caerulescens

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Abstract

Soil contamination with trace metals (TM) such as Zn or Cd is a serious impediment to the development of market and vegetable gardening, especially in (peri)urban areas. Remediation of contaminated soils by phytoextraction has mainly been studied to develop an environment-friendly alternative to classic remediation techniques like excavation. Some studies investigated the efficiency of phytoextraction to decrease TM bioavailable fractions (bioavailable contaminant stripping, Santa-Cruz et al. 2023). However, few studies aimed at testing how the decrease of bioavailable TM concentrations affects TM accumulation in edible crops. Previous results suggest a decrease in TM accumulation in crops grown during or after the phytoextraction process (Keller and Hammer 2004; Yang et al. 2011). In the present study, we used the model Zn/Cd/Ni hyperaccumulator *Noccaea caerulescens* to test the hypothesis that crops growing next to (i.e. intercropping), or after (i.e. rotational cropping) the hyperaccumulator will accumulate less TM. We chose the leafy vegetable *Eruca vesicaria*, or rocket, as a biomonitor to determine the worst-case scenario concentrations. We grew rockets in 2L pots filled with 4 naturally (i.e. non-spiked) TM-contaminated soils (total concentrations (mg/kg) of Cd: 1.7-7.1 and Zn: 440-2700). In each soil, 4 treatments were compared: rotational cropping (i.e. after *N. caerulescens*), rotational control (i.e. no previous culture), intercropping (i.e. rocket grown with *N. caerulescens*), and intercropping control (i.e. 2 rockets). Foliar concentrations of rockets are measured and compared across treatments to determine whether rockets growing after or next to the hyperaccumulator accumulate less Cd or Zn compared to controls. This would allow us to assess the efficiency of phytoextraction by *N. caerulescens* to minimize Cd and Zn accumulation in crops and to identify which of the two cropping systems is more efficient.

Keywords: trace metals, crops, phytoextraction, soil remediaiton

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Isotope based investigation of Agricultural impact on quality and quantity of groundwater in the north-western Ganga plain, India

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Abstract

Groundwater, crucial for the water cycle, serves as the primary reservoir of unfrozen freshwater. Continuous extraction has led to irreversible depletion, causing notable consequences. The extensive removal of groundwater has even impacted the Earth's rotational pole, contributing to global sea level rise and disrupting regional energy balances. This extraction has also affected soil quality and altered the dynamics between surface and subsurface water. The Hindon River basin, historically significant for hosting the Indus Valley civilization and located in the north-western region of India's Ganga plain, now faces adverse effects from human activities. In addition to the industrial activities, a single crop in the form of sugarcane is extensively cultivated which is a water intensive crop. Over recent decades, groundwater levels in this basin have dropped by over a meter, while the concentration of dissolved nitrate, an indicator of pollution, has surpassed safe thresholds. This pollution has resulted in severe health issues, including cancer and liver disorders. Understanding human-induced changes especially from the agricultural activities in the water cycle is crucial. It involves identifying pollutant sources and the processes responsible for redistributing water among different components of the regional hydrological cycle. To investigate these issues, our study utilizes chemical tracers such as stable water isotopes ($\delta D\text{-}H_2O$, $\delta^{18}O\text{-}H_2O$), dissolved nitrate isotopes ($\delta^{15}N\text{-}NO_3$, $\delta^{18}O\text{-}NO_3$), and ionic chemistry [NO_3-]. Initial findings suggest that the ammonium based fertilizer urea is the major sources of nitrate. We suggest that altering existing cropping patterns could enhance water quality and quantity in the water reserve both in surface and subsurface.

Keywords: Water intensive crop, dual isotopes in nitrate, Ammonium fertilizer

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Exploring perceptions of sustainability and its indicators in grape and wine production in South Africa

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Abstract

Climate change plays a critical role in the sustainability of wine producers. The definition of sustainability has been difficult due to the challenges in identifying the key drivers of the concept due to its subjectivity. In the South African table grape and wine industries, the quandary regarding sustainability is even more urgent given the importance of both industries to the economy and the importance of the need to be sustainable. However, research on what sustainability means to both industries, and what and how to measure it is limited and mostly one-dimensional, either from an economic, environmental, or social dimension. This study had a multi-dimensional approach and addressed what sustainability means, and what and how to measure its indicators. The latter was achieved through a qualitative online questionnaire and a Delphi technique with 19 diverse stakeholders of the table grape and wine industries in South Africa. The results showed that different stakeholders interpreted sustainability meaning subjectively and the environmental dimension dominated most perceptions of sustainability. Respondents noted the near-constant trade-offs between the three pillars but deemed the environmental as the most important but the social as the most difficult to achieve. Furthermore, grape/wine demand and prices, brand value and production/quality consistency were deemed relevant for economic sustainability, soil health, chemical/water use efficiency for environmental sustainability and living wage, safe work environment and children's welfare for social sustainability. Our study highlighted the difficulty with balancing the three pillars of sustainability which contributes to the Gross Domestic Product.

Keywords: sustainability, pillars, dimension, Delphi, wine grape, South Africa

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Understanding the role of on-farm agrobiodiversity conservation for agroecological transformation in southeastern Ontario

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Abstract

The state of the industrial food system is at a critical juncture. Alongside other issues is the concern of loss of agricultural biodiversity that is contributing to global diet homogenization and the replacement of nutrient-rich traditional foods with calorie-rich staple food crops. The response to the loss of agricultural biodiversity has been by conserving crop genetic resources in gene banks. However, gene banking comes with its own set of challenges, the foremost of which is the severing of the intricate link between biology and culture. As such, researchers have recommended that gene banking be carried out simultaneously with the continued cultivation of agrobiodiversity in agroecological systems where they will continue to evolve, a concept called on-farm conservation through seed saving. In recent years there has been an emerging body of literature promoting on-farm conservation of agrobiodiversity in various ways, mostly by showing the potential of agrobiodiversity from agronomic, environmental, nutritional, economic, cultural, and health aspects. In Canada, researchers have documented the persistence and importance of traditional crops in Indigenous and the seed-saving practices of farmers and gardeners conserving agrobiodiversity in agroecological systems. However, in Canada and many other parts of the global North, on-farm conservation remains restricted by an adversarial policy environment, including global trade agreements and national laws that curtail producers' abilities to save seeds of agrobiodiversity. This research will examine the role of on-farm conservation of agrobiodiversity in transformations towards agroecological systems, focusing on the region of Southeastern Ontario. More specifically, my research will broaden the scope of previous research on seed saving and traditional crops by taking a multi-level perspective (MLP) of domains of transformation that considers the interactions between the broader policy environment and the ground-level efforts of producers trying to conserve agrobiodiversity on-farm. Furthermore, this framework will be used to identify and examine enabling and disabling conditions for on-farm conservation. This research will primarily ask how on-farm conservation is understood among producers in Southeastern Ontario and what role can on-farm conservation play in transformations towards agroecological systems. This research will be conducted using photovoice with producers to examine the ground-level practices of producers using agroecological practices to conserve agrobiodiversity on-farm in Southeastern, Ontario. This will be accompanied by semi-structured interviews with civil society organizations and government officials

across Ontario and Canada to examine the provincial and national policy environment towards on-farm conservation.

Keywords: agrobiodiversity, seed saving, conservation, agroecology, food systems

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Legume-rich grasslands enhance the quality of forage and other ecosystem services in agroecosystems

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Abstract

Grasslands are an important component of the food supply chain, providing forage for livestock, promoting biodiversity, contributing to soil health, offering other ecosystem services and climate-related benefits. In especially, grasslands containing forage legumes enhance these benefits by providing nitrogen, and replacing of mineral N fertilizer use. Many of the environmental and ecological benefits provided by grasslands arise from the interactions between the plant species and the soil in relation with other environmental conditions. The experiment was carried out with single-species and multi-species swards with three, four, six, and eight plant species in the mixtures, including four grasses and four legumes, with annual fertilization rates of N150 and N0 kg ha^{-1}. Our experiment demonstrated that legume grasses improved the quality indicators of forage and contribute to maintaining a more stable overall forage yield over seasons. This short-term study showed that after three years of using perennial grasses in the grasslands, the amount of organic carbon in the soil did not change significantly compared to the beginning of the experiment. Further research is needed on SOC in different soil management systems with different plant species, especially perennials, which may increase nutrient availability. As the climate continues to become warmer, there is a growing need to study a wide range of plant species and different varieties suitable for local growing conditions.

Keywords: grasses, nitrogen, soil organic carbon, forage yield

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NOVATERRA Project: multidisciplinary and international consortium to enhance sustainable production in vineyard and olive groves

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Abstract

The NOVATERRA project is an international and interdisciplinary project in which the UBU participates, along with 20 other partners from 6 countries. The aim of this Project is to establish different strategies towards more sustainable viticulture and promoting vineyard management following environmental criteria. We studied the efficacy of different ground cover management practice, introducing different cover crops and floral margins such as vineyards as olive groves, during the 2022 and 2023 campaigns. The cover treatments were: Floral Green Cover (FGC), Seeded Green Cover (SGC), Natural (spontaneous) Green Cover (NGC) and also with traditional tillage keeping the soil bare, named Control assay (CT). The vineyard case studies were performed by University of Burgos (UBU) and Terras Gauda (TG) in the D.O. "Ribera del Duero," located at Aster Winery, Burgos, Spain and in TG winery placed in D.O. "Rias Baixas", O Rosal, Spain, respectively. The olive grove case studies were carried out by Instituto Politécnico de Bragança (IPB), in Mirandela, Portugal. In both Mediterranean crops, we studied quality and productive parameters and we also analysed the biodiversity in this cover crops. The abundance and richness of plant species were recorded. Pitfall traps for arthropods sampling were placed in order to identify the main natural enemies. In Spain, in both assayed campaigns, the production did not decrease in those trials with cover crops. The highest floral abundance and richness were found in NGC and FGC treatments. We also found the highest arthropods biodiversity in cover treatments, identifying higher number of natural enemies species from the most representative families of insects and spiders. In relation to 2023 IPB (Portugal) results, infestation of *Prays oleae* during the anthophagous generation was very low. However, during the carpophagous generation in

the Natural vegetation treatment, infestation by *P. oleae*reached 30% of fruits. From our results, the beneficial effects of incorporating cover crops and floral margins could be observed. In particular, the increase of floral and arthropods biodiversity could contribute to introduce new soil management practices regarding to sustainable pest control in vineyard and olive groves.

Keywords: vineyards, olives, cover crops

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Invest soil health for China’s regenerative future: a pathway to sustaining food security for future generations

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Abstract

40% of soils in China are severely degraded due to inappropriate agricultural practices, such as conventional tillage and overuse of fertiliser (Yu et al., 2023). On the basis of soil health promoted by ‘regenerative agriculture’ (RG), The Nature Conservancy (TNC) China has been actively engaging in promoting RG-based practices among major stakeholders, such as farmers, governmental units, academic researcher and industrial collaborators in grain production in China since 2019, aiming to restore degraded soils and improve the soil health from agricultural lands. The RG work by TNC China program incorporates:
1. Identify regional soil-related issues, production challenges and corresponding solutions. For instance, soil erosion due to wind is a major source of air pollution in North China and the production costs are the primary challenge to local farmers; In double-cropping regions in middle of China intensive soil management has caused soil compaction, loss of fertility and shrinking habitat for insects and birds; overuse of fertiliser has become a major source of non-point pollution around Yangtze River Basin. To tackle the aforementioned issues, a series of solutions have been identified, including conservation tillage, cover crops, crop rotation, and efficient nutrient usage.
2. Introducing context-specific knowledge and techniques of soil health solutions to local communities. TNC empowers farmers to protect and improve their land and collaborates with private sectors to facilitate the knowledge sharing and implementation of practices. Among these solutions, conservation tillage stands out as a ready, low-cost but valuable option to bolster climate mitigation and adaptation efforts, boost food production, and enhance financial outcomes for farmers. Conservation tillage, or reduced tillage, allows crop residue to remain on the ground instead of being thrown away or incorporated into the soil.
3. Establish a comprehensive framework for on-farm monitoring soil health in collaboration with domestic and international research institutes. This tool enables end-users understanding the performance of the soil and identifying soil-related issues.
TNC's ambitious aspiration is to bring the benefits of conservation tillage to one of China's key breadbaskets—the Yellow River basin. As the primary producer of 80% of China's domestic wheat, the basin's wheat planting area spans approximately 25 million hectares, accounting for 75% of the nation's total wheat planting area and 36% of its cultivated farmland. With this comprehensive approach to soil health, TNC and its partners strive to safeguard China's food security while nurturing the environment,

fostering a sustainable and prosperous future for the nation. Breaking away from relying on intensive tilling practices that are environmentally disruptive requires a concerted effort in education, demonstrations, and research. Building trust, generating evidence, and encouraging widespread adoption among farmers are key components to drive this transformation. TNC builds a proven track record that conservation tillage is appropriate in the North China Plain, which is situated in the lower reaches of the Yellow River Basin.

Keywords: Soil Health, Regenerative Agriculture, Conservation Tillage, North China Plain, Yellow River Basin

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On the use of climate indicators for strategic planning of natural solutions in French vineyards, the case of St Emilion

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Abstract

Climate change is one of the major environmental and socio-economic challenges facing sustainable wine production. Saint Emilion, a world-renowned wine growing region is witnessing first-hand a series of weather events related to frost waves, hailstorms, rising temperature and shift in rainfall patterns. Accordingly, through the European Commission funded AgriDataValue project, the implementation of natural solutions, based on fine scale modeling of climatic variables is being sought. Saint Emilion has been chosen as the study area given the presence of existing on-field solutions adopted by winegrowers and supported by the Saint-Emilion wine council to mitigate climate change effect such as improving soil health and fertility using grass strips and enhancing landscape feature and hedges planting. A salt dispersing balloons system was also adopted to fight against hailstorms. In addition, Saint-Emilion has a large network of weather stations and data that are key for understanding better climatic events and for modelling the efficiency of active and passive solutions. However, given the costly nature of the latter, strategic risk-based planning is needed. For this purpose, the MeteoFrance DRIAS and outputs of the CMIP6 model are used. Data is obtained in NetCDF format, then rasterized for subsequent downscaling. By transposing NetCDFs to raster and then points, the gridded rasters become a virtual weather station network, and hence can be considered as a mesh of “spatial weather stations”. Through specific Bayesian kriging techniques using semi-variograms, the initial 100 km grid is downscaled to 1 km. Following the establishment of the climate indicators, exposure is determined. This framework embodies the first elements of the IPCC risk analysis framework (IPCC, 2014; 2020). As the studied climatic risks will show different spatial-temporal gradients, different grape types and plantations will be affected at different degrees, hence the GIS-based exposure analysis based on their setting with respect to the risk at different horizons. At this resolution, the evolution of the studied risks can be tracked at a fine scale and at different time horizons and climatic scenarios, namely SSP2-4.5 and SSP5-8.5. Accordingly, with this long-term planning aspect and its climate-informed nature, a strategic planning of solutions in areas of different risk levels can be made following a prioritized approach, thus ensuring both short-term and long-term efficiency.

Keywords: AgriDataValue, climate change, active and passive solutions, vineyards

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Spatial distribution of soil bacterial communities in mediterranean grazing areas

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Abstract

Despite the natural value importance of mediterranean agroforestry systems and the knowledge of soil biological properties to assess the impact of land uses, the spatial distribution of soil bacterial communities has received a limit attention. This study assesses the spatial distribution of bacterial communities in the main grazing areas of Southwest (SW) Spain, seeking relationships between land management, soil properties, and environmental variables. To do that, five farms with different management that respond an increasing gradient of grazing were selected: occasional grazing (OG), holistic management (HM), organic farming (OF), conventional rangeland (CR) and conventional grassland (CG). Also, the main three topographical positions were considered: the hilltop, middle slope and valley bottoms. 71 soil samples were collected, and bacterial communities were analysed through DNA metabarcoding of the 16S rRNA gene. Environmental covariates, including topographic and vegetation indices, were used in a Random Forest (RF) model for spatial modelling. The results indicated that diversity was significantly higher under holistic management compared to conventional management. Actinobacteriota and Proteobacteria emerged as the dominant phyla in all cases studied. Proteobacteria were more abundant in depressed areas with low grazing intensity, whereas Actinobacteria were more prevalent in compacted areas with clayey soil texture. RF demonstrated higher mapping accuracy for Proteobacteria than for Actinobacteriota. Vegetation indexes were more important for mapping Proteobacteria, while topographic indexes were more significant for defining Actinobacteriota. This study provides new insights into bacterial communities in the main grazed areas of Southwest Spain, highlighting the complex influence of management practices, soil properties, and environmental covariates.

Keywords: Agroforestry systems, land management, livestock grazing, dehesas, soil properties

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Do we underestimate the efficacy of spontaneous woody vegetation in urban settings?

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Abstract

The success rate of newly planted trees in the city of Nitra in the last decades is decreasing due extreme heatwaves, new insect pests and fungal diseases. The aim of this study was to evaluate the growth rates of spontanious woody vegetation in Nitra. Our hypothesis is that spontaneous seedlings could outcompete planted standard sized (girth 12/14 cm) urban trees. In 2023 we monitored 20 selected plots where spontaneous woody vegetation occured and could grow for at leats 6 years without human interference. During the inventarisation we found 11 species (*Acer platanoides, A. pseudoplatanus, Cerasus avium, Negundo aceroides, Taxus baccata, Celtis occidenthalis, Fraxinus excelsior, Ailanthus altissima, Robinia pseudoacacia, Populus nigra* and *Populus* x *canadensis*). We determined the age by felling the saplings and counting the year rings. We found the best growth rates in *Ailanthus altissima, Negundo aceroides, Populus nigra and x canadensis* and *Acer platanioides* where the average height after 6 years was 4,5-5,6 m and the average girth 7,2-14,3 cm. We found in average 2,6 pecimens of spontaneous seedlingss in $1m^2$ of monitored plot. The total monitored area was 356 m^2 where we found 949 specimens of spontaneous seedlings. Our findings suggest that spontaneous woody vegetation can be with little management converted to high value urban trees. Under little managenment we understand structural prunning and protection of selected spontaneous seedlings. The cons of spontaneous woody vegetation is the relatively high percentage of invasive species such as *Ailanthus altissima, Negundo aceroides* and *Robinia pseudoacacia*. The occurence of spontaneous vegetation is strongly influenced by the presence of mother trees except tree species with anemochorous seed and seeds which are efficiently spread by birds (*Cerasus avium* and *Taxus baccata* in this case). This topic needs further investigation since it is very site specific.

Keywords: invasive species, growth rate, arboriculture, urban forestry, insect pest damage

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Session NH1: Nature based solution for increasing resilience to water-related hazards

Session organisers

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Assessing the impact of hybrid measures on water retention and soil erosion using environmental modeling tools

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Abstract

Climate and environmental change affect the frequency, magnitude and seasonality of various natural rainfall induced hazards such as floods, landslides, debris flows and soil erosion processes (IPCC, 2019). It follows from the recent studies that water-induced soil erosion risk is expected to increase in most of Europe (Borelli et al., 2020). More specifically, rainfall erosivity that is among the main drivers of soil erosion due to water, has increased in Europe in the past decades (Bezak et al., 2020). In order to deal with changed occurrence and characteristics of natural hazards, different types of measures will have to be implemented including green, blue and grey measures (Kabisch et al., 2017). Although their application is currently emphasized, purely green measures can often not be sufficient to cope with predicted future climate hazards (Johnen et al., 2020; Bezak et al., 2021). Therefore, hybrid solutions that combine elements of green and grey infrastructure seem to be an attractive option for climate change adaptation (Nakamura, 2022). Implementation of hybrid solutions addresses multiple UN sustainable development goals (SDGs) such as good health and well-being (SDG 3), clean water and sanitation (SDG 6), sustainable cities and communities (SDG 11), climate action (SDG 13) and life on land (SDG 15) (UN, 2020). The main aim of this study is to evaluate the effectiveness of selected types of measures to reduce the risk of soil erosion and improve the water retention potential of the landscape, using environmental modeling tools. Since Central and Southern Europe is characterized by a positive trend in rainfall erosivity, two experimental watersheds in Czechia and Slovenia were selected to define the most effective and suitable water retention measures under current conditions. The exact location and spatial extent of the individual measures being implemented into the modeled watersheds are based directly on the suggestions of local stakeholders (especially mayors of municipalities), who pointed out problematic sites in terms of various precipitation-related hazards and in some cases, they also proposed potential solutions themselves. The measures thus identified were schematized as one of the inputs

to the soil erosion/accumulation models LOREP (Pechanec et al., 2020) and InVEST® (Natural Capital Project, 2024), whereby different scenarios of land-use development are simulated considering the expected climate change impacts for the near future. This enables a comparison of the projected scenarios, in which individual groups of measures (green–grey–hybrid) will be emphasized, while the findings achieved can contribute to the efficiency of planning, considering climate change and social acceptability perspective.

Keywords: landscape planning, stakeholder's perception, compound event, rainfall-driven hazard

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"I remember it was a heavily rainy day, when the two rivers merged": environmental histories of water, rural land and the anthropization of the Po Valley.

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Abstract

Water has shaped the rural landscape of Pavia since its earliest settlements, becoming a core element of the region's cultural and agricultural heritage. In Lomellina, rice cultivation was facilitated by fertile soils and innovative irrigation systems. Water, rice fields, mulberry trees along dug canals and distant farms, places of multispecies coexistence, became ground figures of this landscape. In common perception, water enabled this rural landscape to rise and thrive, and it is associated with collective environmental histories and personal experiences. A collaborative map created with Pavia citizens in 2023, as part of the Nodes research project, visually translated memories of the Ticino River into signs, annotations, sketches. These ranged from women’s labour in rice fields to the adaptation of irrigation techniques; from bathing in the 1960s and 1970s, which ceased in the 1980s due to fears of pollutants from Switzerland, to more recent floods, including a significant one in the 1990s that caused the confluence of two rivers, forming a "lake" that inundated fields, roads, and vegetation . This paper outlines a picture of the Po Valley through its inhabitants’ narratives and discusses how these memories of a wetland are changing amidst the climate crisis. In recent years, the region has faced significant environmental challenges: droughts have severely impacted water levels in the Po and Ticino rivers, reducing water availability for irrigation and threatening rice production. This has had economic repercussions for thousands of rice farms and has forced farmers to rationalise water use and adopt dry rice planting. However, this technique has impoverished the biodiversity that traditionally characterised this rural landscape. The paper discusses a dual narrative: on one hand, citizens' perceptions and nostalgic narratives outline a landscape that no longer exists, although its ground figures are still identified. On the other hand, the need to adapt to resource scarcity and mitigate the effects of extreme weather is driving the development of new agricultural approaches. These changes are leading to the rise of an automated and digitalised landscape, where the balance between anthropized and natural elements is not always guaranteed.

Keywords: Rural land, wetland, environmental histories, automated landscape

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Introducing indices to assess the effects of in-stream large wood on water and sediment connectivity in small streams

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Abstract

Large wood (LW) can have significant effects on channel hydraulics by creating hydraulic resistance that decreases reach-average flow velocity and transport capacity, further influencing water and sediment connectivity. Although some case studies have already explicitly dealt with LW considering its effects on connectivity, a conceptualization as well as standardized methods or protocols to assess their effects on water and sediment connectivity in river systems are still missing. Especially in river management, often simple and fast screening approaches are needed to get a system-wide overview on location, type and the potential effects of LW depositions. Here we introduce a simple LW in-stream dis-connectivity index as well as a LW sediment retention potential index for streams narrower than log length calculated based on visually estimated field-derived parameters. Both indices have been applied in two mixed-load streams in an Austrian national park. The newly developed indices have shown to provide a simple means to quantify and compare the effects of LW on water and sediment connectivity and sediment retention potential between different river systems. Moreover, it has been demonstrated that information derived from the indices as well as on type and location is valuable for place-based river management, e.g. related to river sediment, habitat and flood control. Additionally, aspects of using LW as nature based solution to maintain and/or restore river integrity will be discussed.

Keywords: Log jams, river management, sediment storage, sediment yield, nature based solutions

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Low-cost Hydrological Monitoring System For Managing Nature-based Solution (NbS) Related to Slope Instabilities

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Abstract

Shallow landslides induced by heavy rainfall are a worldwide widespread phenomena and their related hazard is expected to increase due to climate change (EEA Report No 15/2017). Soil water content (SWC) is a key indicator for identifying areas prone to potential shallow landslides: high soil saturation reduces cohesion and friction between soil particles, increasing the risk of mass movements.Nature-based Solutions (NbS) offer innovative and sustainable approaches for mitigating these water-related slope instabilities in agroecosystems. Reforestation and vegetation planting increase the soil cohesion and reduce the SWC, through roots water uptake and evapotranspiration processes.Consequently, SWC result closely interlinked to NbS mitigation measures. Data collected from SWC monitoring can indeed guide the planning and implementation of NbS and continuous monitoring information can allow for real-time adaptation or improvements of NbS. Moreover, by comparing soil moisture data before and after the implementation of NbS, the effectiveness of the mitigation measures on slope stability can be quantitatively assessed. The results of a two-year long soil moisture monitoring study using different sensors are here presented. This work aims to compare seven low-cost sensors selected by IMAGEO Srl company together with HORTUS Srl. The sensors have been engineered with a datalogging system and an automatic in-cloud data transmission and, have been located (June 2022) at 2 different depths (-0.6/-1.2 m) at the test-site of Montuè (Italian Northern Apennines), an abandoned vineyard where an Hydrometeorological Monitoring Station (Andromeda Project) is operating since 2012 with high-cost TDR probes placed at the same depths. The comparison between the hydrological data acquired by different sensors allows the quality and reliability evaluation of the low-cost sensors in the perspective of NbS implementation, against hydrometeorological hazards such as rainfall-induced shallow landslides.This conference abstract is part of the project NODES which has received funding from the MUR – M4C2 1.5 of PNRR funded by the European Union - NextGenerationEU (Grant agreement no. ECS00000036).

Keywords: Nature-based Solution, soil water content monitoring, rainfall-induced shallow

landslides

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Sustainable vineyards strategies enhancing groundcover and soil management for improving biodiversity, maintaining vine quality and the agroecosystem health

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Abstract

The wine sector, like many primary agro-industry sectors, is undergoing a significant transformation due to the interconnected processes of automation and digitization throughout the supply chain. Additionally, ongoing climate change is causing substantial impacts on agricultural areas, particularly in the sloping terrains of hilly and mountainous zones. Viticulture, a typical Mediterranean practice, is beginning to experience notable negative effects (Novara et al 2011). Vineyards in Mediterranean Europe have one of the highest soil degradation rates, mainly due to intensive tillage management (Fiera et al 2020). Therefore, practices that enhance soil health are crucial for promoting sustainable wine production (Rodrigo-Comino et al 2018). Innovative and sustainable field practices for vineyard management can: i) Preserve soil water to reduce the negative effects of prolonged water stress during periods of water scarcity and high temperatures (heat waves). ii) Increase the root reinforcement provided by grapevines to reduce shallow slope instabilities, influenced by grapevine root density, vegetational cover, and vineyard management. Sustainable management of natural biodiversity in vineyards is pivotal for the future of viticulture (Warren-Raffa et al 2021). This study aims to maintain and increase the groundcover vegetational component in vineyards, often characterized by non-productive inter-rows that could host diverse plant communities. Typically, mulching, tillage, or herbicides are used to mitigate competition between vines and inter-row vegetation. However, understanding the relationship between vineyard-plant communities and environmental conditions can help predict community and ecosystem processes, which are crucial for preserving ecosystem services like soil erosion mitigation and soil water conservation. This study tests innovative groundcover management strategies in vineyards to help them cope with unfavourable environmental conditions (e.g., temperature and water stress) that affect production both quantitatively (yields) and qualitatively (fruit quality traits). It evaluates the potential for restoring balanced fruit maturation, modifying soil biodiversity, and mitigating the abiotic stress driven by the erratic effects of climate change. Temporal monitoring of soil quality in vineyards with different management types will involve assessing and quantifying biodiversity, considering both plants and insects. In vineyards, restoring ground covers with herbaceous plants has increasingly been considered to mitigate progressive soil

erosion and the loss of organic matter due to intensive agricultural practices (e.g., tillage and herbicide use). While grasses provide root structure and surface cover to protect soil from erosion and drought, cover crops promote nitrogen fixation (Tarricone et al 2020) and additional functions such as interactions with pollinators, beneficial insects, and other wildlife. In this context, we are testing different commercial cover crop mixtures compared to spontaneous groundcover in Oltrepò Pavese, Italy. Experimental trials are also evaluating the use of different machines to determine the best groundcover management methods (e.g., inter-row rolling and sub-row mulching machines). Groundcover management under vine trees and in vineyard inter-rows is crucial for supporting nature-based restoration practices. The agronomic importance of vineyards, combined with their local heritage, represents a great opportunity to investigate the efficiency of wild plants and cover crops in improving overall agrobiodiversity.

Keywords: Groundcover, Mulching, Soil management, Biodiversity, Vineyard

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Analisys of the proneness to soil erosion and shallow landslides in Oltrepo Pavese(Northern Italy) using RUSLE and infinite slope stability models

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Abstract

In recent decades, climate change has increased hydric stress and slope instability in cropfields and agricultural land. Thus, the aim of this research is to identify the most suitable management practices for water retention in vineyard as well as the less prone to soil erosion and shallow landslides. This study is part of the UNDER-VINE project and the areas of study are located in Oltrepò Pavese, a region of the northern appennines in Northern Italy traditionally vocated to sloping viticulture.In order to identify the proneness of the soils with different management practices (grass cover, legume-based mixture, cereal-based mixture, between and under-the-row mulching) to soil erosion, the RUSLE method has been applie, both for yearly period of time and for single rainfall events.For the rusle model, C-factor has been identified from literature data, while K-factor, R-factor-ls factor have been calculated with the data of temperature and precipitation collected over a period of 3 years, and in-situ data for soil properties (grain size, permeability, volumetric carateristics, organic matter content) acquired during different seasons.The proneness of the soils to shallow landslides has been analized with the calculation of the safety factor through a probabilistic model based on infinite slope stability analysis, with the use of a R script and QGIS. The expected results are a decrease of slope instability and a better water retention with different management practices instead of the bare soil.

Keywords: Soil erosion, RUSLE, landslides

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Nature-based Solutions for shallow landslide mitigation in vineyards: the example of Oltrepò Pavese (Northern Italy)

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Abstract

Land degradation, e.g. shallow landslides, along with correlated soil loss and nutrient loss, is a significant environmental problem for the agroecosystems, especially where farming is carried out on sloping soil (e.g. vineyards, olive groves, etc.). Climate change and extreme weather events exacerbate this issue, leading to potential land abandonment. Also the uncontrolled soil tillage by machinery accelerates these processes. Land degradation is also dangerous for rural communities due to its rapid initiation and development, and the lack of warning signs for detection. It is necessary apply effective solutions in agroecosystems for disaster risk reduction (DRR) which, at the same time, are of low environmental impact and economically sustainable. Nature-based Solutions (NbS), widely recognized by the scientific community and often funded by entities like the EU and UN, can address these challenges. However, these are seldom used by farmers and local governments, who prefer grey infrastructure measures that are often ineffective in achieving land degradation neutrality. The aim of this work is to produce an inventory of the Nature-based Solutions applied in vineyards in an Apennine area of Northern Italy (such as management techniques or grassing) in order to verify, at the slope scale, by means of numerical models, their effectiveness in the mitigation of shallow landslides. The study focuses on a sector of Oltrepò Pavese, one of the most important agricultural and viticultural regions in Italy, where, over the past 15 years, intense rainfall triggered more than 2000 shallow landslides, affecting over 40% of grapevine-cultivated land. The work is carried out as part of a PNRR-funded PhD project, in partnership with seven municipalities, focuses on identifying the most effective NbS for the area, considering technical and economic viability. The results of the scientific research will be incorporated within the municipal planning tools and rural police regulation in order to prevent shallow landslides.

Keywords: Nature based Solutions, Shallow Landslide, Land degradation, Vineyards

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Ensuring Food and Fiber Security Begins with Accounting for Soil Water Repellency in Agroecosystems

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Abstract

Yield and quality of food and fiber crops are expected to decline as higher temperatures and more frequent and intense droughts are expected as the climate changes. Climate change impact models are primarily account for known direct effects of heat and drought as plant stressors. These models overlook the indirect effects of rising temperatures and droughts on the plant-water-soil continuum, which can be positively and negatively impacted by on-farm management strategies. This study explores previous research to understand how a changing climate and on-farm conventional and soil health management strategies will likely impact the occurrence and intensity of soil water repellency (SWR), and subsequently result in lower crop quality and yields. A shift from occurrence and intensity of SWR to fingerprinting hydrophobic organic compounds in crop residues is needed. Various stakeholders, including teachers, long-range planners, scientists, conservationists, farmers, and producers will benefit from an explanation of SWR, highlight the importance of incorporating SWR as well as the type of SWR information needed for more robust climate change impact on crops yield models, and how farmers and producers may want to consider pivoting on-farm strategies to manage for SWR.

Keywords: soil water repellency, climate change, food security

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Public Space as urban soil design for ecological cycles well-being

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Abstract

Camillo Sitte, in his book "The Art of Building Cities," nostalgically recalled the value that public spaces held in antiquity: "Back then, the main squares of cities were a vital necessity of the first order," he wrote, whereas "today, squares, rarely used for grand collective festivities and increasingly less for daily life, primarily serve to provide more light and air." What happened throughout the 20th century was the triumph of technique over art, buildings over city space, function over happiness. In 1961, Jane Jacobs wrote "The Death and Life of Great American Cities," a critique of the architects and urban planners of the time, urging a return to the City, which consists of spatial and social dimensions, social and material life, and reciprocal interactions (Perrone, 2017). Modern tradition, envisioning the city as a series of autonomous, non-communicating sectors, pursued the idea of a functional city where the private sphere prevails over the public, assuming that the various activities of the city could be compartmentalized in urban planning. Marco Romano called this an "absurdity," stating that the activities of the city are ephemeral and fragile and do not constitute the city's framework, as they do not admit change. As he wrote in "Building Cities," "the art of the city consists in managing differences, not imagining that these differences do not exist," according to which it is the symbolic city that binds, that holds together the differences and that constitutes the stable structure of the city and from which the reflection on the future of the same must start. From the failure of the modern programmatic thinking, today we witness a reclaiming of public space and with it all the values that characterize it. Since the 1980s, with the first processes of regenerating the suburbs, the recovery of buildings, and the theme of the urban landscape, the reflection on the city has expanded. The idea that the city's design should be subordinated to traffic management is abandoned in favor of citizens reclaiming public space. Alongside social issues, environmental themes arise, with urban spaces being considered responsible for psycho-physical well-being. The objective of public space is to develop a sustainable city model capable of adapting to and mitigating the effects of climate change by reintroducing the relationship between nature and artifice that was lost during the last century. In public space design, the soil with its substrates assumes a fundamental role for the well-being of ecological cycles. The soil, as agronomist William Bryant Logan says, is a "skin" that, like a living organism, breathes, absorbs, and repels. The indispensable role of soil in the ecological system necessitates its recognition as the most important aspect for the city's survival, urging the realization that future planning will be guided by climate change (van der Berg and van der Made, 2021). Healthy soil is the prerequisite for biodiversity and the right living conditions for

people. Through soil design, public space promotes healthy living conditions for its inhabitants, favoring processes of urban renaturalization.

Keywords: public space, urban regeneration, nature-based solutions, ecological cycles, soil

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Nature-Based Solutions for Extreme Flood Events in South East Queensland: Challenges and Innovations

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Abstract

The application of nature-based solutions (NBS) in river and catchment management is increasingly recognised for its potential to enhance ecological resilience and sustainability. However, typical NBS are often designed for low to moderate magnitude events, limiting their effectiveness during extreme hydrological disturbances. This presentation addresses the critical gap in applying NBS to manage water and sediment (dis-)connectivity during severe flood events, with a focus on the unique challenges faced in South East Queensland, Australia. South East Queensland has experienced several extreme flood events in recent years, characterised by intense rainfall and rapid runoff, leading to significant disruptions in water and sediment connectivity. These events highlight the limitations of conventional NBS, such as riparian buffer zones, wetlands, and floodplain restoration, which may not withstand or adequately mitigate the impacts of high-magnitude floods. For instance, the 2011 and 2022 floods caused extensive erosion and sediment deposition, overwhelming existing NBS and underscoring the need for tailored strategies that can endure such extreme conditions. This talk will review a range of innovative NBS designed to address these challenges. Through a comprehensive review of case studies and field research in South East Queensland, this presentation aims to provide a framework for implementing robust NBS that are resilient to extreme flood events. By tailoring these solutions to the specific hydrological and geomorphological characteristics of the region, we can enhance the effectiveness of NBS in maintaining riverine and catchment health in the face of climate change and increasing flood risks.

Keywords: extreme floods, floodplain restoration, geomorphology, connectivity

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Is the abandonment of esparto grass (Stipa tenacissima) fields generating soil degradation and socioeconomic impacts in Southeaster Spain?

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Abstract

Stipa tenacissima, or esparto grass, is an endemic plant of the Western Mediterranean region. It grows in relatively dense formations in dry or semi-arid Mediterranean areas (with rainfall between 200–400 mm/year). Its cultivation has been decreasing over the years, and currently, there are only about 32,000 km^2 of esparto grasslands remaining in the western Mediterranean basin. In Granada province (Southern Spain), the soils where this plant grows are very poor and rocky, formed on limestones and marls, with varying degrees of gypsum and salt content. This plant has been utilized for millennia, but especially between 1939 and 1975, it experienced significant growth with increased production, labor force, population expansion, and even exploration of new markets. However, due to current rural abandonment, production has been reduced to a minimum and even abandoned altogether. Recognizing its significant historical and socioeconomic importance after conducting a detailed socioeconomic study, the next step was to determine through preliminary research if soil degradation was activated after the abandonment of this traditional crop. To achieve this goal, soil sampling (both undisturbed and composite samples) was conducted in the municipality of Benamaurel (Granada) to assess antecedent soil moisture, organic matter content, aggregate structural stability, pH, and soil saturation degree. These analyses were complemented by various experiments (infiltration and soil respiration measurements) conducted along different hillslope positions within both abandoned and cultivated esparto grass plots. Infiltration tests revealed that the abandoned plots have a lower infiltration capacity. Moreover, soil respiration was very low to null due to the high compaction levels in abandoned plots. Conversely, cultivated plots showed higher soil aggregate stability and water retention capacity. We concluded that abandoned areas are experiencing higher levels of soil degradation. Therefore, control measures such as controlled revegetation or the implementation of a secondary land use (e.g., livestock grazing) are crucial. Additionally, public awareness campaigns are needed to address the improper use of abandoned lands as dumping grounds (increasing fire risk and destroying the landscape) and unauthorized encroachment for property expansion.

Keywords: stipa tenacissima (esparto), environmental degradation, regional issues, soil management practices.

Acknowledgments: Erasmus+ (Urban Imprint)

Session NH2: NBS for landscape resilience (fire, droughts and extreme events)

Session organisers

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Nature-based Solutions: Concepts, Principles and Applications to Achieving Implementation of Nationally Determined Contributions

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Abstract

The Fifth Session of the United Nations Environment Assembly (UNEA-5) adopted a universally accepted definition of Nature-based Solutions (NbS) as actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, resilience and biodiversity benefits. These interventions are vital in achieving development goals and targets, addressing climate crises, human wellbeing and minimizing biodiversity loss, among others. Despite the broad significance of NbS, there is limited understanding of the mechanisms by which NbS can achieve the intended goals. Therefore, this assessment aims to broaden understanding on NbS concept and its wider applications with the following specific objectives: (i) to document and communicate the concepts and applications of NbS; and (ii) to summarize the nature-based interventions in the Nationally Determined Contributions (NDCs) of 37 member countries of the Global Green Growth Institute (GGGI) including Ethiopia. Systematic literature review was used to summarize the concepts, principles and applications of Nature-based Solutions. Furthermore, updated NDCs of each GGGI member country were reviewed, data collected and analyzed using descriptive statistics to understand the NbS interventions outlined in the NDCs across the selected GGGI member countries. Major focuses of NbS include societal challenges, biodiversity net gain and co-benefits for human well-being. The findings revealed a strong commitment of the countries in accelerating climate action through NbS. For instance, 87% of these countries have made commitments towards afforestation; 83% have prioritized agroforestry practices and conservation agriculture; 70% on mangrove forests restoration and management; and 43% of these countries have pledged to restore and manage wetlands. Other identified nature-based interventions include restoration and sustainable management of forests, soil and water conservation, rangeland restoration and management. Furthermore, 89% of the 37 assessed countries have recognized the significance of biodiversity in achieving their NDC commitments. This analysis revealed that significant NbS interventions were prioritized in the forestry and agriculture sectors. The study also observed a greater emphasis on commitments to restore degraded ecosystems rather than protecting natural ecosystems. Investment in NbS remains vital in accelerating climate actions, biodiversity conservation, enhanced ecosystem services

and human well-being.

Keywords: Nature-based Solutions, Nationally Determined Contributions, Restoration

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Forest related nature-based solutions for climate-change induced effects: wildfires and forestry pests mitigation

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Abstract

In line with the EU Mission for a Climate Resilient Europe, and analysis of Nature-Based Solutions (NBS) for their effectiveness to create more climate resilience and restore nature was done. In 2021-2023 the work focused on the upscaling potential of nature-based solutions, and particularly on their possible contribution to achieving overarching ecosystem restoration targets. The work focused first on collecting different type of NBS and their potential for large-scale upscaling. Secondly, insights on NBS assessment frameworks, scaling frameworks, and the socio-economic levers and barriers involved in NBS deployment were included in the analysis. The work comprised of NBS evaluation and assessment, including an interview-based review of selected cases that were drawn from the Climate-ADAPT database. From this study that mainly focussed on agricultural system it was concluded that wider application of nature-based solutions (NBS) in agricultural systems would deliver multiple societal benefits, and contribute to both climate resilience and nature restoration. However, there is limited experience of scaling solutions beyond local contexts. However, NBS for forestry are not as well-known, therefore, this current year (2024) the focus lies on understanding the role of NBS in increasing resilience to wildfires and pests in forest under the predicted climate change. Three types of effects of climate change that can be mitigated by NBS will be assessed: Wildfires risk and post-fire management and forest pest mitigation. Damages to forests are increasingly causing economic losses and costs and issues for the LULUCF contribution to climate change mitigation. The way NBS are used in climate change induced disturbances forest are three-fold:
1. Wildfire risk management: Key to wildfire management is the reduction of fuel in the forest: fire management starts with understanding forest processes and forest management. Ways to do this comprise grazing, agroforestry and prescribed fires.
2. Post-fire management. Key to post-fire management is the reduction of connectivity; improving the infiltration of the soil and the reduction of overland flow.
3. Forest pests. Key to pest-management lies in tree species diversification and biological pest control.
An analysis of socio-economic aspects and enablers/barriers relevant to upscaling the suitability and potential of NBS in forestry will be evaluated, specifically for wildfire prevention and post-fire management and forest pest management. This work will give

and overview of existing NBS and make an in depth analysis of case studies, benefitting from Climate-ADAPT resources.

Keywords: Nature-based solutions, wildfire risk suppression, post-fire management, forest pest mitigation

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The renaturalization of urban river channels and the mitigation of flood risk, the “Corredor Verde Barranco de Beniopa” project as a nature-based solution

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Abstract

The torrential nature of the Mediterranean climate has determined that the deadliest natural risk with the greatest material damage in the Valencian Community (Spain) is flooding. The construction of reservoirs and dams has contributed to mitigating the effect of floods, but, on the other hand, the expansion of urbanization in areas at risk of flooding, together with the artificialization of river channels and the waterproofing of surrounding areas, have considerably increased the level of exposure. The Beniopa ravine in Gandia has not escaped these urban trends, with a ravine that presents a risk of flooding as it passes through the city, completely surrounded by densely populated urban centers, and a channel completely sealed with concrete. This typical Mediterranean ravine, dry most of the year and susceptible to major flooding in times of storms, has recorded significant episodes of overflowing, a fact that has forced the administration to act. In 2023, the renaturalization project “Green Corridor Barranco de Beniopa” began, with nature-based solutions being key to recovering the natural channel of the ravine, seeking to provide it with greater resilience against floods, but also to value the spaces peri-urban infrastructure based on ecosystem services, and integrate it within the municipality's green infrastructure. Comparing the effects of torrential rains on the ravine, before and after the execution of the project, will allow us to know the suitability of this nature-based solution and its transfer to other areas with the same problems.

Keywords: natural risks, floods, ravine, nature-based solutions.

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Drought and land use land cover dynamics in the Mediterranean Globally Important Agricultural Heritage Systems (GIAHS) site: Insights from Arganeraie Biosphere reserve in Morocco

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Abstract

Agroforestry systems are critical for environmental and social resilience especially in arid areas where the droughts are very intense. This study aims to assess the environmental impact of drought on Mediterranean Globally Important Agricultural Heritage Systems (GIAHS) site of Ait Saoub-Ait Mansour in Morocco. For this aim, first, machine learning-based random forest (RF) classification and change detection were used to investigate the change in land use classes such as: Built-up areas, Agricultural areas, Woodland, and Bare land. Then, the spatiotemporal analysis of temperature, precipitation, and Precipitation-Evapotranspiration Index (SPEI) is performed using Mann-Kendall the Sen's slope test from 1983 to 2020. Additionally, the Normalised Difference Vegetation Index (NDVI) is analysed from 2000 to 2020 for some specified crop species such as: Argan tree, Cereal, Palm tree, and Cereal mixed. The results show a decrease in the surfaces of agricultural and woodland. The outcomes reveal a consistent increase in drought (decrease in SPEI-6 and SPEI-12) over time, with annual and seasonal negative trends in NDVI for Argan tree, Cereal, Palm tree, and Cereal mixed. These results provide evidence of the ongoing degradation of this ecosystem and the changing climate. In addition, the findings represent a baseline for comparison to other GIAHS sites and inform socio-economic actors for social and ecosystem resilience.

Keywords: Drought, GIAHS, ecosystem resilience, Morocco.

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VULNERABILITY ASSESSMENT TOOL FOR CLIMATE-CHANGE RESILIENT WASTE INFRAESTRUCTURE

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Abstract

The LIFE Green Adapt project primarily aims to assess and quantify the risks posed to landfill infrastructure by climate change, particularly focusing on the impacts of floods and fires. By leveraging green and nature-based solutions, the project seeks to bolster the resilience of waste management infrastructures against these climate-related hazards. The project developed a comprehensive tool designed to measure and evaluate the exposure, sensitivity, adaptive capacity, and vulnerability of landfill facilities to climate risks, both before and after implementing project measures. This tool quantifies the percentage improvements post-implementation, demonstrating significant advancements in infrastructure resilience. Post-project analysis identified an increase in fire exposure by 3 points for enclosed vessels due to revegetation efforts, which enhanced vegetation cover. This finding emphasizes the necessity of balanced vegetation management to mitigate fire risks while still promoting other ecological benefits. The implementation of solutions such as bio-soil application and the creation of ponds for water and leachate storage and treatment markedly improved the facilities' adaptive capacity to flood risks. These measures resulted in a significant reduction in sensitivity to floods, thereby enhancing the overall resilience of waste management infrastructures. Actions undertaken through Green Adapt project culminated in a 19-point reduction in the vulnerability of waste management infrastructures. By boosting adaptive capacity to fires and reducing sensitivity, the total reduction in vulnerability reached 30 points, underscoring the effectiveness of the implemented measures in enhancing infrastructure resilience. The tool offers numerical data on the improvements achieved through the implemented measures, showcasing clear reductions in adverse impacts and increases in adaptive capacity. Accompanied by a user guide, the tool's utility extends beyond the initial project, promoting long-term usability and scalability. This tool is applicable to other landfills, providing a valuable resource for the broader waste management sector. The project addresses both current and future climatic conditions influencing an area's susceptibility to extreme events like heatwaves and rising sea levels. Key concepts include sensitivity, vulnerability, adaptive capacity, and exposure, focusing on the impact of climate changes on systems and species.

Keywords: Resilience, Climate Change Adaptation, Green Solutions

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Exploring the potential of NBS in facing water-related challenges in the Mediterranean Basin and beyond

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Abstract

Climatic projections identify the Mediterranean Basin as a hotspot of change in which data concerning precipitation reduction and warming result to be above the global average (Lionello et al., 2018; Giorgi, 2006). This makes the Basin one of the most vulnerable region regarding the impacts of climate and meteorological phenomena, both in terms of higher occurrence of extreme events (e.g. floods, droughts, wildfires, etc.) as well as in terms of long term impacts (Ali et al., 2022). Indeed, the Mediterranean Basin is one of the areas mainly impacted by anthropogenic activities having impacts both on natural ecosystems and society, mainly in the south and eastern Mediterranean countries (Lionello et al., 2018; Giorgi, 2006). Among extreme events, flood-related hazard, and more in general hazard related to a discontinuous water flow, are the ones that are affecting more the area because of their impacts and frequency. Within the framework of the EU H2020 project, REXUS (managing REsilient neXUS system through participatory systems dynamics modelling) and PRIMA project, LENSES (LEarning and action alliance for NexuS EnvironmentS in uncertain future) methodologies and indicators have been developed to assess the effectiveness of NBS to face the current environmental and social challenges specifically related to the management of the WEFE (Water-Energy-Food-Environment) Nexus. Our contribution wants to present the application of the methodology developed within the two projects to assess the socio-economic possible impacts of the implementation of selected NBS in two different case studies. The restoration of a native riparian forest has been identified as possible NBS in a case study in the Crete island (Lilli et al., 2020), while the restoration of a native forest in the upper part of a catchment has been explored as NBS Colombia. NBS aim to face flood risk, in the first case, and to regulate catchment's water flow, in the second one. The estimation of ecosystem services (ES) provided under the business-as-usual conditions and under the possible NBS implementation have been modelled. Targeted ES and NBS have been analysed and prioritised through a continuous stakeholders consultation and

involvement. Finally, to investigate the sustainability of the NBS investment a cost-benefit analysis have been implemented. Our results show the positive effects of both NBS in regulating the water flow and in improving the biophysical flow of the assessed ES compared to the business-as-usual conditions. Also the economic analysis present positive results confirming, in both cases, the sustainability of the needed investment.

Keywords: cost–benefit analysis, ecosystem services, flood, climate change, hazards

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The impact of plant types on water repellency as a consequence of forest fires

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Abstract

Fire has been used in the Mediterranean orchards and groves to remove the pruned branches. The EU policies are promoting the use of chipped pruned branches to promote the restoration of the soil system. Soils under the use of fire to burn the chipped pruned branches use to be bare and induce high erosion rates and loss of water due to surface wash. On the other hand, the soils covered with chipped pruned branches show higher erosion rates. Moreover, farmers use to light fire on the leaves cover during winter to maintain “clean” the soil which results in a bare soil surface. This research investigates the impact of chipped pruned leaves and burnt leaves on soil water infiltration in the soils of persimmon plantations in Valencia, Spain. We selected 10 paired plots to compare chipped pruned branches mulch covered soils and ask covered soils. The measurements were done in January and August 2022. We used a single ring infiltrometer. Ten samples per site were carried out. The results show an increase in infiltration in the areas where chipped pruned branches were used. The use of fire resulted in a reduction in soil infiltration capacity. The use of mulches has been found in Mediterranean orchards as a sustainable practice and is a positive nature-based solutions

Keywords: Fire, Wildfire, Plants, Soil, Infiltration, Beneixama, Mediterranean.

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Assessing Soil Hydrological Responses to Watershed Management and Topography in Iran

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Abstract

This study examines the impact of watershed management practices on soil hydrological characteristics and infiltration rates in arid and semi-arid regions, specifically focusing on the Gonbad paired watersheds in Hamadan Province, Iran. The research aims to clarify the complex relationships between watershed management operations and soil hydrological properties, providing valuable insights for sustainable land and water resource management. By comparing a restored watershed, where various watershed management activities have been implemented, with a control watershed, this study highlights the effects of vegetation restoration, erosion prevention measures, exclosure, and land management practices on soil properties and infiltration dynamics. Field data analysis revealed significant improvements in soil texture, profile depth, land cover components, and infiltration rates in the restored watershed, indicating enhanced soil stability and water infiltration capacities. Additionally, the study identifies the influence of topographic factors—including slope aspect (north-facing vs. south-facing) and slope position (up-slope, mid-slope, down-slope)—on soil characteristics and infiltration rates. By pinpointing the key factors driving soil infiltration and land cover dynamics, this research offers valuable insights for designing tailored watershed management plans aimed at conserving soil and water resources in arid and semi-arid regions worldwide. amid growing challenges of water scarcity and land degradation.

Keywords: Watershed management, Soil hydrology, Infiltration rate, Vegetation restoration

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Quantifying Hillslope Splash and Sheet Erosion Using Soil Particle Size Distribution

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Abstract

Splash and sheet erosion are major contributors to soil loss and decreased soil fertility in natural landscapes. Identifying areas prone to soil erosion is crucial for effective management and achieving land degradation neutrality. This study introduces a new low-cost and efficient technique for quantifying soil loss rates resulting from splash and sheet erosion on hillslopes. The method is based on the assumption that differences in soil texture between surface (0-2 cm) and subsurface (2-4 cm) soil layers are indicative of erosion and sedimentation processes. The technique quantifies erosion and sedimentation rates using Soil Particle Size Distribution (SPSD), volume, and bulk density of the soil. SPSD involves decomposing soil into various particle sizes, each expressed as a percentage of the total soil sample. To validate this technique, 180 soil samples were collected and analyzed from the hilltops and hill bottoms of the Highlands in Mashhad, Iran, across different geological formations and slope gradients. The results demonstrated that in geological formations with finer particle sizes, the differences between the SPSD curves of surface and subsurface layers increased, indicating significant splash and sheet erosion. This method provides a rapid understanding of erosion processes across landscapes, contrasting with traditional soil erosion methods that require long-term evaluation. Our findings show that erosion results from the interplay of erosion and pedogenesis processes over the long term, and highlight the importance of understanding soil erosion by sheet and splash mechanisms in the context of soil formation and soil properties.

Keywords: Hillslope scale, Sediment transportation, Soil particle size distribution, Splash and sheet erosion

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A Comprehensive Bibliometric Analysis of Forest Fire Research in Iran

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Abstract

Forest fires in Iran pose a significant environmental threat, affecting diverse ecosystems, human societies, and the economy. Iran's forests, covering approximately 7% of the country's landmass, are crucial for maintaining ecological balance, supporting biodiversity, regulating hydrological cycles, and providing essential resources to local communities. This study conducts a comprehensive bibliometric analysis to elucidate key trends and patterns in the scholarly discourse on forest fires in Iran. The focus includes the temporal distribution of articles, prominent authors, top journals, highly cited articles, and the geographical distribution of research efforts. Additionally, the study maps prominent keywords and topics, explores the temporal evolution of research directions, and examines the impacts of forest fires, including hydro-ecological effects, soil properties, and socio-economic consequences. The analysis reveals a significant rise in scholarly interest in forest fires in Iran over the past two decades, with a notable increase in publications from the 2010s onward. Thematic analysis indicates that fire risk prediction and modeling are primary research focuses, with methodologies such as GIS, remote sensing, statistical modeling, and machine learning algorithms advancing fire risk assessment and management strategies. Forest fires significantly impact hydro-ecological systems, altering vegetation dynamics, soil properties, and hydrological processes. Immediate effects include reductions in vegetation cover, soil compaction, increased runoff, and erosion, with long-term implications for ecosystem health and resilience. Climatic variables, including temperature, humidity, and wind patterns, are critical drivers of fire behavior and risk, further exacerbated by climate change. Although underrepresented in the literature, the socio-economic dimensions of forest fires highlight significant economic losses, disruption of livelihoods, and community displacement.

Keywords: Forest fire, Iran, Fire risk, Socio-economic, Ecological impact

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Hydrological Impacts of Forest Fires on Watersheds: A Comprehensive Review and Bibliometric Analysis

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Abstract

Forest fires pose significant environmental challenges globally, profoundly affecting watershed hydrology. As human activities increase and climate change exacerbates, the incidence and severity of forest fires have escalated, leading to substantial modifications in watershed hydrological behavior. This study presents a comprehensive review and bibliometric analysis of literature from 1966 to May 2024, focusing on the impact of forest fires on watershed runoff dynamics. The temporal distribution reveals a steady increase in publications over time, with 15 papers before 2000, 28 in the 2000s, 53 in the 2010s, and 45 after 2020. These studies cover diverse geographic regions, including North America, Europe, Asia, and Australia, reflecting the global scope of research on wildfire impacts on watershed runoff. Notable contributions from influential authors and leading journals highlight the pivotal role of U.S.-based researchers in advancing knowledge on the hydrological impacts of forest fires. The thematic exploration of the reviewed literature elucidates a broad spectrum of hydrological and ecological responses to forest fires, advocating for integrated management approaches to mitigate the impacts of wildfires on watersheds. Key findings include a pronounced increase in runoff volume and peak flow, indicating intensified streamflow and sediment transport following wildfires. Additionally, alterations in water quality parameters such as phosphorus, potassium, arsenic, and nitrate underscore the diverse impacts of wildfires on water chemistry, posing risks to aquatic ecosystems and human health. The analysis also reveals shifts in research focus over time, transitioning from an initial emphasis on flow characteristics to later considerations of water quality, soil degradation, and climate change.

Keywords: Forest fires, Watershed hydrology, Wildfire impacts, Hydrological modeling, Bibliometric analysis

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Towards Sustainable Land Use in Europe: Target Areas for Implementing Mixed Farming and Agroforestry Systems

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Abstract

Agricultural land in Europe is facing several challenges due to climate change and the intensification of agricultural practices since several decades. The aim of our analysis is to define target areas where the introduction of mixed farming (MF) or agroforestry (AF) could provide environmental benefits and increased resilience to climate change. The methodological framework applied is based on an adaptation of the one used by Kay et al. (2019) for agroforestry systems. The selection of these target areas is based on a spatial approach which consists of four steps: (1) selection of suitable potential areas from the total agricultural area in Europe, excluding nature conservation sites and AF areas identified in the land use/land cover cartography, (2) analysis of environmental risks in the potential areas, (3) definition of target areas, and, finally, (4) analysis of the socio-economic context. A total of 12 environmental indicators were used to determine risks related to soils, biodiversity, water, and climate change in potential areas. To evaluate the effects of those risks, threshold values were defined for each indicator, identifying the limits above or below which sustainability is compromised in potential areas. After combining these indicators, heat maps were produced to highlight the intensity of a total of 12 environmental risks. Areas showing 7 or more accumulated pressures were defined as target areas to introduce AF, which amounted a total of 506,249 km^2. Regarding the analysis of the socio-economic context in the target areas, a total of relevant 6 social and economic variables, related to economy (economic size and unemployment rate), training and willingness of farmers to change (training of farm managers, number of organic farming holdings) and demography (ratio of young farm managers to elderly farm managers, degree of urbanisation), were selected to characterize these aspects in the NUTS 2 regions. Each indicator was analysed individually to identify regions with different socio-economic backgrounds. While the analysis of environmental pressures allowed to identify agricultural areas that reported higher concentration of pressures, the characterization of the socio-economic context showed that the social and economic factors varied across the European regions where those target areas were located. The relation between regions reporting higher environmental pressures and the different socio-economic factors that characterize them is key to identify opportunities for establishing AF and MF.

Keywords: land use dynamics, agroforestry systems, risks, Europe

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Session UR: Nature based solutions in urban areas

Session organisers

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Climate adaptation through natural based solutions: heat wave resiliency in schoolyards

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Fundación CIRCE

Abstract

We will be presenting he proposals for the re-naturalization of school playgrounds developed within the European Project CARDIMED (Climate Adaptation and Resilience Demonstrated In the MEDiterranean region). These proposals are currently in progress in various public schools located in Spain. The intervention aims to transform the outdoor environments of schools by reintroducing natural elements and nature-based solutions, to improve the thermal comfort and well-being of students during episodes of extreme heat. This initiative responds to the need for more sustainable and climate-adapted spaces, providing more pleasant and healthy educational environments. The implementation of the project requieres the collaboration of different stakeholders, including educators, students, parents, and school authorities. Participatory workshops are held to gather ideas and opinions, involving the school community in the design and development of the new spaces. The involvement of the school community ensures that the proposed solutions are suitable and address the specific needs of each school. The resulting designs are later evaluated by a panel of scientific experts (architects, engineers, environmental technicians, and biologists) to futher detail the proposals and provide valuable feedback, focusing on the success of the final implementation.

Keywords: climate change adaptation, nature based solutions, heat waves, community participation

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ISCR-based Remediation of Herbicide/Pesticide-impacted Soils in Europe: 22 Years of Success and Surprises

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Abstract

Agricultural land is often converted to residential use as urban centers grow. An issue that may be encountered during these changes in land use is the presence of chlorinated pesticides and herbicides at concentrations above regulatory criteria. Over the past two decades, soil at many pesticide/herbicide-impacted sites has been successfully remediated using in situ chemical reduction (ISCR) treatments based on zero valent iron combined with organic carbon. A cycled, anaerobic/aerobic approach is used. This ISCR treatment has enabled attainment of industrial and residential remediation standards and provided an environmentally sustainable, greener alternative to excavation and off-site disposal. ISCR technology is now considered a proven alternative to excavation and off-site disposal. Large-scale in situ treatment is usually conducted only after completion of bench-scale testing on a representative soil sample(s) to determine if adequate removal efficiency can be attained. The bench work also provides estimates of the required soil amendment dosage and treatment time. In some cases, bench results indicate that remedial objectives cannot be attained. In cases where bench testing yields positive results, a variety of site-specific scale-up issues must be addressed, and regulatory approval secured before treatment at a site can be initiated. After successful bench-scale testing, a pilot-scale demonstration may be prudent, to ensure successful scale-up under field conditions. Treatment at sites can be conducted in situ or on excavated soil using a variety of soil mixing techniques to incorporate the soil amendments. In most cases, irrigation is also required to achieve a soil water content conducive to reductive dechlorination. A variety of soils containing chlorinated herbicides and pesticides, including 2,4-D, 2,4,5-T, Metolachlor, Chlordane, DDT, Dieldrin, Aldrin, Lindane, PCP, and Toxaphene, have been treated to applicable criteria. In some cases, treatment has been completed rapidly, without difficulty, within the predicted time, and on budget. In others, soil characteristics, weather, and unexpected site conditions (e.g., very high pesticide concentrations) have rendered treatment slower or ineffective due to the need for many treatment cycles. Case studies, both successful and unsuccessful, will be presented. Reasons for observed performance, both good and bad, will be proposed and discussed.

Keywords: Bioremediation, Soil, Herbicide, Pesticide

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Waste2bio, a Walloon initiative for the socio-economic and environmental redevelopment of polluted and derelict lands through Nature-based-solutions

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Abstract

As part of the new Walloon Smart Specialisation Strategy (S3), the Waste2Bio initiative aims to implement innovative nature-based solutions to give a second life to wasteland and polluted sites (https://s3.wallonie.be/home.html, www.waste2bio.org). The 40,000 hectares of potentially polluted land in Wallonia, i.e. 2.3% of the territory, are the starting point for our initiative (de Thysebaert et al., 2022). Remediation is not the only solution for all polluted sites because of its very high cost, estimated at between €2.5 and €5 billion for the 2,000 most polluted sites in Wallonia (Carnoy & Moric, 2010). At present, many sites remain abandoned for several decades before they are cleaned up and redeveloped. Contaminated and abandoned sites, like forests and farmland, provide multiple services and functions that can be enhanced by appropriate management. These sites could support permanent or temporary vegetation until the site can be recycled for a new use. Plant species and associated soil microorganisms not only improve the physical, chemical and biological properties of soils and enable sustainable management of water and soil resources, but also increase above-ground biodiversity, act on the climate through carbon sequestration, reduce the risk of flooding, promote the health and well-being of citizens and provide economic value (Garbisu et al. 2020, Seddon et al. 2020). These nature-based solutions address societal challenges such as climate change, biodiversity loss and the green transition. The Waste2Bio initiative aims to accelerate the rehabilitation of abandoned and polluted land by managing sites with resilient NbS that provides multiple ecosystem services. The initiative relies on a consortium of more than 100 Walloon stakeholders in brownfield redevelopment and the bioeconomy involved at all levels of the value chain: land managers, public authorities, service providers, bio-based product companies, non-profit organisations, universities and research and training institutes. It is coordinated by researchers at the University of Liège and supported by the Walloon Region. One of the Waste2Bio's activities is to set up pilot sites to validate innovations and demo sites to inform stakeholders, and to enable the deployment of suitable NbS. Around thirty abandoned sites have been identified as potential pilot sites. The communication will present Waste2Bio's missions, ecosystem and activities, as well as regional and European projects developed in Wallonia, such as WallPhy, New-C-Land, Martinet and ECOSOL.

Keywords: phytomanagement, soil health, multi actor approach, Smart specialization strategy

Acknowledgments: Walloon S3

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The organic soil enrichment as a remedy for agri-environmental problems

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Abstract

Nowadays, we are struggling with many environmental problems, the effects of which are visible in many elements of various ecosystems. Negative effects are expressed in deterioration of the health and functioning of a given habitat, with particular emphasis on the soil. Soil is exposed to a number of threats leading to its degradation as: soil pollution by heavy metals, water/wind erosion, loss of soil organic matter or soil acidification. The several practices have been launched to combat land degradation. Among different managements, application of organic matter in the form of various organic amendments was recognized as the most preferable in enhancement of soil health. The introduced organic matter together with various organic amendments contributes to a number of beneficial changes expressed by improving physical, physicochemical and chemical properties, strengthening the soil structure, mitigating indices of drought and pollution by heavy metals, reducing soil compaction, increasing microbiological activity and carbon sequestration. Referring to the organic amendments, it is necessary to emphasize the possibility of recycling waste biomass in the form of sewage sludge, municipal biowastes or agro-wastes, which, in accordance with the circular economy, is subject to recycling, becoming an alternative source of organic matter and nutrients to the conventional fertilizers. Many studies have been shown the beneficial effects of the organic amendments on fundamental soil properties. There is much fewer studies concern the impact on the quality and quantity of soil humus compounds, which are the most important part of organic matter and, next to TOC, are a crucial indicator for soil health and fertility. This study presents the characteristics of various organic substances in terms of the quantity and quality of humic substances (HSs). The analysed amendments (vermicompost, municipal biowaste compost, sewage sludge compost, sewage sludge biochar) were compared and their fertilizing properties were assessed. It was found that the amounts of organic matter, TOC and HSs were the highest in vermicompost and sewage sludge compost. The lowest values of the discussed parameters were determined for biochar. At the same time, HSs of sewage sludge biochar were highly polymerized and HSs of vermicompost the least polymerized. Simultaneously, the vermicompost showed the lowest amounts of easily decomposed carbon compounds and sewage sludge compost the highest contents. The fertilizing effect of organic amendments expressed by changes in the quality and quantity of soil carbon compounds was more pronounced in the case of composts than in the case of biochar.

Keywords: organic amendments, soil health, biomass, carbon farming

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Blue Infrastructure in Urban Areas: A Lost Opportunity? Insights from Western Romania

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Abstract

Urban areas face increasing challenges related to climate change, population growth, and environmental degradation, highlighting the need for innovative approaches to sustainable urban development. Blue infrastructure, which encompasses natural and human-made water systems, offers significant potential to address these challenges by providing multiple benefits, including flood mitigation, water quality improvement, and enhanced biodiversity. Despite its potential, the integration of blue infrastructure into urban planning remains underexplored and often overlooked. This article explores the status of blue infrastructure implementation in urban areas, focusing on insights from Western Romania. Drawing on case studies and empirical data, the article examines the barriers and opportunities for incorporating blue infrastructure into urban planning processes. Key factors influencing the adoption of blue infrastructure are identified, including regulatory frameworks, funding mechanisms, stakeholder engagement, and public awareness. Furthermore, the article discusses the potential benefits of embracing blue infrastructure strategies, such as increased resilience to climate change, improved urban livability, and enhanced ecological connectivity. By highlighting lessons learned and best practices from Western Romania, this article aims to inform policymakers, planners, and practitioners about the importance of prioritizing blue infrastructure as a cornerstone of sustainable urban development. It concludes by advocating for greater attention to be paid to blue infrastructure in urban planning processes, emphasizing the need for integrated and holistic approaches to create resilient and livable cities for future generations.

Keywords: blue infrastructure, urban areas, western Romania

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Maintaining soil organic matter quality and stability in an olive orchard sustainibly managed for 21 years: insights in local and global implications

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Abstract

Among the current global challenges, the research of new practices aimed at mitigating soil impoverishment, exacerbated by the pressing climate changes, is the most urgent (Chittora et al., 2020; Kalyanasundaram et al., 2020; Gonçalves, 2021; Tan et al., 2021). Studying soil organic matter (SOM) dynamics and comparing the conventional intensive farming practices with the emerging alternative sustainable ones can represent a key indicator in soil health investigation, helping to find new guidelines for conservative agrosystems management (Doran and Zeiss, 2000; Fierer et al., 2021). Olive is an economically and socio-culturally important tree crop for the countries of the Mediterranean area. However, its management is becoming unsustainable because of the lack of young farmers, increasing soil degradation, and the high cost of mineral fertilizers (Sofo and Palese, 2021). In this long-term study, the soil from a Mediterranean olive orchard, with both sustainable (S_{mng}) and conventional (C_{mng}) land use for 21 years, was investigated for its physicochemical properties, with particular attention to the aggregate-associated organic matter (SOM-A) and its interaction and distribution in aggregates and depths. Also, a detailed metabolomic analysis of SOM-A was carried out. A higher amount of total carbon (+50.7%) and nitrogen (+74.9%), as well as of SOM-A aromatic component (+76.0%), was detected in the first analyzed layer (0-5 cm) in the S_{mng} soils compared to the S_{mng} ones, a sign that the organic matter from surface deeply penetrates very slowly. This evidence was highlighted especially in micro-aggregates (<0.063 mm) (C = +59.3%; N = +86.7%; SOM-A = 87.7% in the S_{mng}), likely due to their capacity to bond more easily the smaller colloidal particles with a higher specific surface. This trend was also reflected in an increase in bacterial abundance and a different accumulation of organic compounds deriving from microbial fermentation processes in S_{mng} soils, as highlighted by the SOM-A qualitative characterization by metabolomics. The soil mineralogical analysis showed that minerals maintained a higher crystallinity in the S_{mng} than in the C_{mng}, where soil tillage promoted their alteration. Moreover, Fourier-transform infrared (FTIR) spectroscopy analysis highlighted that soil disturbance due to the C_{mng} can affect SOM distribution, creating different spatial distributions in the

particle aggregates and soil depths. In order to maximize soil health in Mediterranean orchards, living roots should be maintained, i.e., the soil needs to be covered in a mantle of diverse living plants (cover crops or spontaneous weeds) for as long as possible, while bare soil should be avoided at all times. Besides living plants and their root exudates, plant residues (e.g., stalks and leaves) and compost can also drive soil health. Distinguishing SOM quantity, quality, and interaction with mineral components can help to understand if the potential for desorption of SOM determines its degradability and the dynamics of carbon accumulation into the soil, both essential for mitigating the effects of climate change and promoting land protection (Canisares et al., 2023; Li et al., 2023). In this scenario, the benefits of sustainable soil management involve not only the agricultural sector but also the social and ethical sphere, a prerequisite for trying to maintain the functional autonomy of agroecosystems over time and ensuring that they continue to perform their wide range of ecosystem services. Finally, the results obtained can be extended globally, considering that the olive tree is currently cultivated on 5 continents, with an area of 11.6 million hectares in 66 countries.

Keywords: Fourier-transform infrared (FTIR) spectroscopy, mineral-associated organic matter (MAOM), soil metabolomics, soil mineralogy, sustainable soil management.

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The recovery of urban peripheries and the creation of spaces for citizenship: the project of the Gandia Green Ring

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Abstract

Over the last few centuries, urban peripheries have absorbed facilities and infrastructure that urban centers could not maintain. As a result, a process of decentralization towards the urban peripheries began. This process has led to many municipalities having degraded urban peripheries disconnected from citizens, where the population no longer visits despite their proximity to the city and often to natural spaces. A Green Belt is a green infrastructure aimed at recovering urban peripheries through nature-based solutions. In addition, it aims to provide a space for urban disconnection, an area for walking and practicing sports, as well as an alternative for intra-urban and sustainable mobility. Through a peri-urban circular route, the urban suburbs are connected and provided with a series of equipment and infrastructure to reconnect citizens with their natural environment, such as urban gardens, viewpoints, green areas or the restoration of natural spaces near the city. Through the application of qualitative and quantitative techniques, the effects that green infrastructure has on the habits of the population and on the perception of living in urban peripheries are studied. The Vitoria Green Belt sets the standard in Spain, and cities like Gandia have sought to develop similar projects to take advantage of its potential and recover its urban environment. Since its implementation in Gandia, mobility and the way in which citizens interact with their environment have changed. Studying these changes in citizenship is essential to understanding the potential of green infrastructure and nature-based solutions in cities.

Keywords: Green infrastructure, urban peripheries, urban habits, mobility.

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Snags and stumps as catalysts of biodiversity in temperate forest ecosystems

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Abstract

The aim of the research was to determine the properties of decaying wood of stumps and snags in mountain forest ecosystems. The number and diversity of microorganisms involved in the deadwood decomposition process and their relationship with the physicochemical properties of wood were analyzed in detail. The conducted research confirmed the differences in physicochemical properties between the wood of stumps and snags, which had consequences for the biochemical activity expressed by enzyme activity. Significantly higher activity of three out of four tested enzymes was recorded in wood samples from snags. Analysis of the amount and diversity of bacteria and fungi indicates differences between the wood of stumps and snags. We noted significant differences in the number of bacteria between the tested types of wood. The performed analyzes indicate a strong relationship between microorganisms inhabiting decaying wood and the physicochemical properties of wood. Our results can be practically used in the management of deadwood in forests, which will consequently be important in shaping biodiversity.

Keywords: deadwood, enzymes activity, microorganisms, NGS

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Rhizosphere effect: Microbial and enzymatic dynamics in the rhizosphere of various shrub species

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Abstract

Our research aimed to characterise the properties especially microbial parameters in the rhizosphere of selected shrub species growing in the temperate climate zone. The study involved determining the abundance and diversity of microorganisms in the rhizosphere, along with assessing the basic chemical properties and the activity of enzymes crucial to the carbon, nitrogen, and phosphorus cycles. The investigation was conducted in pine stands with an understory of shrubs forming biogroups. Samples for analysis were collected from both the rhizosphere and bulk soil. Our research confirmed that the rhizosphere of shrubs characterised by different chemical and biochemical properties compared to bulk soil. The enzymatic activity in the rhizosphere was significantly higher than in bulk soil. The tested enzymes, both intracellular and extracellular, exhibited a positive correlation with basic biochemical parameters. Moreover, the number of bacteria and fungi was notably higher in the rhizosphere of the examined shrub species compared to bulk soil. The abundance and diversity of microorganisms underscored the rhizosphere of the researched shrubs is a hotspot. The findings from our research may have practical applications in shaping the species composition of tree stands, with potential implications for future soil condition.

Keywords: enzyme activity, forest soil, hotspots, microorganisms, NGS, shrubs

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The VeBS project - "The Proper Use of Green and Blue Spaces for the Promotion of Health and Well-being"

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Abstract

Cities can address climate change through two pathways: mitigation (energy efficiency, decarbonization, emission reduction) and adaptation (resilience improvement). Nature-Based Solutions (NBS) combine these strategies with significant human involvement. NBS enhance resilience, remove air pollutants, and create economic opportunities, demanding analysis and public engagement for being effective. The last National Statistics Institute data show a worsening of air quality in most Italian cities (8 out of 10 cities exceeding WHO interim target for PM10 of 20 µg/m3) paralleled by negligible increases in green space per capita (+1,5 square meter/inhabitant) in the last 10 years. In this context, the VeBS project (PNRR/PNC project) involving 4 Italian Regions is aimed at implementing initiatives for study, research, training, and communication to promote the correct, conscious, and participatory use of green and blue infrastructures. It aims to implement evidence-based policies for planning and managing urban green and blue spaces and to enhance understanding of the associated health effects. Specifically, the VeBS project aims to improve the shared knowledge among key stakeholders involved in the development, maintenance, and sustainable use of green-blue infrastructures by capitalizing on the health benefits, especially in vulnerable groups such as children and elderly, while reducing disadvantages (e.g. pollens). This is to promote the proper use of

these areas and fully understand their benefits for physical and mental well-being, social cohesion, and equity. It is crucial to address the synergies between the concepts of ecosystem services and resilience in the context of natural infrastructure planning at the local level. The ecosystem services approach focuses on maximizing humans' direct and indirect benefits from ecosystems in urban areas, such as food production, water purification, flood and microclimate control, opportunity for physical exercise, social interactions and recreation, and mental well-being. In parallel, the resilience approach focuses on the ability of a socio-ecological system to absorb disturbances, reorganize, and maintain its essential functions in the face of external changes or shocks. This approach highlights the dynamics of urban systems, encouraging flexible and participatory governance practices. Regarding these two lines of action, some expected outcomes of the VeBS project are: mapping policies related to the development and implementation of green-blue areas; studying the effects of green-blue spaces' frequentation on the most vulnerable populations in specific Italian areas, and supporting nature-based health and wellbeing prevention practices; developing an atlas of plant species to support multifunctional reforestation; training courses for both professionals and citizens and dissemination activities with active participation from local stakeholders. In particular, we believe that the drafting and dissemination of products like the plant species atlas and dissemination interventions aimed at various stakeholders can support planners, decision-makers, environment and health practitioners with a set of general principles and tools to correctly address, manage and promote nature-based solutions. These aim to enhance urban resilience by focusing on the benefits of green and blue infrastructures, including the promotion of polycentric, participatory, and adaptive governance processes and the encouragement and care of their management. In summary, the VeBS project’s focus on education, study of ecosystem services, and stakeholder engagement aims to foster a comprehensive understanding and application of NBS, thus enhancing urban resilience and improving the quality of life in urban environments.

Keywords: blue-green areas, health benefits, ecosystem services, stakeholders involvement, Italian regions

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The VeBS project - Multifunctional reforestation: a tool for urban resilience

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Abstract

The VeBS project is a national initiative funded by the PNRR/PNC that aims to improve the conscious and participatory use of green and blue infrastructures in Italian cities, with a particular focus on multifunctional reforestation. Cities can address climate change through two main pathways: mitigation and adaptation. Nature-Based Solutions (NBS) combine these strategies and require significant human involvement. NBS enhance resilience, remove air pollutants, and create economic opportunities, demanding analysis and public engagement to be effective. Last UNFCCC COP28 conference in Dubai highlighted green spaces or "nature-based solutions" for their role in enhancing urban adaptation and mitigation to climate while contributing to biodiversity conservation and offering significant health benefits in urban populations. In Italy, there is a growing effort about reforestation triggered by the Climate Law of 2019 and accelerated with the National Recovery Plan and the Mitigation and Adaptation Policies more recently. This is a unique opportunity for improving greenspace available to Italian citizens, but it is crucial to address several critical aspects: the protection of biodiversity and the careful selection of species, the selection of reforestation areas that should prioritize equity considerations alongside ecological factors, the triggers of extreme events—especially droughts—and the ongoing maintenance and funding requirements for the long term. Moreover, successful reforestation requires active participation from all stakeholders and especially from local communities. In this context, the VeBS project,

involving four Italian regions, aims to implement initiatives for study, research, training, and communication to promote the correct and conscious use of green and blue infrastructures. Multifunctional reforestation is at the heart of the VeBS project, considering the forest as a complex ecosystem capable of providing multiple ecosystem services. This land management practice aims to restore or increase forest cover to pursue ecological, economic, and social objectives simultaneously. Unlike traditional reforestation, multifunctional reforestation focuses on various benefits, such as food production, water purification, flood and microclimate control, physical exercise, social interactions, and mental well-being. The VeBS project aims to develop evidence-based policies for the planning, maintenance, and management of urban green and blue spaces, improving the understanding of associated health effects. Specifically, the project seeks to enhance shared knowledge among key stakeholders involved in the development, maintenance, and sustainable use of green and blue infrastructures, capitalizing on health benefits, especially for vulnerable groups like children and the elderly, while reducing disadvantages such as pollen. Among the expected outcomes of the VeBS project are the mapping of policies related to the development and implementation of green and blue areas, studying the effects of using these spaces on the most vulnerable populations in specific Italian areas, supporting nature-based health and well-being prevention practices, developing an atlas of plant species to support multifunctional reforestation, and conducting training courses and dissemination activities with active participation from local stakeholders. In particular, the drafting and dissemination of products such as the plant species atlas and outreach initiatives aimed at various stakeholders can support planners, decision-makers, and environmental and health professionals with a set of principles and tools to correctly address, manage, and promote nature-based solutions. These efforts aim to improve urban resilience and quality of life in urban areas, promoting polycentric, participatory, and adaptive governance processes and ensuring careful management of green and blue infrastructures. In summary, the VeBS project focuses on multifunctional reforestation as a key tool to promote urban resilience, improve air quality, and enhance the quality of life in Italian cities, capitalizing on the ecological, economic, and social benefits of green and blue infrastructures.

Keywords: Multifunctional, reforestation, urban, ecosystem, services, green, blue

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The potential of nature reserves to enhancing Urban Ecological Sustainable Development

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Abstract

Cities provide multiple opportunities for social and economic development, but urbanization encompasses relevant ecological pressure and loss of ecosystem services. Nature reserves, protected areas for habitat, flora, fauna and/or funga, play a central role in maintaining biodiversity and providing essential ecosystem services (ES). However, their impact in promoting urban ecological sustainable development has not been adequately assessed. This study explores the role of nature reserves on ES in urban areas, the driving factors affecting the spatiotemporal dynamics of ES, and assesses the role of nature reserves in supporting the achievement of sustainable development goals in large cities. The study focuses in Panjin, a Chinese city recognized as an International Wetland City by the Ramsar Convention in 2022. The city expands over an area of 3683 km² and embraces the Liaohe Estuary Wetland Nature Reserve (LWNR), which includes provincial, national and internationally protected areas. LWNR was designated a national nature reserve in 1988 and was listed as an internationally important wetland in 2004. The study uses Landsat remote sensing images to investigate the land use changes during an active urbanization period (1990-2010) and an urban stabilization phase when ecological restoration projects were implemented (2010-2020). The impact of land use changes on ecosystem services are assessed by estimating dynamics on carbon storage, water yield, soil retention and habitat quality using the InVEST model. Redundancy Analysis was used to identify the social (e.g. population), economic (e.g. GDP, traffic network) and environmental (e.g. climate) drivers determining ES dynamics over the study period. The ecological source areas (i.e. those playing a relevant role in ecological processes and functions) were mapped. The impact of the ES provided by the nature reserve on the ecological sustainability of cities (i.e. SDG6, SDG13, SDG14 and SDG15) were also evaluated by comparing the contribution of the ES provided by the LWNR to those provided in the study area. The results show that during the urbanization period, the constructed area increased by 159%, while ES continuously declined. The ecological

restoration projects implemented during the urban stabilization period have led to a recovery of 24% of wetlands area and a 68% increase in ES. The nature reserve provides over 40% of the ES value despite covering only 23% of the city's area, and contributes to > 30% to of city ecological sustainable development. The study stresses the need to formulate ecological strategies to support urban ecological sustainable development.

Keywords: Nature reserves, cities, ecosystem services, ecological source areas, SDGs

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Implementing Nature-Based Solutions in Western Romania: Current Projects and Ongoing Initiatives for Sustainable Development

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Abstract

In Western Romania, the implementation of Nature-Based Solutions (NBS) should emerge as a pivotal strategy for fostering sustainable development amidst the challenges of climate change. We will explore two ongoing projects that could have a strong contribution in the region’s commitment to integrate NBS into its landscape and community fabric. The first project, Horizon Europe project "Utilization of Private Land for Mainstreaming Nature-Based Solutions in the Systemic Transformation Towards a Climate-Resilient Europe," focuses on mobilizing private landowners to embrace NBS practices. By supporting landowners, this project aims to enhance ecological resilience and mitigate climate risks across Western Romania's diverse ecosystems. The second project, "Empowering Local Climate Action," empowers communities to take proactive measures against climate change impacts through grassroots initiatives and participatory governance. This project engages local stakeholders, including municipalities, NGOs, and grassroots organizations, in developing and implementing NBS that address local climate vulnerabilities. By fostering collaboration and knowledge-sharing, it strengthens community resilience and contributes to sustainable development goals. This presentation highlights the approaches, challenges, and successes of implementing NBS in Western Romania. It underscores the importance of multi-stakeholder collaboration, policy alignment, and community engagement in scaling up NBS initiatives for climate resilience and sustainable development. By showcasing these ongoing projects, the presentation aims to inspire and inform stakeholders about effective strategies for integrating NBS into regional development agendas and advancing towards a climate-resilient future.

Keywords: nature-based solutions, Western Romania, projects, sustainable development

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climate-resilient Europe\\\", funded by the Executive Agency for Higher Education, Research, Development and Innovation Funding (UEFISCDI), Romania.

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Introducing earthworms as nature-based solution to improve soil properties related to water retention capacity in vineyards

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Abstract

Earthworms are considered key indicators of soil quality and health in vineyards. However, there is a lack of studies considering them as nature-based solutions to improve soil water retention capacity. Vineyards like other crops worldwide are experiencing the negative impacts of long droughts and high runoff rates, losing the water after the concentrated rainstorm of the Mediterranean belt. Therefore, the main aim was to design a laboratory essay in the open air to test if the introduction of earthworms (Lumbricus terrestris) in vineyard soils can improve soil hydrological properties. The selected earthworm type is known for being a soil eater and for forming large systems of horizontal and vertical burrows, ultimately being capable of tilling the soil. Best of all, it's a native earthworm species found throughout Europe. To achieve this goal, two wooden boxes of identical dimensions (1x0.5.0.3 m and 7.5% slope) were constructed and filled with soils coming from a conventional vineyard located in the Granada province (southern Spain) and from two different soil depths (0-10 and 10-25 cm). The key soil properties analysed during five months (considering a variation of soil water content) were organic matter, pH, infiltration, aggregate stability, soil respiration and soil moisture. Our results showed that soil infiltration has been greatly enhanced in the box with earthworms in comparison to the control one (without them). The samplings collected during the last part of the trial indicated a significant improvement in other soil properties such as XXX. The soil has transitioned from practically not allowing water infiltration to being capable of infiltrating a large quantity in a very short period. Another positive aspect that is being favoured is the retention for longer periods of soil moisture. In the earthworm box, our results showed that soil moisture levels in the deeper zones are 5% higher compared to the control box. We conclude that that earthworms can help to enhance soil hydrological properties and confirm that next step can be the introduction at larger scales and real vineyard soil conditions.

Keywords: earthworms, nature-based solutions, infiltration, soil management practice, viticulture

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Caracterizando la degradación ambiental en el viñedo granadino. Un enfoque multidisciplinar a largo plazo utilizando parcelas experimentales y muestreos poblacionales; ii) PPJIA2022-58 Caracterización hídrica del suelo en viñedos para la optimización de recursos agrícolas y ambientales; c) Visiting Scholar; and, d) Grupos Operativos (CAPDE-AGRI Junta de Andalucía) GOPG-GR-23-0003 Proyecto GO-SOSVITI

Session MET: Advances in land ecosystem restoration monitoring using remote sensing and machine learning

Session organisers

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Full-scale Application in Italy of a Combined ISCR and ERD Technology for the treatment of an Aerobic Aquifer Impacted with Carbon Tetrachloride and Chloroform

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Abstract

The site is in a highly industrialized area of northern Italy, where groundwater is contaminated with carbon tetrachloride (CT) (>10 mg/L), chloroform (CF) (>10 mg/L), hexavalent chromium and, to a lesser extent, tetrachloroethene and trichloroethene (<1 ppb). The EHC® Liquid technology deploys in situ chemical reduction (ISCR) mechanisms for treatment of impacted groundwater. It is comprised of two ingredients which are easily combined and diluted for injection: i) ELS™ Microemulsion; a controlled-release food-grade carbon in the form of lecithin, and ii) EHC® Liquid Reagent Mix; an organo-iron compound. The addition of organic carbon in a saturated zone is widely known to promote conventional enzymatic reductive dechlorination (ERD) reactions. As bacteria ferment the ELS™ Microemulsion component, they release a variety of volatile fatty acids (VFAs) such as lactic, propionic and butyric, which diffuse from the site of fermentation into the groundwater plume, and serve as electron donors for other bacteria, including dehalogenators. Lecithin itself is primarily composed of phospholipids, with both hydrophilic and hydrophobic properties in the molecular structure. Further, phospholipids support ERD by providing essential nutrients (carbon, nitrogen, phosphorus) to bacteria. Synergistically, the soluble organo-iron component is contains a source of a ferrous iron (Fe[II]) that can combine with other elements to biogeochemically form a variety of reactive iron minerals (e.g. magnetite, pyrite). These minerals are capable of ISCR of contaminants as they oxidize further to the ferric (Fe[III]) state via one electron transfer. The Fe[III] can then be “recycled” back to Fe[II], as long as other electrons from supplied carbon and indigenous carbon are available. In the intervention areas and the respective downstream sectors, standard Pump & Treat wells were located, designed to accelerate the removal of various contaminants. However, the presence of active pumps inside, or in the immediate vicinity, of the EHC® Liquid injection zones could have compromised ISCR/ERD effectiveness. This is a function of an increase in groundwater flow rate and potential removal of the injected emulsion and EHC® Liquid mix. For this reason, a strategy was planned to optimize the onsite wells by reducing the groundwater extraction rates, thus protecting effectiveness of the ISCR/ERD treatment. Through use of mathematical modelling, optimal extraction rates were defined which would keep the natural seepage velocity to less than 300 m/year in the ERD treatment area. Application of the EHC® Liquid remedial reagents was performed via direct injection through fixed Manchette tubes distributed in the

source area and hot spots. Less than 12 months after injection of EHC® Liquid into the main source area and hot spots, concentrations of CT and CF contaminants were rapidly reduced up to 95% compared to pre-treatment levels. Requisite remedial target values were reached in all main monitoring piezometers in the areas. The major observations of field parameters in the ISCR & ERD treatment areas included: i) an increase of manganese and Fe[II] in solution as anaerobic cometabolites, ii) a decrease of competing electron acceptors dissolved oxygen and sulfate, stability of pH in the neutral range, and iii) establishment of negative Redox around -150 mV.

Keywords: Bioremediation, Dechlorination, Microemulsion, Groundwater, Carbon Tetrachloride, Chloroform

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Application of an All-In-One ISCO Technology for the treatment of Monochlorobenzene, BTEX and Chloroform in groundwater at a Former Pharmaceutical Facility in Italy

Alberto Leombruni

Evonik Operations GmbH

Abstract

Activated Klozur® persulfate creates a multi-radical attack providing greater oxidation power capable of treating common and the most recalcitrant compounds alike. Klozur® persulfates include both sodium (SP) and potassium (KP) products. Both dissolve to provide the persulfate anion, which is typically stable for weeks to months. Sodium persulfate is highly soluble and available to react at the time of application whereas the low solubility of potassium persulfate has been observed to provide extended release of the persulfate anion over months to years. This allows immediate distribution in the subsurface with the stability providing a greater radius of influence and allowing more time to make contact and degrade a wide variety of contaminants in soil and groundwater, including chlorinated solvents, petroleum hydrocarbons, and PAH's. Klozur® CR, a blend of Klozur® SP (sodium persulfate) and PermeOx® Ultra (extended-release calcium peroxide), coupled with Klozur® KP has been selected as the best long-lasting treatment solution for the contaminants of this site by providing immediate treatment with the Klozur® SP and extended treatment with both the PermeOx® Ultra and Klozur® KP. Klozur technology has been successfully applied at several sites in Italy within the past few years. This presentation will discuss the broader program using specific sites as case studies. One of these specific sites was at a densely populated urban area site in the northern Italy. The site was characterized by historical contamination of various toxic compounds. The site, a dismantled former pharmaceutical facility, was impacted by the storage of Hydrocarbons and Chlorinates Solvents which have resulted in the groundwater contamination, including benzene (~ 1000 µg/L), monochlorobenzene (~ 250000 µg/L), chloroform (~ 54000 µg/L) and light TPHs (~ 16000 µg/L). In 2022, a successful pilot has been implemented injecting on site a total of 5600 kg of Klozur CR along with 1700 kg of Klozur KP in a 25% aqueous solution. In 2023, full scale has been completed applying approximately 29 MT of Klozur CR and 9 MT of Klozur KP in a 25% aqueous solution. The combined remedy of ISCO followed by bioremediation has proven successful in treating petroleum hydrocarbon and chlorinated solvent contamination. With regard to the Northern Italy site, following 12 months after the full-scale application, the concentrations of contaminants had reached and maintained concentrations below the remediation goals in all monitoring piezometers in the treatment area. In particular, TPHs were reduced by greater than 85 percent, while MCB was reduced by greater than 95 percent. Monitoring data confirmed sustained

elevation of oxidation-reduction potential (ORP) and dissolved oxygen (DO) as necessary subsurface conditions to support treatment.

Keywords: ISCO, Bioremediation, Combined strategy, Groundwater, Monochlorobenzene, Toluene, Chloroform

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Assessing NW Iberian Blue Carbon Ecosystems and their dynamics in recent decades

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Abstract

Coastal wetlands, with their abundant biodiversity, provide essential services, supporting fishery and shellfish harvesting, as well as contributing to coastal and estuarine protection and water quality. Furthermore, these highly productive ecosystems play a crucial role in the carbon cycle by capturing and storing significant amounts of carbon dioxide, being therefore denominated Blue Carbon Ecosystems (BCE). Given the climate neutrality challenge posed to Europe and the urgency of preserving and monitoring BCE, which are already impacted by present-day climate change, the Galicia-North Portugal Euroregion cooperation area shares the need to discover sustainable solutions for preserving and enhancing ecosystem services. Thus, there is a collective responsibility to identify the threats, vulnerabilities, and climatic risks BCE face and to establish coordinated actions for their conservation. The CAPTA project strengthens cross-border cooperation by supporting the development of homogeneous procedures and data analyses for BCE climate risks. Within this project, the Faculty of Sciences of Porto University and the Interdisciplinary Centre of Marine and Environmental Research aim to provide valuable information on BCE's growth, health, and services in the study region. The distribution and dynamics of BCE are analysed using historical data and available land-cover/use maps. To assess BCE services, a methodology is tested and optimised for monitoring BCE Aboveground Biomass (AGB) using multispectral (5-band) UAV and Satellite Images. Ground truth, georeferenced with a GNSS antenna with RTK correction, and remote sensing data are used to identify BCE vegetation species and to investigate a possible relationship between aboveground biomass and the spectral signature of species. The models built using high-resolution UAV imagery (2.5 cm GSD) are upscaled to analyse lower-resolution satellite imagery (30 cm GSD), monitoring 350 square kilometres of the region's 14 largest BCE and updating the existing information on the area, dominant species, biomass, and carbon content. Results show that, since the 1990s, the BCE area in the study region has remained relatively stable, shrinking by approximately 1% only. However, with ongoing sea level rise and anthropogenic pressures, projecting future trends is critical for BCE preservation. Therefore, the project will also estimate future trends in the BCE area, considering sea level rise scenarios and BCE-surrounding land use, which may condition BCE migration. In terms of biomass estimation, the adopted methodology has the potential to monitor AGB in BCE through

remote sensing, providing significant insights for coastal management strategies and conservation efforts and contributing to more accurate carbon dioxide inventory programs.

Keywords: Remote sensing, multispectral images, unoccupied aircraft systems, satellite imagery, blue carbon ecosystems

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Land restoration effectiveness assessed by satellite-based remote sensing technologies as a new monitoring approach

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Abstract

To assess the effectiveness of land restoration efforts, traditional methods are often time-consuming, require special skills, expensive, subjective. One of the traditional methods to evaluate restoration effectiveness is direct field observations- used to estimate the condition of the vegetation, soil, and overall ecosystem. These methods primarily can indicate the extent of organic recovery, and accumulation of soil nutrients, particularly their depth and how biodiverse it is. Advanced technologies e.g. satellite-based remote sensing provide more accurate, efficient, and data-driven evaluations. Spectral indices are known indicators for estimating the status of vegetation health, nutrient cycles in soil, soil quality, and biodiversity. Remote sensing is a powerful tool that, when combined with field observations via machine learning and spectral-induced approaches, provides effective results for assessing the land restoration of ecosystems. While the implementation of the indicators can be done and analyzed. This study examines that there is potential for multispectral imagery across visible and near-infrared regions collected by satellite data to prove the effectiveness of restoration activities as a sustainable ecosystem method assessing the values and properties of vegetation indicators. In this context, this study will demonstrate that using Landsat or Sentinel satellite's multispectral imageries was employed to monitor the restoration effects during a time series of seasons on multiple Mediterranean pilot areas. One of the pilot areas is Food Forest in Bethlehem of Galilee, Israel. Since 2017, the owners started to enhance biodiversity and regenerate soil, adopting agroforestry principles. We have achieved significant results while applying the vegetation indicators as compared to a control area that is adjacent to it where traditional agriculture is practiced without any treatment. Additionally, notable findings were when indicators were applied on planted forests in Heraklion, Greece where no active restoration was applied, demonstrating the effectiveness of natural processes. Spectral information is used to evaluate plant robustness, biomass, health, and vegetation diversity values. By calculating the top-down satellite-based indicators on multiple areas in the Mediterranean region, results show an excellent performance, which shows that deep network-based near-infrared remote sensing technology has a future potential to become an alternative and reliable monitoring method for sustainable ecosystem land restoration.

Keywords: Restoration Actions, Forest, Top-Down Indicators, Satellite-based Remote Sensing, Time-Series.

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Synergistic Fungal-Bacterial Consortia Mediated Bioremediation of Petroleum-Contaminated Soils Using Spent Mushroom Substrates

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Abstract

The contamination of soils with petroleum hydrocarbons (TPHs) represents a significant environmental challenge, due to the toxicity, persistence, and complex composition of these contaminants. Bioremediation, which uses the metabolic capabilities of microorganisms to mitigate pollution, represents a sustainable approach to addressing this issue. This study examines the potential of spent mushroom substrates (SMS) from three fungal species, *Agaricus bisporus*, *Pleurotus eryngii*, and *Pleurotus ostreatus*, to facilitate the biodegradation of TPHs in contaminated soils. The main objective was to elucidate the shifts in soil microbial communities resulting from SMS amendments. A comprehensive bioremediation assay was conducted using microbiopiles containing soil contaminated TPHs and various SMS treatments. The experimental design included untreated soil as a control and seven different SMS treatments. Soil samples were collected and analyzed at the beginning and end of a 60-day incubation period to assess microbial activity, TPHs degradation, taxonomic shifts, and predictive functional gene profiles. The results demonstrate that all SMS treatments significantly enhanced the degradation of both aliphatic and aromatic hydrocarbons. Among the SMS types, *A. bisporus* exhibited the highest efficacy, promoting an efficient microbial consortium comprising bacterial families such as *Alcanivoraceae*, *Alcaligenaceae*, and *Dietziaceae*, along with fungal genera *Scedosporium* and *Aspergillus*. The introduction of SMS led to substantial shifts in the soil microbiota, increasing the abundance of hydrocarbon-degrading microorganisms. Metagenomic analyses revealed that the microbial community dynamics and functional capabilities were profoundly influenced by the type of SMS applied. Predictive functional analysis using PICRUSt2 indicated that there were also changes in the degradative genes associated with hydrocarbon metabolism. These findings suggest that SMS not only serves as a nutrient source and physical amendment but also actively alters the microbial ecology to favour biodegradation processes. This study provides novel insights into the complex interactions between soil microorganisms and fungal substrates in the context of TPHs bioremediation. The integration of advanced sequencing techniques and bioinformatics tools allows for a deeper understanding of the

microbial mechanisms driving the degradation of contaminants. The implications of these findings extend to the development of more effective bioremediation strategies, taking advantage of the synergistic relationships between fungi and bacteria. In conclusion, spent mushroom substrates, particularly from *A. bisporus*, represent a promising biotechnological solution for the remediation of hydrocarbon-contaminated soils. Future research should explore the scalability of this approach and its application in diverse environmental settings.

Keywords: Biodegradation, Fungi, Bacteria, soil microbiota, microbial consortium

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Comparison of Different Digital Elevation Models (DEM) in the Google Earth Engine Database with Türkiye Topographic Map Data

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Abstract

Topography is a pivotal variable in both the restoration of terrestrial ecosystems and the determination of soil formation processes. Remote sensing and machine learning methodologies represent critical advancements in this domain. The Google Earth Engine (GEE) platform stands out for its expeditious provision of digital elevation models (DEMs) across various spatial resolutions, including Copernicus DEM GLO-30 and GMTED2010. This study performed a comparative analysis of these datasets with National Topographic Data. Elevation data derived from distinct DEM datasets within the confines of the Gönen district in the Isparta province were subjected to rigorous comparison and subsequent post hoc analysis. The findings revealed no statistically significant disparities among the three datasets ($p<0.05$). Each dataset exhibited commensurate elevation values, thus meriting recognition as a reliable data source. In conclusion, comparing DEM datasets with different spatial resolutions is an important step in the restoration and monitoring of terrestrial ecosystems. The fact that these data sets provide compatible results shows that they can be used effectively in future studies.

Keywords: Topography, Remote sensing, Terrestrial ecosystems, Digital elevation models, Monitoring

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Fencing Mediterranean Shrubland, a Decade Later

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Abstract

Soil degradation and desertification are considered major threats to Mediterranean ecosystems (Daliakopoulos et al., 2017). Marginal maquis shrublands of Messara in Crete, Greece, are a typical example of poor land management under Mediterranean conditions, with overgrazing (Papanastasis et al., 2017) shaping vegetation composition and density (Jucker Riva et al., 2017), and leading to widespread soil erosion and desertification (Kosmas et al., 2015). With ecosystem restoration becoming a global priority (Robinson et al., 2012), total removal of livestock and revegetation actions have been widespread throughout the Mediterranean (Korkanç, 2014). However, few of these restoration projects have been analysed after the intervention (Nadal-Romero et al., 2016). Land function analysis (LFA) (Tongway et al., 2004) is the weapon of choice for assessing the impact of land use in a wide range of climates and ecosystems including semi-arid rangelands (Maestre & Puche, 2009), and semi-arid woodlands (Eldridge & Delgado-Baquerizo, 2018). Here we use LFA to assess the restoration of a former grazing site in the present (2024), hereafter called “fenced” (0.45 ha), where livestock had to be excluded to comply with a CAP afforestation action taking place in adjacent land. A neighbouring site (0.71 ha), which was assessed using LFA during FP7 Project “CASCADE” in 2014 and where land management continues “as usual”, serves as the control plot. Preliminary results indicate that, while soil stability index of the control remained unchanged at 54.3% (±2.7%) for 2014 and 52.9% (±2.9%), by 2024, that of the fenced plot increased to 67.4% (±3.2%). More importantly, while the landscape organization index (percentage of patches) in the control declined from 68% (±5.2%) to 36% (±10.72%), that of the fenced plot increased to 90% (±1.49%). At the same time, while the average interpatch length of the control plot increased from 0.75 m (±0.09 m) in 2014 to 1.4 m (±0.34 m) in 2024, that of the fenced plot decreased to 0.62 m (±0.80 m). On the other hand, there are no differences between the sites’ infiltration index (mean value 31.3%), and nutrient cycling depicts differences between the older (2014) measurements of the degraded site (23.8%±2.3%) and the fenced one (34.8%± 5.5%), but not between the aforementioned and the more recent measurements of the degraded (27.9%±3.9%). According to our results, fencing (a) promoted the recovery of the site, (b) enhanced resources conservation towards improved ecosystem functioning, and (c) reduced overland flow connectivity towards improved resources stability. This study will serve as a proof of concept to assess ecosystem restoration in other plots under a diversity of land uses including afforestation and terracing.

Keywords: Landscape Function Analysis, LFA, Overgrazing, soil stability, Livestock exclusion

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Advanced analysis methods for woody crops using GIS, remote sensing, and vegetation index: The case of Mediterranean vineyards

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Abstract

One of the major challenges in contemporary agriculture is the proper management of agricultural environments and their crops, with a sustainable focus for future generations. This requires multidisciplinary involvement from both the scientific and professional experts of the sector. This communication aims to present the results of a methodological study employing GIS and remote sensing, to identify the best way to manage a conventional vineyard. The main goal is to test different dataset of vegetation indexes using satellites and drones to be processed through various tools and techniques within a specific study area. This area is located in an experimental vineyard plot in Villamena (Granada, Spain), covering approximately 9.2 hectares. Since mid-2022, various data from remote sensors (both aerial and satellite) have been collected. The study began with a highly accurate multispectral and orthophotogrammetric UAV flight (spatial resolution≈3 cm^2), complementing the UAV's limited temporal resolution with satellite images from different providers (from Sentinel 2 to very high-resolution images). This initial study demonstrates the effectiveness of these specific technologies for studying and monitoring the vineyard, which can be expanded to any similar Mediterranean-type crop.

Keywords: Remote Monitoring, Geospatial Technologies, Crop Analysis, Precision Agricultur

Acknowledgments: We would like to thank the owners of Bodegas Calvente, in the Villamena municipality (Granada, Spain) and colleagues that helped us to conduct this research in the field. This work was produced with the support of a 2021 Leonardo Grant for Researchers and Cultural Creators and BBVA Foundation and is gratefully acknowledged. Also, we want to thank the Projects granted by the University of Granada within the Plan Propio: i) PP2022.EI-01 Caracterizando la degradación ambiental en el viñedo granadino. Un enfoque multidisciplinar a largo plazo utilizando parcelas experimentales y muestreos poblacionales; ii) PPJIA2022-58 Caracterización hídrica del suelo en viñedos para la optimización de recursos agrícolas y ambientales; c) Visiting Scholar; and, d) Grupos Operativos (CAPDE-AGRI Junta de Andalucía) GOPG-GR-23-0003 Proyecto GO-SOSVITI

Session SB: Science brokers for transitioning to a climate resilient and circular society

Session organisers

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After the party is over: looking back at the successful conception of four Dutch NBS

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Abstract

While Nature-Based Solutions admittingly have proven benefits for a wide range of issues, they are generally not the solution of choice when faced with a pressing issue. How are NBS-projects realized (process) and how can (the choice for) NBS be stimulated? Comisisoned by the Dutch Ministry of Agriculture, Nature & Food Quality, Wageningen Research investigated four realized NBS project sites in the Netherlands: 1) the Koopmanspolder (a double dike water retention zone), 2) the Grensmaas (river gravel extraction combined with flood safety & nature development), 3) the 'Bee'landscape Noord-Brabant (municipal measures for bees), and 4) the Hoorn foreshore (flood safety & recreation). Research was carried out with approximately 4 to 10 interviews per case with stakeholders (both promoters and opponents), along with literature research. Using a policy arrangement framework (Arts & Tatenhove, 2004) we were able to highlight specific institutional, financial, governance and human factors that influence the process of a new NBS intervention. The project tried to capture the rich narrative of politics and planning in a modern democracy. The processes our interviewees went through, although specific to their cases, are undoubtedly of value to the broader NBS community. We look forward to discuss our findings with participants and to reflect on policy processes to stimulate NBS. We are currently starting a community around our NBS research sites and hope to connect policy makers to practitioners, and to the wider scientific community.

Keywords: policy process, success, case study, politics, governance

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Setting up a region-focused strategic research and innovation agenda for soil health in Europe

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Abstract

Soil health is essential for achieving climate neutrality, a clean and circular economy and stopping desertification and land degradation. It is also essential to reverse biodiversity loss, provide healthy food and safeguard human health. Within the EU funded project PREPSOIL 20 regions across Europe were consulted to assess the regional soil needs using a methodology (DPSIR) to evaluate the different drivers of change, processes that lie at the basis of the soil needs, the current state of soils and the way people use it, the impact the soil state has on the biophysical and socio-economic situation, and the possible solutions that could be implemented to mitigate the issues that are forming the barriers for change in every specific area. This information together with a synthesis of insights generated from relevant projects such as EJP SOIL and running projects under the Mission Soil a region-focussed strategic research agenda will be made that aims to guide the implementation of the Mission Soil's ambition to roll out successful LLs and LHs across Europe and identify soil needs related to the transitional change needed to adapt to biophysical and socio-economic changes. For this, for each land use (agriculture, forestry, natural areas and urban and industrial areas) the most important drivers, constraints and research and innovation gaps were identified for four regions in Europe (North, South, East, West). Important elements of the output will be i) R&I needs for soil health including the landscape view; ii) inventory of policy and socio-economic constraints and opportunities for LL/LH design and implementation including business plans; iii) soil literacy needs; iv) soil needs for multi-land use areas; v) soil needs for changing land use including restoration; vi) drivers of land use change; vii) policy barriers and needs for broad implementation of sustainable land use practices; and viii) how to advance good practices.

Keywords: regional roadmap for research, Living Labs, Lighthouses, Innovation, stakeholders, soil needs

Acknowledgments: PREPSOIL project; Horizon Europe funded number: 101070045

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Enhancing Higher Education in Agriculture Through Multi-Institutional Course Design and Implementation.

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Abstract

In an era of declining operating budgets for higher education institutions, providing university courses that captivate students' interests and impart practical knowledge can be a challenge. One innovative solution is to leverage the expertise of professionals across multiple institutions to collaboratively teach a single course. Multi-institutional courses offer many benefits but are time and resource intensive at the development stage. A course entitled “Cover Crops in Agroecosystem” was jointly offered and taught by faculty at seven universities across the United States. Higher education instructors as well as primary and secondary educators will benefit by recognizing the critical considerations involved of designing and implementing a collaborative multi-institutional agricultural course. Examining student and instructor artifacts after the first two of three course offerings led to identifying course adjustments to improve the overall student learning experience and time efficiency for instructors.

Keywords: multi-institutional agricultural course design, collaborative teaching,

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Real-Time Insights: Revolutionizing Ecophysiological Education Amidst the Climate Change using the Interactive BioMeteorological Online Lab

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Abstract

The contribution aims to present a newly built online biometeorological laboratory www.biolab.sk that, through a user-friendly web application, depicts and examines the response of physiological processes of plants (a biological component of the landscape) and soil moisture characteristics to changing environmental conditions (abiotic component) and their interactions in situ and in real-time. The project features modern live streaming of processes occurring in woody plants (sap flow and stem circumference changes) and in the environment, alongside their reactions to changing atmospheric conditions, directly to the user's mobile phone and computer. The primary advantage of the online educational laboratory is the ability to display and analyse current data, as well as to work with historical data in a cloud environment without additional software installation. That makes the laboratory a unique interactive educational tool for students of forestry or ecological disciplines and public users alike. Interactivity, online access, and cloud accessibility enhance the utility of the BioMeteorological laboratory in distance education, significantly increasing the efficiency and accessibility of the educational process. This approach improves the level of awareness of the functional relationships between physiological processes in the environment and weather conditions, thus supporting systematic education. By integrating education and practical application, the laboratory plays a crucial role in preparing the population and various economic sectors for impending climate change. The scientific research conducted as part of this comprehensive educational project, which we proudly present here, is extensively described and showcased on the website www.biolab.sk. This site is a testament to our commitment to raising awareness and educating not only students but also the broader professional and lay public on the crucial issue of adapting forestry activities to future climatic conditions. We believe that by providing this comprehensive resource, we are empowering you to make informed decisions and take responsible actions in the face of climate change.

Keywords: education, online lab, ecophysiology, changing conditions, tree sap flow, stem circumference

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Republic and by the Slovak Research and Development Agency under contract No. APVV-21-0224.

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Developing a Carbon farming framework supporting Ireland to meet its climate targets

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Abstract

The European Commission defines carbon farming as “a green business model that rewards land managers for taking up improved land management practices, resulting in the increase of carbon sequestration in living biomass, dead organic matter, and soils by enhancing carbon capture and/or reducing the release of carbon into the atmosphere, in respect of ecological principles. Carbon farming can enable the facilitation of certified climate action which has the potential to be rewarded through result-based contracts/approach with other actors in the value chain or through public support.” In its role of helping Ireland meet its Climate targets, a fit for purpose National Carbon Farming Framework will provide opportunities for Irish farmers/land managers to derive a new and diversified income stream for their farm. It is essential that this Framework provides confidence, trust, fairness, verification and certification to support rewarding Irish farmers/foresters for the actions they take to remove and store carbon in our soils, forests, grasslands, croplands, peatlands and hedgerows. The Framework will create the structures needed to leverage appropriate financial incentives to scale up adoption of measures by land managers that will result in Ireland achieving its ambitious targets on emissions reductions, biodiversity and water quality improvements. The Core Carbon Principles (CCPs), have been adopted to set out fundamental principles for high-quality credits that create real, verifiable climate impact, based on the latest science and best practice. Following input through public consultation, the CCPs have been adapted to include biodiversity/water quality improvements in the Irish context. Two additional overarching principles have also guided the development of this Framework; Just Transition & Learning By Doing. This research presents the outcomes of a public consultation, elements of policy lab and describes the process to develop the national framework and outlines the framework that will be submitted for approval by the government. Elements of the new policy identified as key by various stakeholder groups will be described, as well as areas of concern and implementation conditions that should be ensured. Analysing qualitative data from the entire policy creation process as well as quantitative data from the public consultation stage itself, we use the Transformative Innovation Policy approach, trying to understand what forms of creating climate policies have the greatest potential to activate various resources.

Keywords: Carbon farming, ecosystem, public consultation, climate policy, governance

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Deep Demonstration partnership: Sustainable food systems in Ireland

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Abstract

Decarbonising agriculture and food production is one of the biggest challenges of this century. Ireland's agri-food sector contributes 38% of the country's overall greenhouse gas emissions. Yet Ireland has committed to cut 25% emissions in the agri-food sector by 2030, and to achieve climate neutrality by 2050. The Deep Demonstration partnership between EIT Climate-KIC and Ireland's Department of Agriculture, Food, and the Marine is supporting the entire Irish land and agri-food value chain to identify and implement sustainable practices, so that farmer communities can thrive and agri-food industries can transition to sustainable business models, all while meeting challenging climate targets. Two years after its kick-off, the partnership has achieved a comprehensive mapping of the system, and identified concrete pathways grouped under seven flagship areas of innovation to overcome challenges for farmer communities and citizens, such as reducing emissions, diversifying incomes, cutting food waste, and shifting to healthy diets. These include both immediate outcomes in dairy farm emission reduction, sustainable beef production, carbon farming and tillage, as well as long-term objectives such as investing in new value chains and alternative proteins, help entire regions become circular, and chart a new vision for the future of farming. We are now moving to implement four of these frameworks. The presentation will provide an overview of the activities implemented so far and will detail its current approach on obtaining investment in implementation of a portfolio of systemic innovations.

Keywords: Systems innovation, Deep demonstration, learning-by-doing, innovation in finance

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Nature based solutions for regeneration of a small brook and adjacent wetland in the Netherlands

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Abstract

The Noorbeemden, a Natura 2000 nature area in the southernmost part of The Netherlands, is a diverse but fragile wet ecosystem. The vegetation is strongly depending on seepage from the deeper $CaCO_3$ rich geological formations. The Noor brook cuts deeply into the unconsolidated valley fill sediments. This deep incision accelerated over the last decades due to exceptional peak flow discharges, caused by extreme weather conditions causing overland flow and sewage spills. Because of this deep incision it is feared that in near future seepage may go directly to the Noor brook instead of the Noorbeemden. Since 2016, several experiments have been done to prevent further incision, while rising the channel bed. One example is involving the suppletion of woody debris dams at vulnerable locations (Campuzano, 2017); Mesman, 2019). These experiments provided positive results in reducing flow velocity and erosion and promoted sediment aggradation in certain areas. However, woody debris proved to be a temporary solution and has the risk of accelerated erosion below the woody debris patches. Experiments with gravel suppletion in combination with woody debris patches showed that accelerated erosion below woody debris could be reduced. Recently, Woolderink & Harkema (2023) explored strategies to achieve a morphodynamic equilibrium in combination with preserving the aquatic ecosystem, by exploring the pro’s and con’s of gravel bed armouring and gabion dams. It was found that gravel up to 10cm and larger is needed to create a stable brook bed, even under extreme discharge conditions. Ramirez Cortes (2024) used HEC-RAS modelling technique to do a 1D steady state and a 1D quasi unsteady state analysis to see where and how much erosion and sedimentation could be expected. It is concluded that armouring of 5cm gravel in combination with gabion dams can protect the book bed and thus the Noorbeemden.

Keywords: HEC-RAS modelling, armouring, peak discharge, wet ecosystem, gabion dams

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Noor Brook. MSc thesis report Wageningen University.

Program for TERRAenVISION 4 in València

Preconference excursions	
6th July	The lagoon of Prat de Cabanes Torreblanca. The challenges of a coast under the pressure of Turism
7th July	Due to rough sea the boat trip is cancelled. We are now planning an alternative trip. Soon to be updated here.

Monday 8th of July:		
11.00-13.00	City walk for NBS in Valencia city. Departing from the NORD train station.	
13.00-14.00	Registration	
14.00-14.30	Opening by UVEG	
14.30-15.00	Opening keynote: Fernando Valladares (CSIC)	
15.30-17.00	Plenary session NATURE BASED SOLUTIONS FOR AGRICULTURE AND NATURE AREAS (SOIL, WATER AND LANDSCAPE) (Aula) Keynote 1: Robert Zougmore (AICCRA West Africa Lead, CGIAR) Keynote 2: Dinesh Dhanush (Clim-Eat) Discussion between keynotes and audience	
17.00-17.30	Coffee/tea/orxata break	
17.30-19.00 Parallel Session	AN Land management and carbon sequestration in agricultural soils (Aula)	AN Microorganisms in Agriculture: Direct Application or Management (room 2)
19.00-20.30	Poster session	

Tuesday 9th July			
8.00-9.00	Registration		
9.00-10.30	Plenary session theme Methodologies: how to measure processes and impact of Nature-based solutions (Aula) chair: Keynote 1: Gemma Garcia Blanca (Technalia) Keynote 2: Stéphane Ourevitch (**EUSSO**) Discussion between keynotes and audience		
10.30-11.00	Coffee/tea/orxata break		
11.00-12.30 Parallel session	NH: Nature based solutions for increasing resilience to water-related hazards (Aula)	MET: Advances in land ecosystem restoration monitoring using remote sensing and machine learning (room 2)	Workshop: Synergies and trade-offs of carbon sequestration as a climate mitigation solution (room 3)
12.30-14.00	Lunch break		
14.00-15.30	Plenary session theme: Nature-based solutions for natural hazards (Fire, Floods and Droughts) (Aula) chair: Keynote 1: Heleen van den Hombergh (IUCN) Keynote 2: Celia Gouveia (University of Lisbon) Discussion between keynotes and audience		
15.30-16.00	Coffee/tea/orxata break		
16.00-17.30 Parallel session	AN: Nature-based solutions for agriculture and natural areas (soil, water and landscape)(Aula)	NH: NBS for landscape resilience (fire, droughts and extreme events)(room 2)	MET: **NBS for sustainable soil management and biodiversity. (room 3)**
17.30-19.00	Poster session with refreshments		
21.00-	Conference dinner in DON PELAYO RESTAURANT Address restaurant: Carrer d'Antonio Sacramento, 17, Quatre Carreres, 46013 València		

Wednesday 10th July			
8.00-9.00	**Registration**		
9.00-10.30	**Plenary session theme: SCIENCE BROKERS FOR TRANSITIONING TO A CLIMATE RESILIENT AND CIRCULAR SOCIETY (Aula) chair: Margot De Cleen** **Keynote 1: Wouter Vanneuville (European Environment Agency)** **Keynote 2: Pablo Modernel, (Friesland Campina)** **Discussion between keynotes and audience**		
10.30-11.00	**Coffee/tea/orxata break**		
11.00-12.30 Parallel session 2	**SB: Science brokers for transitioning to a climate resilient and circular society (Aula)**	**Workshop** Workshop: Realising carbon neutrality across scales from farm level to landscapes **(room 3)**	**Workshop Humus (room 2)**
12.30-14.00	**Lunch break**		
14.00-15.30	**Plenary session theme: Theme Nature-based solutions for urban and industrial areas (soil, water and spatial planning). Sustainable solutions for the València City. (Aula) chair: Artemi Cerdà** **Keynote 1: Guiseppe Grezzi (Mobility plans in València city)** **Keynote 2: Natxo Lacomba (European Green Capital Valencia)** **Keynote 3: Emilio Barba (Universitat de València)** **Discussion between keynotes and audience**		
15.30-16.00	**Coffee/tea/orxata break**		
16.00-17.30 Parallel session	**Nature based solutions in urban areas (Aula)**	**Workshop Transition towards Circular Land and Soil Management; Building networks, bringing together interests and coping with friction in regulation (Room 3)**	
17.30-19.30	**Poster session with refreshments and closing of indoor event**		

11th July: Conference excursion	
11th July	NBS in coastal wetlands in Valencia. Nature and agriculture. The Natural Park of L'Albufera. A Geographical Approach.

Post-conference excursions

12th July	Drip and flood irrigation systems in La Costera and La Safor districts. Water and Soil under the commercial agriculture. Problems and solutions.
13th July	Rainfed vineyards and olives in Moixent and Font de la Figuera. Quality of agriculture products and landscapes. There is a future for traditional rainfed agriculture?

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