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

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TerraEnVision 2022

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

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The Mission of TerraEnVision 2022

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
Wageningen Environmental Research, Netherlands, Conjoint Associate Professor,
University of Newcastle, Australia

Keynote speakers

Esther Blom

Co-director, Stichting Ark



Esther Blom (1972) is a biologist who majored in vegetation ecology at the Utrecht University. Ever since, she has worked for the conservation of nature, internationally as well as in the Netherlands, always for NGOs. Esther was the secretary of a small grants fund for the conservation and restoration of wetlands in developing countries, hosted by IUCN Netherlands. For the Mountain Institute she studied the high-altitude wetlands of Nepal and Tibet. At WWF-NL, she headed the freshwater programme, during which she was closely involved in the river restoration work in China as well as the Southwest delta of the Meuse-Rhine, in the Netherlands. For the latter, she set up a large restoration programme for the Haringvliet, a cooperation between the six Dutch biggest NGOs. Since over 5 years she works for ARK Nature, where she is one of the two directors. ARK focuses on rewilding the Netherlands and surrounding regions.

Drs. H.Th.M. (Hein) Pieper

Dijkgraaf of Waterschap Rijn en IJssel



Drs. H.Th.M. (Hein) Pieper is dijkgraaf [chair] of Waterschap Rijn en IJssel [regional water authority Rijn en IJssel] since 2011 and president of the European Union of Water Management Associations. He has been vice-chairman of the Unie van Waterschappen [Dutch Water Authorities] from 2015 to 2021 and expert in the Horizon Mission Board, advising the European Commission on climate adaptation and social transformation (2019-2021). In these positions he connects parties and partners, thereby putting water and water management on the international, national and regional agenda.

Annette Schneegans

Senior Expert, DG for Agriculture and Rural Development



Annette Schneegans is a senior expert at the European Commission, with a track record of almost 20 years on European research policy and research funding, notably in the areas of life sciences and agriculture. Within her current activities, Annette is responsible for research programming in the areas of crop production and natural resources. This includes overseeing the research portfolio on plant genetic resources and breeding. As secretariat for the Mission Board Soil Health and Food she has contributed to the development of Horizon Europe mission “A Soil Deal for Europe” and will be involved in its implementation. Annette has an academic background in agricultural sciences and international agricultural development with a focus on plant nutrition.

Lilian van den Aarsen

Director, Central Office of the National Delta Programme Commisioner



My experience lies in connecting knowledge and policy and connecting state and region. After my promotion at Wageningen University & Research, I went from the scientific world to working at the government, a conscious choice for the public cause. My affinity lies in the physical domain and especially: water, nature, environment, landscape and spatial planning. Later, I did my MPA (master of public administration) study at the Netherlands School of Public Administration. Since 1-12-2020 I am the director of the central office of the National Delta Programme Commisioner. The Deltaprogramme focuses on protecting the Netherlands from flooding, to ensure a sufficient supply of fresh water, and to contribute to rendering the Netherlands climate-proof and water-resilient. The programme involves concerted efforts by several governments and organisations. From 2010-2020, I worked at the Ministry of Infrastructure and Water Management as director of Knowledge, Innovation and Strategy (KIS) which stimulates, supports and coordinates the use of knowledge and innovation in the primary policy process. Before this, I was program director of the Delta program Rivers. Here, representatives of provinces, water boards and the central government worked together on a long term sustainable strategy for the entire river delta, including a strategic knowledge and innovation agenda for water security and other spatial ambitions. I’ve started at the Ministry of Agriculture, Nature and Food Quality, first at the board of nature management and later at the board of regional affairs as the regional director east. The driving motivation for my studies and work is to contribute to a more ecologically healthy and sustainable world. My phD-research focused on the application of an ecological theory on persistence and resilience as a framework for judging interactions between agriculture and nature conservation. I am still interested in the use of ecological theories in policy- and decisionmaking, therefore my interest in 4TU Resilience Engineering.

Nicola Di Virgilio

Policy Analyst, DG Agriculture and Rural Development



Nicola Di Virgilio is policy analyst at the European Commission's DG Agriculture and rural development, Unit B.2 Environmental sustainability. He is seconded National Expert from the National Research Council of Italy – Institute for the Bioeconomy, with research and innovation experience on climate change mitigation and adaptation in agriculture. He graduated in Agricultural sciences at the University of Bologna and holds a PhD on environmental sustainability of land use in agriculture. Nicola Di Virgilio provides a keynote speech for Theme 3 of TerraEnVision.

Willem H. Ferwerda

CEO Commonland Foundation



Ferwerda is CEO of Commonland, that he founded in 2013 with the Rotterdam School of Management -Erasmus University, the IUCN Commission on Ecosystem Management and the COmON Foundation. Commonland is a system developer of large integrated, holistic landscape management and restoration projects, bringing solutions at a landscape scale on biodiversity, carbon, regenerative agriculture, and communities. Ferwerda is involved as an advisor or board member with various international organizations in the field of nature, biodiversity, agriculture, and sustainability. He is executive fellow at the Rotterdam School of Management - Erasmus University, and theme lead at the IUCN Commission on Ecosystem Management. In 2016, he was awarded first place in the Sustainable 100, the list of Dutch people with the most influence on the environment and sustainability. In 2019 Ferwerda received the Dutch sustainable landscape award. From 2000-2012 Ferwerda was director of IUCN Netherlands. There he was, among other things, leading large ecosystem grants programs, and initiator of Leaders for Nature, an international network of CEOs and prominent people from the business community addressing biodiversity conservation. It led to several agreements and policy changes with industrial networks. Between 1995 and 2000 he headed the Tropical Rainforest Grants Program of IUCN NL that supported hundreds local conservation and restoration projects in more than 40 countries. In 2012, Ferwerda left IUCN NL for a sabbatical in which he developed the 4 Returns Framework on Landscape Restoration. Ferwerda studied biology, tropical agriculture and environmental science at the Free University and University of Amsterdam in The Netherlands and at the Universidad Nacional in Bogotá, Colombia. He is specialized in the interaction between tropical ecosystems and agriculture, and system change management. Before joining IUCN, he worked in the eco-tourism industry and led expeditions in Latin America and Europe. The 4 Returns Framework for Landscape Restoration was published in 2015 by the IUCN Commission on Ecosystem Management and the Rotterdam School of Management (Erasmus University) and further developed with other landscape experts and colleagues leading to an updated publication under the UN Decade on Ecosystem Restoration in 2021. Willem Ferwerda will provides a keynote speech on Theme 1 of TerraEnVision.

Prof. Dr. Thomas Hartmann

Chair of Land Policy and Land Management, School of Spatial Planning, TU Dortmund University



Thomas Hartmann is the chair of land policy and land management (www.bodenpolitik .de) at the School of Spatial Planning, TU Dortmund University, Germany. His research focuses on strategies of municipal land policy, and the relation of flood risk management and property rights. He is also vice-chair of LAND4FLOOD (www.land4flood.eu), and president of the International Academic Association on Planning, Law, and Property Rights (www.plpr-association.org).

Dr. Marco Roos

Assistant Professor, Leiden University Medical Center



Trained as a botanist and phylogenetic systematist, as scientist of Naturalis I focus on biodiversity in urban areas. My main interest is in rewilding cities, i.e., spontaneous plant growth and in soil/vegetation succession as a way towards nature inclusive urbanization. I especially pay attention to what can be called hidden biodiversity, small faunistic and floristic organisms, which play an important role in the urban ecology, but which are mostly neglected or even disliked. A recent focus is on soil biodiversity as the intricate soil biome is carrier of the above ground biodiversity. This has a.o. resulted in https://www.nai010.com/nl/publicaties/biodivercity-a-matter-of-vital-soil/245962. A substantial part of my time I am teaching these topics to students from Leiden university and other academic institutions, including the supervision of BSc- and MSc-internships. I have several projects running in Amsterdam, Leiden, The Hague, and other areas in the west of the Netherlands.

Keynotes

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Vol. 3 TNV2022-Keynote-3227
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How to make system change practical at landscape level? Experiences, lessons and needs

Willem H. Ferwerda

CEO, Commonland Foundation

Abstract

It’s clear that we need to transform to healthy landscapes to meet global demand for healthy food and we need to significantly innovate agricultural and other landuse practices and dramatically reduce GHG emissions. This requires integrated and systemic responses, which spark hope. A return of inspiration and enthusiasm is essential for communities to turn back decades or centuries of degradation and rebuild a living landscape. Such initiatives must be based on long-term visions, operate at an ecosystem (landscape) scale and involve a wide range of societal stakeholders in conception, planning and implementation. And, to succeed, these initiatives must be driven by a shared recognition: that we need to reconnect with nature, that the environment is not a lost cause and that we have the power to turn things around. The question is how to do this. The 4 Returns framework for landscape restoration is a generic, practical and tested system-change framework that can be used by stakeholders to undertake a landscape approach. It seeks to balance competing stakeholder demands in a mosaic of different management approaches, to supply a full range of inspirational, natural, social and economic returns. After years of testing, the 4 Returns Framework for restoring landscapes is building a sound concept that can go to scale. It is a valuable tool to achieve the goals of the UN Decade on Ecosystem Restoration and EU Green Deal, and lays the basis for a landscape restoration industry.

Keywords: Experiences, lessons and needs

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Rewilding nature to combat societal challenges

Esther Blom

Co-director, Stichting Ark

Abstract

35 years ago, it was realised that just conserving the remaining nature of the Netherlands would not suffice as a strategy to combat the degradation of ecosystems and the loss of biodiversity. The concept of nature development was introduced and put into practice, in first instance especially in the riverine system of the Netherlands. New nature was developed; nature that was more robust and spontaneous, based on the principle of rewilding. From the beginning, ARK realised that it is necessary to cooperate with other sectors that also profit from this new nature, for example to reach water safety goals, combat droughts, provide space for drinking water and to improve the living environment of municipalities. This presentation will focus on several concrete examples where we combined rewilding with reaching relevant societal goals.

Keywords: societal challenges

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The climate challenge in water management

Drs. H.Th.M. (Hein) Pieper

Dijkgraaf of Waterschap Rijn en IJssel

Abstract

As the Netherlands is 60% below sea level, the present water system is primarily aimed at the rapid drainage of water. Climate change forces us to think and act differently - a great mind shift is needed. From draining water to retain, catch and store water. But there's more. We need to look further, think differently, work and act together. Not with technocratic solutions, not top down, but rooted in the region, together, with respect to nature, culture and history. The perspective on the role of water, water authorities and other parties is explained, and how to deal with the urgent and complex climate challenge in local, national and international context.

Keywords: climate challenge, water management

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EU Climate policies in the land sector

Nicola Di Virgilio

Policy Analyst, DG Agriculture and Rural Development

Abstract

The European Green Deal aims to make Europe climate neutral by 2050. To make this objective legally binding, the Commission proposed the European Climate Law, which also sets a new, more ambitious net greenhouse gas emissions reduction target of at least -55% by 2030, compared to 1990 levels. Stronger provisions on adaptation to climate change is also included. In order to ensure this ambition the Commission adopted a package consisting of a set of inter-connected proposals across a range policy areas and economic sectors: climate, energy and fuels, transport, buildings, land use and forestry. In particular for the land sector, the Commission proposed a sink target of -310 Mt CO_2eq in 2030 and the climate neutrality of the land sector by 2035, by combining emissions of CH_4 and N_2O from agriculture with CO_2 net removals from the land sector. The increase of the EU sink is necessary for balancing residual emissions in 2050 and then reaching the neutrality. The role of land managers for the uptake management practices for carbon sequestration and protection in soil and biomass becomes then fundamental and specific enabling policies and initiatives are required. On The 15 December 2021 the Commission adopted a Communication on Sustainable Carbon Cycles, setting out short- to medium-term actions to also support carbon sequestration in the land sector and upscale this green business model to better reward land managers for carbon sequestration and biodiversity protection. As a key step, the Commission will propose by the end of 2022, an EU regulatory framework for the certification of carbon removals based on robust and transparent carbon accounting rules and requirements to monitor and verify the authenticity and environmental integrity of high-quality sustainable carbon removals. Other initiatives, such as on forest, biodiversity, methane emission reduction and the Farm to Fork strategy are there to ensure an holistic approach of sustainability. The Common Agricultural Policy will anyway remain the main financial instrument for the green transition in rural areas.

Keywords: Climate policies, land sector

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Urban floods and private land-challenges of implementing nature-based solutions

Prof. Dr. Thomas Hartmann

Chair of Land Policy and Land Management, School of Spatial Planning, TU Dortmund University

Abstract

The traditional approach of flood protection with grey infrastructure is increasingly questioned, and nature-based solutions as a complement are discussed in practice and academia. This contribution will discuss three basic characteristics of nature-based solutions for flood risk management in urban areas, leading to fundamental consequences for its implementation. First, nature-based solutions need more land! Second, hitherto, there is a strong focus on measures on public land, while huge potentials and challenges are on private land! Third, the land needed for nature-based solutions is often in private ownership! These three characteristics lead new challenges in the implementation of nature-based solutions. Approaches for collaborating with private land users to realize risk reduction and adaptation measures on private land are lacking in theory and practice. This contributions explores such approaches.

Keywords: floods, land-change

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Wanted: biodiversity in the City; do we realize what it entails? - from decoration to ecology

Dr. Marco Roos

Assistant Professor, Leiden University Medical Center

Abstract

The recent urge to enhance urban biodiversity as a means to improve the ecosystem services in cities is often based on an incomplete view on biodiversity. I will argue that most biodiversity is hidden and neglected, though essential for sustainable urbanization. Innovation is in acceptance and patience: accepting and maintaining ecological processes and patience for the pace of spontaneous soil and vegetation development. Rewilding cities is the key to nature inclusive urbanization.

Keywords: biodiversity, ecosystem services

AG: Transforming agriculture - Nature based Solutions between the poles of tradition and innovation to tackle land degradation

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Agroecosystem diversification and sustainable management lead to increased biodiversity, crop production and socio-economic advantages: the case of Mediterranean olive orchards

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Abstract

Climate change, in terms of increased temperature and extreme precipitation regimes, will have agricultural consequences because of the interrelations between climate, land and water use, soil degradation and landscape changes. Sustainable agriculture offers new chances to mitigate these deleterious effects. Sustainable management practices can increase soil carbon (C) inputs, reduce greenhouse gases emissions from the soil and, at the same time, increase agroecosystem biodiversity. This study shows the benefits of sustainable management on biodiversity, crop production and socio-economic aspects in a Mediterranean olive orchard. In 2000, the field was divided in two plots: *a)* sustainable (S_{mng}) with no-tillage, prunings and spontaneous vegetation used as mulch, irrigation with treated wastewater, correct pruning; *b)* conventional (C_{mng}) with soil tillage, mineral fertilizers, burning of prunings, empirical irrigation and pruning. Results show that a 21-year period of S_{mng} caused increases in soil organic carbon levels (6.74 vs 11.84 t ha^{-1} in the 0-30 cm soil layer), soil water retention (up to 40% more) and soil permeability (from 13 to 160 mm H_2O day^{-1}), so allowing farmers to save irrigation water and improve soil structure (Sofo and Palese, 2021). The adoption of a correct irrigation management had a key role in the potential role of orchards in C sequestration and on vegetational, and on soil faunal and microbiological diversity (Sofo et al., 2019). Compared to dry areas, wetted soils had a higher microbial respiration and SOC mineralization, and a faster bacterial C and N turnover. Finally, the S_{mng} brought benefits on plant yield, that was improved (8.4 vs 6.3 t ha^{-1} yr^{-1}) (Pascazio et al., 2018). The endogenous C additions had positive effects on the reserves of soil water and nutrients (N, P, K, Ca, Mg) and on CO_2 soil emission (Palese et al., 2015). Promoting cost-effective sustainable land use strategies aimed and increasing agroecosystem biodiversity can avoid soil erosion, compaction and contamination, that are important ecosystem services. The S_{mng} was more effective in terms of productivity and profitability. The economic analysis showed that the gross profits of the S_{mng} were considerably higher (6276 vs 1517 € ha^{-1}), likely because of the higher yield and its superior quality (Pergola et al., 2013). Given the importance of the olive growing and the area covered by this crop, the study could be adapted for scaling up for the whole Mediterranean area (9,800,000 ha covered by olive), and adapted for other crops.

Keywords: Agroecosystem biodiversity, ecosystem services, soil carbon storage, socio-economic benefits, sustainable agricultural practices.

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Breaking monoculture: crop rotation scenarios with maize

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Abstract

Maize, together with grass, is the basic component of the ration for cattle in Flanders. On most cattle farms, especially on specialized dairy farms, maize takes up most of the arable land and is often grown for several consecutive years. Monoculture maize, certainly without grass or other cover crops during winter and without additional application of organic material such as farmyard manure, is detrimental to the soil organic matter content and to the physical, chemical and biological soil quality in general. Fields with a history of maize monoculture are often characterised by a poor soil water balance: a low moisture retention capacity, poor water infiltration and silting, resulting in erosion and reduced yields. In recent years, these problems have become even more apparent due to lower fertilisation standards and more extreme weather conditions. The aim of this study was to demonstrate the beneficial effects of crop rotation and breaking maize monoculture on overall soil quality as well as crop profitability on cattle farms. The results of 2 long-term crop rotation trials on sandy and sandy loam soils were used to develop and calculate 8 different crop rotation scenarios, specifically tailored to cattle farmers. Three maize monoculture scenarios, with or without a grass cover during winter, were compared with 5 alternative scenarios including crops such as (3 year) grass-clover, winter cereals, potatoes, fodder beets and field beans as well as mustard cover crops. Fertilisation in the scenarios was based on filling the applicable fertilisation standards with cattle slurry, supplemented with mineral fertiliser, in accordance with the current practice and legislation in cattle farms. Each of these scenarios was calculated from a business economics perspective. The positive effect of the alternative scenarios on the soil organic matter content was calculated using RothC simulations. Based on scientifically substantiated relationships, the beneficial effects of an improved organic matter content on the soil-water balance were translated into potential increase of financial maize yields. Finally, the short- and long-term effects of the scenarios on the availability of mineral nitrogen during the growing season, and thus the possible savings on mineral fertilisers, and on the risk of nitrate leaching during autumn and winter were calculated based on a simple soil-nitrogen balance.

Keywords: maize monoculture, crop rotation, soil quality, soil organic matter, soil nitrogen balance

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Crop diversification in low input viticulture on steep slopes

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Abstract

The EU-funded project DIVERFARMING (Horizon 2020 no 728003) aims to develop and deploy innovative farming and agribusiness models based on crop diversification. Germany is involved with a broad-based study in organic low input viticulture on steep slopes in Wawern (Saar Valley/ wine region Mosel). The investigated *Eutric Skeletic Regosol (Aric, Humic)* is characterised by an extreme soil climatic regime.
A fundamental issue of steep slope viticulture is related to vegetation management below the vines. In order to overcome problems of soil erosion and soil organic matter depletion, an increasing number of winemakers is establishing cover crops such as grasses and legumes in driving lanes. On the contrary, the area underneath the vines is typically kept free of vegetation to avoid fungal diseases and competition on water. As cover crops do not benefit to the value chain and may compete with vines on water or have other adverse effects on vine performance, an alternative strategy for vegetation management underneath vines in steep slope viticulture is required.
Therefore, intercropping vines with perennial herbs like Thyme and Oregano growing underneath is a promising cropping practice to address the abovementioned issues. Both herbs are economically valuable and originate from dry and warm environments, which are typical for most viticultural areas. Furthermore, their relatively low need for water and flat-growing habitus is assumed to be suitable to cover the soil underneath the vines in order to protect against erosion and suppress weeds without having adverse effects on vine growth and -health. In addition, they can be marketed directly or indirectly as extracts for cosmetics, perfumes, dietary supplements, food and plant fortification.
The field experiment is set-up as randomized block design, with three blocks, each consisting of two grapevine rows per treatment. Rows are either cultivated with Riesling (*Vitis vinifera L.*) as monocrop or intercropped with *Origanum vulgare* or *Thymus vulgaris*.
In this presentation, we will inform about the main agronomic, environmental and socioeconomic results.

Keywords: intercropping, grape production, perennial cropping systems, experimental design

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Soil nutrients washing in dehesa farms of Extremadura, SW Spain

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Abstract

The dehesa farms occupy ca. 1.3 million ha of total land surface of Extremadura (40% of its regional territory). This land system is the main life support for millions of livestock such as sheep, cattle and Iberian pigs. The content of soil nutrients is therefore crucial both to ensure soil fertility and to provide pasture production for animal feeding. Nonetheless, these nutrients are unequally distributed in space as a consequence of local topography. This spatial variability has been little studied so far in this kind of environments in spite of being a key factor on the spatial distribution of soil nutrients. The aim of this study was therefore to quantify the amount of key nutrients in soil fertility in 5 representative farms. Soil properties such as nitrogen, phosphorous, potassium and soil organic matter were analysed in 97 sampling points, taking into account the summits, middle slopes and valleys bottom (catena rationale). The results show that more nitrogen accumulates in the summits (0.33%) and in the valleys bottom (0.26%) than in the middle slopes (0.19%). This trend is maintained in other key properties such as phosphorus, as higher values were recorded in the summits (36.08 ppm) and in the valleys bottom (33.69 ppm) than in the middle slopes (25.89 ppm). Furthermore, the difference is also noticeable in the potassium values, since in the summits (0.89 meq 100 g^{-1}) and in the valleys bottom (0.83 meq 100 g^{-1}) higher values were reached than in the middle slopes (0.63 meq 100 g^{-1}). Although these differences are minimised by organic matter, the values for the middle slopes (3.23%) are still lower than those recorded in the valleys bottom (3.39%) and summits (3.77%). Taking into account that the surface occupied by the mid-slopes in some livestock farms reaches almost 68% of the total surface area, the need to apply nutrient retention techniques should be considered. Furthermore, the need to consider spatial variability in the experimental design of future field campaigns is also evidenced.

Keywords: topographic position, fertilisers, rangelands, soil variability

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How does different crop type classifications affect biodiversity indicators in arable regions in Germany: towards (geo)data fitness for use quality metrics

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Abstract

The increasing intensification of agricultural production due to rising population numbers and changing dietary habits is leading to a sharp decline in biodiversity and landscape diversity. The decreasing diversity in agricultural regions has strong impacts on soil quality, species richness and crop yield. In order to observe and analyse the biodiversity trend of recent years, a nationwide monitoring of biodiversity is conducted based on remote sensing and other spatial land use and land cover (LULC) data within the framework of MonViA (German national project for the monitoring of biodiversity in agricultural landscapes). In this context, a set of biodiversity indicators is being developed to assess the status, changes and trends in land use and land cover at different temporal and spatial scales. Since the usage of public crop type information like the European Land Parcel Information System (LPIS) is often restricted by data protection regulations and with the increasing availability of dense remote sensing imagery, crop type classifications represent crucial input data for agricultural biodiversity indicators. In Germany, various crop type classifications are available (e.g. Preidl et al., 2020, Blickensdörfer et al., 2022). Although these products contain map-specific accuracy metrics, they are only comparable to a limited extent from a user perspective because they differ in terms of the class catalogue and underlying validation strategies. In this study, we investigate how well remote sensing-based crop type classification products can replace LPIS information. In order to take the user perspective into account, content tests are performed to determine the suitability along specific research questions. With the continuous implementation of an application-data-matrix, previous uses of data will be documented to enable further reuse. We use the data fitness for use approach (Höck et al., 2020) in the first step to adapt biodiversity indicators to changing requirements and simplify the use of different input data. The analyses on the usage of diverse input data in the form of crop type classification products compared to LPIS information using several biodiversity indicators (e.g. Shannon Index) will be presented, which lead to best practice guidelines and algorithms for data fitness for use assessment.

Keywords: crop type classification, agriculture, biodiversity indicator, landscape metrics, data fitness for use

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Establishment of thyme-based living mulch and its effects on carob drought stress under rainfed conditions

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Abstract

Diversified agroforestry systems are considered more resilient to stressors, provide elevated ecological and economic stability and may assist CC adaptation. However, mono-cropping and unsustainable soil management dominate Mediterranean agroecosystems. Establishing permanent living-mulch within tree crops under drought stress may provide benefits for CC adaptation, but is rarely applied fearing water competition. We assess the effects of such systems based on thyme-based living mulch (TBLM) within carob agroforestry systems (CAFS) in Cyprus by testing for the first time whether TBLM using *Thymbra capitata* can (a) become established under rainfed conditions assisted by soil beneficial microbes (SBM) (e.g. mycorrhiza plus plant growth promoting bacteria), and natural aluminosilicate minerals (attapulgite), (b) improve neighbouring carob tree water potential (WP), (c) improve biodiversity for carabid and tenebrionid beetle assemblages. Four different treatments were applied i.e. (i) TBLM, (ii) Mulching control (MUL), (iii) Tillage control (TLG) and (iv) Wild control (WILD) in two 18-20-year-old carob plantations (SKR and VRY) on 43 trees in total for two years. Thyme survival rates reached ca. 85% (SKR) and ca. 67% (VRY) after a wet and a dry year (655mm vs. 310mm SKR; 513mm vs. 289mm SKR for precipitation) providing an average biomass of 26 g/m^2 (SKR) and 18 g/m^2 (VRY). Mid-summer soil temperature was significantly higher in TLG plots compared to all others, with the lowest values in TBLM and WILD plots for both plantations. Soil moisture during the dry season appeared the highest in the TBLM and MUL plots ($p<0.05$), while carobs at the end of the dry season in TBLM and WILD plots had the highest WP ($p<0.05$ for 2020). Edaphic arthropods (Carabidae and Tenebrionidae) produced increased abundances and species richness in TBLM over MUL, WILD and TLG plots. Furthermore, carabid diversity indices (Shannon and Simpson), were associated with higher scores in TBLM compared to all other treatments, while the tenebrionid beetle index scores for TBLM were higher compared to WILD plots. Thus, SBM together with attapulgite appear to promote the establishment of TBLM at early stages under rainfed conditions. After two years TBLM appears to produce less drought stress on carob trees compared to tillage. By reducing soil temperature and evaporation in the dry season and by using water conservatively, it can improve soil moisture, while benefiting edaphic arthropods. Therefore, TBLM could be regarded as a sustainable nature-based solution for carob and similar crops compared to conventional tillage assisting CC adaptation and promoting biodiversity conservation.

Keywords: permanent living-mulch, agroforestry, drought stress, biodiversity, beetle communities

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Developing the first national database of soil erosion in vineyards to promote the protection of fertile soil

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[1]*Departamento de Análisis Geográfico Regional y Geografía Física, Facultad de Filosofía y Letras, Campus Universitario de Cartuja, Universidad de Granada, 18071 Granada, Spainveloping the first national database of soil erosion in vineyards to promote the protection of fertile soil*
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Abstract

Land Degradation is a process that results in the loss of soil fertility, reduced food production and a decrease in farmers' income, and is very active in Mediterranean ecosystems where agriculture has been present for millennia (Cerdà et al., 2021; Panagos et al., 2014). The misuse and abuse of soil resources result in their complete loss of functionality (Keesstra et al., 2021). Vineyards are well known as bucolic landscapes but that in the most recent scientific investigations have shown as an unsustainable practice in many cases due to the high soil erosion rates (Rodrigo-Comino, 2018). Vineyard landscapes are a cultural heritage of our country, Spain, a reservoir of fauna and flora, a legacy that winemakers shaped since historical times. However, to date, most of the vineyards are not sustainable as a result of intense chemical agriculture based on bare soils that trigger rates of erosion, biocides that damage biodiversity and the ageing of the population in rural areas that put the succession of farmers at a risk (e.g. Capello et al., 2019; Marques et al., 2020). A national study accessible to the entire population would reveal the "real" situation of Spanish viticulture and its soils, together with the problems that rural inhabitants experience daily, which would allow the development of solutions on a regional scale. In this abstract, we present a novel project to estimate erosion rates in vineyards using a standardized method, ISUM (Improved Stock Unearthing Method; Rodrigo-Comino and Cerdà, 2018), in ones of the most important wine-growing regions in Spain. We will compare the incidence of erosion control systems, comparing vineyards in each study area with conventional management and with soil protection measures, creating an open, freely accessible and updatable online database to show the results at the national level.

Keywords: Soil erosion, vineyards, Spain, national system management, regional studies.

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Seasonal changes in the effectiveness of a seeded cover crop to reduce the loss of soil nutrients in a rainfed vineyard

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Abstract

In permanent crops, ground covers have demonstrated their effectiveness to increase surface water infiltration and to reduce the loss of soil (see references). However, the temporal evolution over the course of the year of the benefits of soil and water conservation measures is rarely evaluated. The effectiveness of a seeded cover crop to reduce the loss of soil nutrients (N-P-K) was evaluated in a rainfed vineyard under Mediterranean conditions (552 mm/yr; annual temperature: 14.3 °C). The vineyard is located in NE Spain (Huesca), the vines (variety Grenache) were planted in 2008; and the plantation is arranged in straight lines. The inter-row areas include spontaneous vegetation and a plantation (seeded in early 2016) of common sainfoin, but the percentage of ground cover varies across the field. Two sediment tanks were installed (ST2: drainage area with high ground cover (GC: 82%), and ST3: very high GC (89%)) and samples from 26 time-integrated periods were collected over 15 months (23 events/yr had > 8 mm/event, and 16 events/yr recorded > 12 mm/event). The average soil nutrient content was previously estimated in the drainage areas of ST2 (N_{total}: 0.967 mg/g; P_{ava}: 0.411 mg/g; K_{ava}: 1.762 mg/g) and ST3 (N_{total}: 0.711 mg/g; P_{ava}: 0.437 mg/g; K_{ava}: 1.856 mg/g). The sediment nutrient concentrations and the sediment/soil enrichment ratios (ER) were comparable between ST2 (ER = 3.12, 2.27, 1.75 for N, P, K) and ST3 (ER = 4.57, 1.95, 1.77), but the total loss of nutrients clearly differed among areas. The loss of nutrients in the area with lower GC (379.7 g N-P-K / ha yr) was 8.3 times higher than in the area with higher GC (45.8 g N-P-K / ha yr), and this pattern remained during the months with low (Jun–Oct), medium (Nov–mid-Feb) and high (mid-Feb–May) GC: 91.9, 2.1, 2.1 g N-P-K / ha month in ST2 and 6.9, 3.0, 3.5 g N-P-K / ha month in ST3. Greater GC promoted soil and nutrient conservation all year long.

Keywords: Vineyard, Cover crop, Soil nutrient content, Enrichment ratio, Sustainability

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Determination of dry matter production by spectroscopy techniques in rangelands of SW Spain

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Abstract

Dry matter production in rangelands of southwest Spain by means of new methodological techniques is an essential issue for a correct pasture management. The objective of this study was to evaluate the potential of spectroscopy techniques for the estimation of dry matter production. To this purpose, reflectance spectra of a total of 54 samples were measured in the field with the ASD FieldSpec 4 spectrometer. Then, two predictive models were developed by means of regression techniques, using the MARS data mining algorithm. In a first model, only the 350-2500 nm spectra were considered as predictive variables, while in a second model, in addition to the spectra, grass height was also included as a predictive variable. To evaluate the reliability of the models, the coefficient of determination (R^2) and the root mean square error (RMSE) were taken into account. As results, the first model yielded an R^2 value of 0.85 and an RMSE of 366.13 kgDM•ha^{-1}, being the mean value of dry matter (n=54) 1783.26 kgDM•ha^{-1}. The most important variables were the wavelengths of 1557, 1452, 724, 2208, 2500 and 1892 nm. As for the second model, an R^2 of 0.85 and an RMSE of 349.02 kgDM•ha^{-1} were obtained. In this case, the most important variable were grass height, followed by wavelength 1672 nm. Therefore, the usefulness of spectroscopy for obtaining dry matter values in pasture areas, especially in large geographic areas that require continuous monitoring of these values, has been demonstrated.

Keywords: spectrometry, VNIR spectra, predictive modeling, MARS

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Mathematic programming and model simulation for cover crops in Northwest China by assessing ecological and economic values

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Abstract

As a sustainable agriculture tool, cover crops can be broadly defined as any non-cash crop grown in addition to the primary cash crop. These crops have the potential to increase soil organic matter and fertility, reduce erosion, improve soil structure, promote water infiltration, and limit pest and disease outbreaks. There are numerous benefits to cover cropping, though, as with any management technique, trade-offs and limitations must be considered. Model simulation will be used to identify the sustainable cover crop management practice of wheat-maize cropping in Northwest China with maximizing social welfare, including agricultural production and ecosystem services. This study is a farm-scale ex-ante assessment including three steps: quantifying ecosystem services (ES), monetizing ES and mathematic programming.

Keywords: Cover crop, Sustainable Agroecosystem Model, Ecosystem Services, Wheat Rotation

EC: Erosion - Connectivity

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Assessing and managing soil erosion and lateral sediment connectivity in agricultural catchment systems: an Austrian example

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Abstract

Soil erosion has a major impact on the delivery of ecosystem goods and services. Besides causing severe on-site effects (i.e. soil degradation), soil erosion is one of the biggest environmental pressures on river ecosystems in agricultural areas. Water-mediated soil export from arable field to river channels results in environmental damage such as eutrophication of water bodies or fine-grained sediment accumulation in river channels clogging and smothering spawning habitats. Knowledge on hotspots of soil erosion (as sediment source areas) and their connectivity to the channel network is therefore essential for environmental management of agricultural streams. High rates of soil erosion and associated fine-grained sediment and nutrient/contaminant input from arable fields to the channel network of the Fugnitz River system (Austria) induce significant environmental problems such as degraded aquatic habitats and deterioration in biogeochemical water and sediment quality. As a consequence, river recovery concepts have been incorporated within a catchment management plan that includes: 1) system state evaluation (i.e. fine-grained sediment loading and water/sediment quality assessment), 2) soil erosion and lateral connectivity assessment, and 3) development of nature-based management/mitigation strategies. Methods of analysis included bed sediment mapping (Poeppl et al., 2015), water quality assessments (Poeppl et al., 2020), and soil erosion analysis. The latter incorporated process-based soil erosion prediction modelling and field-based mapping of lateral fine-grained sediment connectivity along the main river courses (Poeppl et al., 2012; 2019). Moreover, the sediment retention efficiency of selected Natural Water Retention Measures (NWRM) and riparian sediment fences has been tested and evaluated (Poeppl et al., 2020).

Keywords: soil erosion, lateral connectivity, river ecosystems, pollution, fine sediment

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Measuring the size of pendant water drop generated by hypodermic needles for construction of rainfall simulator for soil erosion research

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Abstract

Dripping rainfall simulators for soil erosion research generate pendant water drops of simulated rainfall with different types of drippers, such as plastic and glass tubes, drippers in a form of holes, irrigation drippers and hanging yarn, among which metal tubes are the most commonly used. Metal tubes appear in the form of capillaries with a flat tip or in the form of hypodermic needles. Hypodermic needles are suitable for this purpose because their diameter size is standardized with relatively small deviations from the standardized dimensions, they are available on the market, relatively cheap, made of stainless material and have a threaded connector (Luer taper). Since scientific papers that used dripping rainfall simulators are often incomplete in terms of data for diameter, length, and type of hypodermic needle as a dripper, as well as data on pendant water drop size that needles can generate, a performance analysis of hypodermic needles was performed. For the purpose of this study, dripping rainfall simulator was originally designed and made for laboratory use. Pendant water drops are generated with 11 different needles, ranging in size from 16 G to 32 G, at different dripping intensities. Obtained water drops size ranging from 3.70 to 1.48 mm, were acquired using weight measuring method. Based on research data, two nomograms were made for determination of interconnected parameters of simulated rainfall: pendant water drops size under different dripping intensity, drippers discharge, number of drippers, and kinetic energy of water drops for the given falling height. The results of research facilitate the design of dripping rainfall simulators for soil erosion research.

Keywords: water drop size, water drop diameter, hypodermic needles, rainfall simulator, dripping intensity

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Socio-ecosystemic analysis of the 2018 drought in Wallonia (Belgium) and possible recommendations for a transversal and sustainable risk management

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Abstract

Drought – extreme climatic event due to an abnormal rainfall deficit – is a complex hazard which generates, depending on environmental and societal context, multiple and cumulative impacts that are often dramatic. Water scarcity is a major consequence of this meteorological phenomenon. Indeed, water is essential to the existence and sustainability of all the socio-ecosystems that make up our territories. Moreover, it is now clear that current and future global warming will lead to an increase in the frequency and intensity of droughts in Europe (IPCC, 2021). Wallonia (southern part of Belgium) is no exception to this observation and suffers, since the start of the 21st century, from recurrent water deficits and strong pressure on its water reserves in the summer period (Thibaut and Ozer, 2021). In this context, the objectives of the study (Thibaut et al., to be submitted) are (1) to better understand the interdisciplinary process of droughts and (2) to highlight ways of improving the management of this risk. In order to achieve these objectives, we used an original and innovative tool: the chrono-systemic timeline. This consists in a transversal analysis tool that allows visualization – in a single diagram – of temporal and multi-sectoral highlights of crisis and their relationships (Bergeret et al., 2015). Considered exceptional by the Royal Meteorological Institute of Belgium and qualified as an agricultural calamity by the Walloon government, the 2018 drought served as a case study for development of the chrono-systemic timeline. The data introduced into the model concern environmental conditions (climate and hydrology), economic and social context (water production, agriculture, natural environments, energy, navigation, tourism) and political and administrative decisions of the case study. The chrono-systemic timeline of the 2018 drought in Wallonia (cf. figure 15 in Thibaut, 2020, p. 31) highlights an often long period of major impacts, a slow return to normal situation and a reactive crisis management. It also shows presence of water stress situations in all socio-ecosystems of the territory. The study concludes that it is necessary (1) to better consider risks associated with water deficits in public policies and (2) to put in place anticipatory and adaptive management of these risks. In view of the many socio-ecosystemic connections engendered by water scarcity, nature-based solutions appear to be efficient future strategies for integrated adaptation to droughts.

Keywords: drought, risk management, chrono-systemic timeline, socio-ecosystemic analysis, Wallonia

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The feasibility of applying nature-based solutions for flood mitigation in Israel: Marrying hydro-morphological analysis with land property rights

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Abstract

In Israel, as in other developed countries, a slow but profound, shift is occurring from traditional engineering-based approaches to nature-based solutions (NBS). These promote the restoration of a variety of ecosystems. Implementation of NBS will ultimately lead to a reduction in flood risk, as part of a new, holistic integrated watershed management approach. For flood regulation, NBS aims to restore the functional processes of streams and floodplains, i.e., hydro-geomorphic dis/connectivity. Therefore, NBS require more designated open areas for collecting and restraining the floodwater than engineering solutions such as building canals, riverbank fortifications, or dams. The main constraints are real-property rights in agricultural land or other types of open space. Engineering solutions usually come packaged with existing public-finance resources – national or local budgets, or dedicated fees or levies. NBS are new, and thus have no tradition of public funding to compensate farmers or other users of areas targeted for seasonal (or permanent) flooding. The purpose of this research is to "marry" a double-track methodology to guide professionals and decision-makers in how to develop feasible NBS while taking into consideration land-tenure configurations and related economic or social interests among stakeholders. Both tracks are applied to case study areas selected for their variety of hydro-geomorphic conditions as well as a variety of land-tenure configurations. The first track of the method is a GIS-based hydro-geomorphic connectivity analysis where we integrate two key indices: the topographic wetness index (TWI) and the index of connectivity (IC). The targeted area is then evaluated based on ecological surveys. The second track of the methodology is a land tenure and land-use analysis of the case-study areas. For each, we conduct a land valuation to estimate the economic damages, if any, to current, future property values, income from agriculture, or other land use activities. The assessment yields the monetary compensation needed for the implementation of NBS. We also interviewed stakeholders to gauge their willingness to participate. Legally compulsory tools are also considered. The outcomes of this method provide watershed managers with a realistic perspective on the feasibility of integrating NBS into watershed flood risk planning.

Keywords: Mediterranean watersheds, river and floodplain restoration, land tenure configurations, property values, income from agricultural land rights, fluvial floods, ecosystem

services

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Four perspectives on agri-forest configurations for natural flood management

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Abstract

Natural flood management (NFM) has been increasingly acknowledged in recent debates as it offers combined effects for reducing the flood risk and enhancing ecological functions in floodplains and beyond. In flood planning policies and empirical case studies, forest and extensive agricultural land uses are in particular considered suitable for NFM. Yet, several reviews published in the last couple of years point to the essential barriers impeding implementation of NFM across scales and socio-ecological settings. In this poster we develop on these works and debates held in the Land4Flood Group and we reframe these into four perspectives enhancing future research on flood-reducing functions of agri-forest configurations. We understand the agri-forest configurations as a domain ranging from agroforestry *sensu stricto* (agrisilvicultural, silvopastoral and agrosylvopastoral) to spatial configurations of individual forests and patches of agricultural land. First, from the hydroecological diversity perspective, we argue that we need more nuanced research on effects of forests and agricultural land of different age, structure, and management on the components of the water cycle. Second, extending the long-term SLOSS (single large or several small) debate, we assert that landscape planning perspective must develop the knowledge on how land use patterns at the catchment scale affect agri-forest interactions and their outcomes for NFM. Third, from the perspective of law, we argue that while agroforestry *sensu stricto* may yield promising effects for NFM, such combined land uses became increasingly regulated in recent cadastral systems. This refocuses efforts toward configurations of individual forest and agricultural patches of land. Nonetheless, the stakeholder perspective shows, that ownership structures (namely average area per owner) differ significantly for forests and agricultural land, thus hampering stakeholders collaborations in catchments. These four perspectives will be illustrated with examples from Central-Europe.

Keywords: flood, nature-based solutions, forestry, agriculture, stakeholders

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Estimation of shallow landslides susceptibility by the hydrogeological characterization of vineyard steep slopes, through a multidisciplinary survey.

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Abstract

Vineyards cultivated in steep terrains are widespread all over the world, constituting the main economic activity and the main landscape element of many territories. These vineyards can be affected by several problems, as the triggering of shallow slope instabilities during very intense thunderstorms or prolonged rainy periods. These phenomena can provoke the partial or the total destruction of vineyards, together with a general loss of fertility and biodiversity in the soil horizons. It becomes fundamental a multidisciplinary characterization of the slopes where vineyards can be cultivated, in order to assess possible unstable conditions and the effects of different inter-row managements in the probability of occurrence of slope instabilities. This work aims to present a multidisciplinary method for the estimation of the susceptibility of a steep terrain cultivated with vineyards towards shallow slope instabilities, carried out following different steps: i) preliminary characterization of the slope geological, geomorphological and hydrogeological settings through soil trenches and electrical tomography surveys; ii) assessment of grapevine root density and reinforcement in inter-rows with different soil management (e.g. conventional tillage or sustainable solutions); iii) application of a simplified probabilistic model for the assessment of the probability of occurrence of shallow slope instabilities in correspondence of different soil managements. This approach was applied in different test-sites located in Oltrepò Pavese and Piacenza Province (northern Italian Apennines), two important Italian wine districts very prone to water stress and slope instabilities. The results of this work can allow to recognize conditions leading to shallow failures in vineyards cultivated in steep terrains, highlighting the positive role of particular type of soil managements. This work is realized in the frame of VIRECLI (funded by Regione Lombardia) and LIFE-DRIVE projects.

Keywords: Vineyard, landslide

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Impact of Nature-Based solutions on flow connectivity and flood hazard mitigation within a Mediterranean peri-urban catchment

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Abstract

Urban expansion alters runoff processes within catchments and is often associated with increasing flood hazard. In peri-urban areas, subject to high urbanization pressure but relatively low sealing rates, the opportunities to implement landscape features able to enhance runoff storage and infiltration are higher than in urban areas. This study explores the potential of natural inundation of abandoned land, as a nature-based solution (NBS) to mitigate flooding of urban infrastructures. The study is performed in a peri-urban catchment in central Portugal, prone to flash floods driven by urbanization and short but intense rainfall events typical of the Mediterranean region. The study uses a coupling of hydrological HEC-HMS and hydraulic HEC-RAS model simulations, to assess flood inundation under distinct return periods (10, 20, 50 and 100 years) for current condition (without NBS) and three NBS scenarios: installing one NBS upslope; installing one NBS downslope; and installing a combination of upslope and downslope NBS. The model-simulation approach provides good estimates of catchment streamflow (NSE = 0.91, RMSE = 0.08). It shows that NBS decreases flood hazard, and that placing it downslope leads to 5-10 times higher decrease in the water depth at catchment outlet than upslope. Combining both upslope and downslope NBS leads to a marginal additional impact in reducing water depth. A network of NBS, however, may be more efficient in improve flood risk management under increasing urbanization and climate change projections.

Keywords: flood hazard, nature-based solutions, HEC HMS model, HEC RAS model, peri-urban catchment, Mediterranean

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The role of extreme rainfall events on soil erosion on bare and plant covered plots: A 7-year assessment under Mediterranean climatic conditions

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Abstract

Low frequency – high magnitude rainfall events are a threat to soil conservation as they can induce high erosion rates that wash the upper fertile layers of the soil. To understand the role of those extreme rainfall events on Mediterranean agricultural land, we set up 8 plots in the Sierra de Enguera (Spain). Soil Erosion Experimental Station from 2008 to 2014. Runoff discharge was collected in each plot (1, 2, 4, and 16 m^2) under 5 years of abandonment and under tillage conditions. The results have shown that the bare plots (under tillage) contributed to an average of 159 mm runoff during the 7 years study period. While the plots covered by plants yielded 87.02 mm of runoff. The average soil losses were measured as 10.27 Mg ha^{-1} y^{-1} for the bare plots and 1.46 Mg ha^{-1} y^{-1} for the covered ones. On the bare plots, out of 215, 10 rainfall events have generated nearly 68 % of the total runoff, while the same was measured as 60.36% for the covered plots. The big rainfall events (>100mm) have played a major role in generating substantial runoff volume and resulting in soil losses for both bare plots (69.6 %) and covered plots (47.7 %). In comparison, the smaller rainfall events were found ineffective to produce substantial runoff. More control experiments are needed to understand better the close association between rainfall events and soil losses across the scale.

Keywords: Soil, Erosion, Runoff, Extreme, Rainfall, Mediterranean, Abandonment

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The role of plant species on runoff and soil erosion in a Mediterranean shrubland

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Abstract

Shrubland is a Mediterranean biome characterized by densely growing evergreen shrubs adapted to fire events. The objective of this research is to determine: i) runoff and soil losses in a shrubland-covered rangeland at Sierra de Enguera, Spain; and ii) how four plant species affect soil and water losses. We measured soil cover, soil properties, runoff discharge and sediment yield under natural rainfall for five years (2010-2014) in a typical shrubland burnt in 1999. Four plant species were selected with 4 plots each: *Ulex parviflorus* Pourr., *Pistacia lentiscus* L., *Quercus coccifera* L. and *Rosmarinus officinalis* L. Despite that the soil properties and plant cover did not exhibit statistically significant differences among plant species, the runoff discharge was lower on *Q. coccifera* (4.87 %, SE 0.24) and *P. lentiscus* (6.24 %, SE 0.51) than on *U. parviflorus* (13.41 %, SE 0.58) and *R. officinalis* (13.84 %, SE 1.23). Sediment concentrations were, respectively, 3.91, 4.33, 4.31 and 4.88 g l^{-1}, and the differences between *R. officinalis* and the other species were statistically significant. The runoff discharge determined differences in soil erosion rates amongst the plant species with lower rates on *P. lentiscus* (1.36 Mg ha^{-1} y^{-1}) and *Q. coccifera* (1.53 Mg ha^{-1} y^{-1}), than on *U. parviflorus* (3.17 Mg ha^{-1} y^{-1}) and *R. officinalis* (3.85 Mg ha^{-1} y^{-1}). This long term *in situ* study indicated that *Q. coccifera* and *P. lentiscus* are more efficient in controlling runoff discharge and soil losses than *U. parviflorus* and *R. officinalis* one decade after a fire. We discuss these results in light of the recent findings by the scientific community of the role of the canopy cover (rainfall interception), soil macropore and root system, and the water repellency that control the hydrological response of the soil (e.g. runoff generation, infiltration). The information supplied by 5 years of research is relevant for restoration and rehabilitation programs and advises that *Q. coccifera* and *P. lentiscus* are the most efficient plant species to control soil and water losses within the Mediterranean shrubland. This is an applied science approach for better management of rangelands.

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Keywords: Plants, Shrubland, Plots, Rainfall, Runoff, Soil, Erosion, Sediment, Mediterranean

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Treatment of landfill leachate using an innovative test facility. A significant step towards a more sustainable and biodeverse water treatments

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Abstract

Introduction
Most contaminated waterflows are treated with energy intensive technologies, producing large quantaties of CO2, occupying space that cannot be used otherwise. These solutions may be acceptable for short term projects. However, in case of long-term projects, or projects where waterflows require indefinite treatment, these conventional techniques have a significant negative environmental impact. An exmaple of projects where indefinite treatment is required are landfills. In most landfills, leachate is continuously produced by infiltration of rainwater, potentially forming forming a treat over decades for catchment areas.
Innovative test facility
In order to test an environmetally freindly method to treat water, a constructed wetland pilot was started in the summer of 2021, at the Nedereindse Plas (Utrecht), in the Netherlands. The purpose of the pilot is to assess the replacement of the current conventional treatment installation. Final goal is the realization of a constructed wetland for the treatment which should also provide settlement space for wetland flora and fauna and thus improve biodiversity in the area.
The leachate constitus a waterflow of 2m^3/hr. The leachate composition is quite complex: it contains contaminants such as oil and PAH. Apart from these contaminants, the leachate contains very high levels of calcium, ammonium, bicarbonate and sulfur. The conductivity (Ec) of the leachate is very high, providing a challange for plant growth.
The design of a biological water treatment always require a tailor made approach. Apart from contaminants, parameters such as pH, Ec, redoxpotential, macro-chemicals etc. al have an impact on biological processes.
To overcome the site-specific issues for testing, a container with several wetland modules and plants was designed and installed on the site, treating a split-off stream from the leachate. With the test facility it is possible to apply various biological conditions and altenate these conditions. The pilot mimics the natural conditions in order to represent a full-scale wetland. Ambient termperature, nighttime - daytime alteration, sunlight and moisture are all kept identical to those on the site. The monitoring program includes pH, Ec, redox, macro-chemicals, temperature, and analyses of contaminants.
Presentation
We will present results of the pilot and its implications for future water treatment

projects. Not only source contaminations but also for catchments areas in genaral. We will explain the set up of the pilot in detail and present results and an outlook on a full-scale biological treatment system for the site and wider applications for catchement areas.

Keywords: nature based remediation, biodiversity, water treatment, landfill leachate,

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On the use of the Resilience Performance Assessment framework for evaluating NbS-induced hydro-geomorphic connectivity

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Abstract

With the aggravation of climate change and its subsequent impacts, efficient evidence-based decision making is a must. As freshwater bodies and watersheds are some of the most affected terrestrial ecosystems, quantum leaps in their management strategies are needed. In this vein, Nature-based Solutions (NbS) hold a large potential for catalyzing these shifts. They are trusted by organizations such as the IUCN and the UNEP and hold a strategic position in Europe given their status in the Horizon 2020 program. Despite the promises they hold, quantitative evidence on their performance is still limited. Moreover, robust conclusions of their efficiency are still indecisive. In response to these gaps, the Resilience Performance Assessment (RPA) framework aims to provide a solid assessment of NBS projects through: (i) exposure evaluation (ii) vulnerability scoring under current and future climatic scenarios, (iii) cost-benefit and avoided costs analysis, and (iv) overall resilience performance scoring. Due to its flexibility, RPA can integrate NbS as a land cover input - among others - hence providing outputs across the different phases of the NbS cycle (design, planning, implementation, and monitoring). At the catchment scale, the implementation of NbS such as grassed waterways and buffer strips (among others) at specific locations can help restore hydro-geomorphic and ecological connectivity. The latter strengthen the catchment's resilience through increased ecosystem services and feedback loops, landscape-waterscape connectivity, water-sediment-nutrient transport, and increased biodiversity. For quantifying these changes in resilience, RPA can be used to determine the effects of NbS-induced connectivity, while highlighting the intrinsic and extrinsic threats through exposure and vulnerability analysis. The produced simulations can also highlight places where NbS are needed or missing. Accordingly, in addition to quantifying resilience, RPA can help allocating solutions through a priority-based approach, hence its role as an evidence-based decision-making tool. The RPA framework has been tested in a Caribbean Island as part of a post-disaster planning phases. More aspects on RPA's "back office" and preliminary results can be given during the training.

Keywords: resilience, nature-based solutions, climate change, resilience metrics, cost analysis

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Developing Watershed Resilience with Indigenous Traditional Ecological Knowledge (ITEK) and Nature-based Solutions (NBS)

Garrett Altmann, M.Sc.

Santa Clara Pueblo, USA

Abstract

Santa Clara Pueblo is a federally recognized Native American tribe located on the Rio Grande in northern New Mexico, USA. Over the past 25-years, multiple wildfires have burned over 80% of Santa Clara forested lands. Compounding these disasters, post-fire flooding devastated the Santa Clara Creek and Canyon, an area historically relied upon for recreation, economic revenue, and spiritual sanctuary. The magnitude of these events has resulted in five Federal Presidential Disaster Declarations, over $200M in infrastructure damages, and 100% fish kill in the watershed. The Tribe has since embarked on a recovery strategy that is being made possible through collaboration and developing nature-based solutions (NBS) with indigenous traditional ecological knowledge (ITEK). By combining ITEK with expertise from federal and state agencies, non-governmental organizations, and specialized consultants, the Tribe is able to implement '*a naturalistic approach to flood mitigation and watershed restoration*.' This approach recognizes naturally occurring processes that mitigate disturbances, and then replicates these nature-based processes to mitigate hazards and maximize ecosystem services. Due to the continued risk of flooding and sediment transport, a top-down approach restoring the watershed has been implemented. This approach reduces risk of flood damage to new treatments, while developing resilience to future climate disturbances such as fires, floods, and drought. Our projects include sediment stabilization, reforestation, roadway crossings, off-channel ponds, beaver dam analogs, and riparian restoration that integrate natural materials. Santa Clara Pueblo also applied resilience and adaptive management principles to treat their landscape according to site conditions and successional trajectories. The goal is to restore connectivity in vital and resilient habitat that will support native trout reintroduction and, in turn, sustain the cultural and recreational activities that are central to the Tribe's traditional "Kha'P'o" way of life. By taking a natural approach to watershed restoration and flood mitigation, the Tribe can begin to restore this landscape which acts as their spiritual sanctuary, natural pharmacy, food store, clothing store, and biologic classroom.

Keywords: fire, nature-based solutions, flood mitigation, erosion, creek restoration, drought resilience

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Inclusive Outscaling of Agro-ecosystem REstoration ACTions for the MEDiterranean - Pilot Area Bethlehem of Galilee, Israel

Anna Brook

University of Haifa

Abstract

General information Geographical and governance description: A food forest, also called a forest garden, is a diverse planting of edible plants that attempts to mimic the ecosystems and patterns found in nature. The food forest (total updated area in 2020 is 500 km2) in Bethlehem of Galilee, Israel, was established in 2017, planted in the middle of an agricultural area. Concerning mainly about the degraded soil and biodiversity loss associated with conventional agriculture and pointed to the regeneration of nature (and human health) as a major motivation for implementing this food forest. Since 2017, this action performs well on social-cultural and environmental criteria by building capacity, providing food, enhancing biodiversity, and regenerating soil. Food forest adopted basic principles of agroforestry that improve water cycle and soil formation, store carbon, regulate the microclimate, increase biodiversity, and create livelihood opportunities. This case study will set an example of sustainable food production by producing nutritious food, providing wildlife habitat, build soil, and sequester carbon. It also builds diversity of plants and animals while embracing the diversity of people. Direct anthropogenic drivers: The site was an abandoned agricultural area with degraded flat bare soil. Considering the climatic condition, the main impact of this action is its water conservation and soil formation measures for water (e.g., drip irrigation, rainwater harvesting) and soil (e.g., chop-and-drop, mulching, Terra Preta) together with high species diversity and cultivation of rare varieties (flora), undisturbed areas for fauna, connection to green corridors throughout the area. Restoration initiatives: The restoration was completed by regenerating soil in a slow, laissez-faire approach with a naturally occurring groundcover. The hydrological processed are managed to prevent soil erosion and degradation by mulching and by using strata and succession-based management for efficient water storage and biomass production. Cost-benefit of restoration: The presented food forest is a part of multifunctional space and organizational hybrid with diverse services, products, and income sources. Apart from producing food, it offers social-cultural and environmental services.

Keywords: Restoration Actions, Food Forest, Social-Cultural and Environmental interactions

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Analysis of land use changes and erosion process for a Degraded Rural Landscape using DEMs, Historical Images, LEM and USPED Models

Antonio Minervino Amodio and Dario Gioia

National Research Council (CNR), Institute of Heritage Science (ISPC)

Abstract

Soil erosion is one of the most significant natural risks for the sustainable use of high-value crops, and a precise estimation of the spatial distribution and rates of soil degradation can be important in avoiding crop damage. In southern Italian landscape, several factors such as abandonment of rural landscapes, climate changes and spreading of more sustainable crops promoted a change in land use from intensive farming to higher-value permanent crops such as orchards and vineyards. Consequently, there is an urgent need to assess the effects of these land-use changes on soil erosion. In this study, we use comparisons between high-resolution DEMs, USPED model and LEM data to evaluate the effects of land-use change on soil erosion in a small catchment near Irsina town (Italy). After a detailed analysis of the geological, geomorphological, climate, and land use features of the study area based on classical and consolidated approaches such as field surveys, photo-interpretations, and DEM analysis, we prepared the basic parameter maps of the USPED and LEM models. Finally, the results obtained by using the USPED and LEM models were compared to photo-interpretations of historical photos and the short-term analysis of erosion/deposition processes obtained by using a UAV-based high-resolution DEM. We concluded that land use change from arable/abandoned land to orchard land reduced soil erosion from the catchment.

Keywords: Soil erosion model, land use change, Landscape Evolution Model (LEM), Southern Italy

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Modelling the effects of vegetated landscape elements on the rainfall-runoff behaviour in a small agricultural watershed.

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Abstract

In Europe, river flooding is the most damaging type of natural disaster and there is strong scientific evidence that flood events might become even more frequent in the future. Also in Flanders, flooding is a recurring problem, which was demonstrated again by the destructive events of July 2021. Climate-smart upstream land use systems are increasingly recognized as a way to mitigate downstream flood risk (Gabriels et al., 2022; Minang et al., 2015). Vegetated landscape elements (vLEs) such as hedges and tree lines are inherent components of climate-smart agricultural land use systems. Their typical position along the edges of agricultural parcels creates networks. Little quantitative evidence is available, however, about the hydrological functioning of these networks and how this is affected by their geometric and hydro-physical characteristics.
We used Landlab, an open-source earth systems modelling environment (Hobley et al., 2017), to quantify the effect of various vLE characteristics in a 26 ha agricultural watershed located in the Belgian Loess Belt. In particular we made use of Landlab's Green-Ampt infiltration component and its overland flow component, based on a formulation of the shallow water equations for 2D flood modelling by de Almeida et al. (2012). Numerical experiments were conducted by varying the density, orientation and connectivity of the vLE network, together with the manning's roughness coefficient and saturated hydraulic conductivity (K_s) associated with the vLEs using values found in literature. A spatially uniform, composite design rainfall event with a 50-year return period was considered and the discharge volume (V_Q), peak discharge rate (Q_p) and lag time (t_c) at the outlet were assessed as outcome variables.
Our modelling results demonstrate that under the considered rainfall event, the abundance, geometric characteristics and hydrological properties of vLEs in a catchment affect runoff in various ways. Higher vLE densities lead to a significant decrease in V_Q and Q_p and increase in t_c. vLEs associated with higher K_s values lead to similar decreases. The correlations between the level of connectivity and V_Q on the one hand and Q_p on the other hand, are both weakly negative and only applicable when the initial soil moisture content is low. vLE elements both parallel and perpendicular to the flow direction result in a decrease of V_Q and Q_p and increase of t_c compared to vLE elements with interlaying angles. Our findings provide insights that are ultimately meant to support decisions about the conservation and extension of vLE networks in agricultural landscapes.

Keywords: surface runoff modelling, landscape elements, natural flood protection

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Modeling Soil Texture Parameters for Irrigation Optimization: a case study from Crete (Greece)

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Abstract

In the framework of this study and considering the inevitable consequences of climate change, the rational management of water resources and the optimization of irrigation, we propose an interdisciplinary approach based on robust techniques from the fields of earth and soil sciences assisted by statistics and GIS techniques. We applied this methodology in the arable fields of the Chania plain (Crete, Greece). The clay or the sum of clay and silt soil content is successfully determined from the normalized chargeability using induced polarization and electrical resistivity techniques. Finally, we distinguished three classes (S1, S2 and S3) considering the clay or the sum of clay and silt soil content in the study area a) based on the dry period geophysical data and b) using as classification criterion the spatial distribution of the geological formations. S1 class mainly corresponds to formations older than Upper Miocene comprising the parent material of S1 class soils. These older than Upper Miocene formations are a) the Phyllites-Quartzites unit (Ph) of Permian-Triassic age, and b) the phyllitic-quartzitic conglomerate and breccia (Me) of Middle-Upper Miocene. S2 class corresponds to Holocene and Pleistocene formations including the alluvial (al) and dilluvial (dl) deposits and some transitional zones. Most of the S2 class members reveal sand content around 58%. A reliable explanation for the high percentage of sand content in Holocene and Pliocene formations of S2 class members is the extended presence of the Phyllite-Quartzite unit that feeds with erosional material places of lower elevation in the study area. S3 class corresponds to the Pliocene marls of Tavronitis Formation, which exhibit scattered clay content and available water content (AWC), compared to the other classes. Future crop and tree planting planning and agricultural water strategy for the Chania

Plain may consider the above findings since soil texture is significantly affected by the agrogeological characteristics in this area.

Keywords: soil water, irrigation, geological formations, electrical resistivity

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Historical evolution and future storylines of biophysical and socioeconomic drivers of ecosystem changes in the Mediterranean

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Abstract

Mediterranean ecosystems are already under pressure from the combined impacts of direct human activities and anthropogenic climate change. In this highly human managed region, significant streamflow decreases in a large number of rivers have been observed, the overexploitation of groundwater resources is clearly detectable in large-scale satellite gravity data, and the decline on soil water resources are already evident, largely dominating vegetation changes. A key question however is “what is the driving force of the changes”, is it due to direct human management or anthropogenic climate change is responsible? The attribution of these changes plays a key role in the better management of the arid and semiarid Mediterranean agro-ecosystems, especially in the perspective of a different future climate. Here we examine the net effect of anthropogenic climate change induced changes in the state of soil water resources across the Mediterranean region based on results from a global land surface model. We compare soil water conditions since the onset of industrial revolution (1860-2005) against a preindustrial control run of and reveal the historical imposed changes in the soil water resources attributed to human induced climate change. We further analyze scenarios of future climate change to unravel future trends. In the frame of REACT4MED project, this work will expand based on an ensemble of biophysical indicators derived from historical and naturalized simulations of the largest multi-model, cross-sectoral process-based simulation project available, the ISIMIP.

Keywords: Water scarcity

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How much have the nature-based solutions incorporated in the studies of Iranian paired watersheds?

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Abstract

One approach to quantify and evaluate the effects of watershed-scale conservation activities is to use natural experiments or field studies. Various experimental designs are available for field studies, mainly including comparing the collected data before and after treatment, comparing the data between the affected and unaffected conditions, or comparing the data relationships with the type of treatment. One of the types of field studies is the paired watershed (PW) approach. PWs of Iran are established, maintained, and operated by the Natural Resources and Watershed Management Organization and the Ministry of Energy as the highest organizations related to water and soil resources protection. Since 2001, different studies, research, and projects have been done concerning the PW approach in Iran. In addition, multiple activities based on nature-based solutions (NBS) are recently proposed for watershed restoration worldwide. NBS includes any practice that could sustainably protect, manage, and restore natural or modified ecosystems. The question here is how much has the NBSs incorporated in the studies of Iranian PWs. No review study has been conducted yet to investigate the trend and effectiveness of the application of NBS in the PWs of Iran. To this end, about 12 PWs located in 12 different provinces and are active in recording data (i.e., meteorology, hydrology, erosion, sediment, vegetation, soil, permeability, and piezometer) have been the target of the present study. Towards this, about 161 research conducted on these PWs was found and reviewed in detail. Our review showed that only about 19% of the literature considers the NBSs directly and indirectly. The others focused mainly on modeling and simulating water, soil, and vegetation components. The most widely used NBS (No. of references) in the PWs of Iran include restore/plant/sustain native vegetation (17), grazing management systems (12), install barriers (10), restore/improve soil health (9), implement terraced/ contour planting (4), restore/improve/ stabilize substrates (4), plant vegetation buffers (2), and harvest and store rainwater (2). Based on these insights from the literature review and due to diverse NBS and their importance, it is highly suggested to cover all NBS in the PWs studies to draw an integrated managerial framework that is capable of mitigating the ecological and anthropogenic disasters.

Keywords: Conservation, Experimental watersheds, Restoration activities, Watershed

management

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The effect of different urban land use on the deposition of particle matter by plants in southwestern Iran

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Abstract

The ability of plants to adsorb particulate matter (PM) varies according to different urban uses. Airborne PM is a combination of soil particles, heavy metals, black carbon, polycyclic aromatic hydrocarbons (PAHs), and etc. This study was performed to compare the amount of deposition dust on different plant species in 10 areas of Ahvaz, which were divided into industrial, recreational, high-traffic and residential areas. In this research, 40 young (exposed and unexposed) and intact leaves (three replications) of dominant trees and shrubs were sampled randomly between the 2nd and 8th node of the plant for particle matter analysis from the selected point for calculation of particulate retention content per unit leaf area. *Phoenix dactylifera L.* in Ahvaz city has been able to precipitate particle matter between 1.7 to 66.22 grams per square meter of leaves. Distribution of particles deposited by other plant species such as *Nerium oleander L.*, *Conocarpus erectus L.*, *Ziziphus spina-christi (L.) Willd.*, *Albizia lebbeck (L.) Benth*, *Prosopis caldenia* and *Eucalyptus camaldulensis Dehnh*, respectively between 22.83-2.39,1.14-8.75,0.11-36.36, 1.49-43.37, 0.40-2.11, 0.85-4.85 grams per square meter of leaves. Spatial distribution of precipitated particles shows that the amount of airborne particles in the city of Ahvaz is very variable, so that the amount of particle matter in the area of steel industry and rolling and pipe company is much higher than other areas. The origin of particle matter is internally deposited. High-traffic industries and industrial areas are the main hotspots for the production of particle matter in the city of Ahvaz.

Keywords: Urban Land use, Particulate, Dust, industrial landuse

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ME: Methodologies

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Adoption of nature-based solutions and orchard sustainable management to face kiwifruit vine decline syndrome (KVDS)

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Abstract

Italy, the third largest producers of kiwifruit in the world, lost 10% of its production in recent years because of the spread of the kiwifruit vine decline syndrome (KVDS) (Bardi, 2020). Although the etiology of KVDS is still not clear, it is often associated with water excess and stagnation. We hypothesize that soil compaction and hypoxia could have a priming effect in the emergence of KVDS. To investigate the causal factors and potential solutions to counter KVDS, a multi-disciplinary experimental trial was undertaken in a kiwifruit orchard (*Actinidia chinensis* var. chinensis 'Zesy002') affected by KVDS in Latina (Italy). Soils from two areas were sampled: *a)* vines showing severe symptoms of KVDS, and *b)* healthy vines as control (CTRL). Soils showed different levels of compaction, clay/silt content and water content, with higher values in KVDS field, compared to CTRL. The topsoil (0-30 cm) redox potential was significantly lower in KVDS field than in the CTRL (256 vs 327 mV), so indicating low soil oxygen content. Higher soil CO_2 and CH_4, two greenhouse gases that also are indicators of hypoxic conditions, were found in KVDS field (Sofo et al., 2022). The analysis of topsoil (0-30 cm) thin sections showed KVDS soils had fewer macropores than CTRL (8.5 vs 11.5%, v/v). Macroscopically, the roots affected by KVDS were rotting, showing a loss of rhizodermis and cortical parenchyma. Microscope analysis revealed damage to the root system, with tissue breakdown and decomposition (D'Ippolito et al., 2022). Genomic analysis identified some abundant fungal species in KVDS roots (*Ilyonectria vredenhoekensis, Fusarium oxysporum and Paraphaeosphaeria michotii*), but further investigation is required to determine the eventual role of these fungi in KVDS emergence. A metagenomic/metatranscriptomic analysis of rhizosphere-associated microorganisms was carried out for detecting *a)* eventual beneficial microorganisms and biocontrol microbial agents for KVDS control isolated from healthy plants, and *b)* the hypothetical role of pathogenic microorganisms detected in KVDS plants, able to compromise roots functionality. Nature-based solutions were applied, such as planting decompacting crops (*e.g.*, *Rafanus* spp.) for increasing water permeability and agroecosystem diversification, the application of compost and bio-fertilizers containing plant-growth-promoting microorganisms and mycorrhiza (*Saccharomyces cerevisiae, Bacillus megaterium, Bacillus pumilus, Pseudomonas striata, Azospirillum brasilense, Candida tropicalis, Glomus intraradices,* and *Trichoderma harzianum*), the amelioration of water drainage into the soil, and root pruning for improving root regeneration. Implementing novel

management strategies can improve kiwifruit growth and vine productivity, also reducing KVDS symptoms in impacted vineyards, contributing to the socio-economic sustainability of farms, and increasing the ecosystem services, according to a sustainable, modern and multifactorial concept of agriculture.

Keywords: Kiwifruit, KVDS, nature-based solutions, socio-economic benefits, sustainable agricultural management.

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Impact of Plant Protection Products Application on Pesticide Residues in Golf Course Soil

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Abstract

The pesticide hazards are well documented in their capacity to adversely affect public health and the environment. At these days, the human health and environmental concerns of pesticide used for turf grass management at golf courses have increased. Our work presents data from the analyses of pesticide usage practices on a golf course in Žabalj, Serbia in 2021 and highlights the possible risks for golfers but also for the environment from the use of the plant protection products. In order to carry out the QuEChERS extraction for the pesticide residues determination in the golf course soil by the liquid chromatography coupled with tandem mass spectrometry (LC-MS/MS) was applied. For the pesticide extraction two methods were used EURL SRM 02 for bentazone, 2,4,5-T, haloxyfop, 2,4-D, imazamox, imazethapyr and dicamba using bentazone-D7 as internal standard and EN15662:2018 for cyprodinil, fludioxonil, fenpropimorph, prochloraz and tebuconazole using acetamiprid-D3 as internal standard. The validation parameters (linearity, recovery, precision, matrix effects, limit of detection and limit of quantification) were set in accordance with the SANTE/12682/2019. The obtained validation results showed that the safe and reliable LC-MS/MS method was developed which consequently was applied for the analyses of 30 soil samples. The soil samples were from the different golf course parts (teeing areas, fairways and greens). The haloxyfop, imazamox and imazethapyr were detected in all soil samples. The detected pesticide concentrations in soil were in the range from 0.01 to 2.217mg/kg. From all detections 17.95% were higher from the 0.1 mg/kg (bentazone in the concentration of 0.217 mg/kg and imazamox in the range from 0.199 to 2.217 mg/kg). Many of the detected pesticides have the potential to adversely affect human health. For the future work, constant monitoring should be performed so that the evaluation data becomes more reliable.

Keywords: pesticide residues, soil, golf course, LC-MS/MS

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Long-term effects of afforestation on hydrological ecosystem services on the Loess Plateau

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Abstract

Loess Plateau is a typical ecologically-fragile area worldwide. Vegetation restoration acts as a long-term and important strategic program wherein, while the ecological effects after long-term vegetation restoration need to be further clarified, which could support for ecological restoration in similar areas. Across the Loess Plateau, the P. tabulaeformis forest, P. orientalis forest, R. pseudoacacia forest and natural Secondary forest were selected as typical artificial plantations and natural forests in this study. The soil properties, vegetation attributes, hydrological processes and ecosystem functionswere measured and compared, to analyze ecological benefits under different vegetation restoration types and discuss the optimal model of artificial afforestation in the future. The results showed that: (1) the soil properties of natural forest, especially soil water retention, were better than that of artificial forest; (2) the biomass of arborous synuium in natural forest was lower than that in artificial forest, while it was significantly higher at shrub and herbaceous synuium; (3) there were differences in rainfall redistribution between natural and artificial plantation forest, but both had the satisfactory water storage conversion; (4) according to the structure equation model (SEM), the vegetation attributes at arborous synuium most affected the hydrological process and function in ecosystem. The results indicate that afforestation should be conducted in a close-natural method, which can provide a pattern and guidance for vegetation restoration in the Loess Plateau and similar ecologically-fragile regions in the future.

Keywords: Loess Plateau, Vegetation Restoration, Vegetation Attributes, Soil properties, Vegetation Types

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How can different decision-making criteria shape mulching techniques in burnt areas?

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Abstract

Wildfires have severe direct and indirect impacts on an ecosystem's hydrological and sediment processes. Wildfires are linked to events such as flash floods and droughts, while high concentrations of sediment and contaminants often appear in streams and reservoirs near burned areas. Moreover, erosion can lead to loss of soil organic matter and detachment of seeds and seedlings, which hinders the affected area's recovery. Mulching is one of the measures implemented directly after a fire to reduce soil erosion and increase soil water retention, yet implementation has proved a challenge. The issues faced are not only related to its efficacy for erosion mitigation; there are also relevant to socioeconomic factors such as cost and public acceptance. This research aims to address the understanding of the different approaches and criteria used when designing mulching treatments. The chosen case study area is situated in the West Algarve region of Southern Portugal, which has been inflicted by recurring fires. The first step was to investigate the decision-making criteria connected to mulching. To gather this information from sources with various viewpoints, seventeen experts from various disciplines were interviewed. Twelve of those experts filled out questionnaires about their priorities when it comes to decision-making. The next step was to identify three prioritization scenarios to select target areas for mulching treatment. The scenarios were based on existing protocols, input from the interviewees, and the information that is available for the area. The first scenario considers the net potential erosion level of burnt soils calculated using the Revised Universal Soil Loss Equation (RUSLE). The second prioritization scenario is based on an estimation of the ratio of sediment eroded from hillslopes that will reach important road infrastructures. The third scenario is based on the same concept as the second one, but the targets are the water streams, which are at risk of pollution and siltation. The index of sediment connectivity (IC), coupled with the Sediment Delivery Ratio and RUSLE were employed for these two scenarios. The thresholds of 1 and 10 Mg ha-1 yr-1 were used for all three scenarios. The simulations were carried out using ArcGIS Pro 2.4.0 and the characteristics of the resulting areas were systematically compared with each other. The results show that the prioritization scenarios lead to areas with common characteristics, but of significantly different sizes. The models used can be useful for land managers to assess how their priorities are linked with the practical issues of emergency stabilization.

Keywords: wildfires, erosion, mulching, prioritization, modelling

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To seal or not to seal – what kind of soil is lost in Germany?

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Abstract

Soils are dynamic systems that are of highest importance for all terrestrial and human life and deliver multiple services. Due to their regulatory and utilisation functions, soils are most worthy of protection. Among other things, the United Nations Sustainable Development Goals aim to protect soil and stop and reverse global soil degradation. In Germany alone around 56 ha of soil are damaged partly or completely in their soil functions daily, however, there is a lack of spatially explicit high resolution information on the quality of German soils and its losses.
Within the SOIL-DE project we explored various existing and newly available digital data sources in order to provide information on the yield capacity, vulnerability and land loss of agricultural soils on a Germany-wide and regionally differentiated basis. Therefore, soil functionality and potential of agricultural soils in Germany is assessed using the best possible resolution Germany-wide soil map. Subsequently, and for the first time soil loss due to sealing for building and infrastructure development is evaluated quantitatively and qualitatively.
The qualitative soil assessment is based on seven different criteria: biotic yield potential, resistance to water and wind erosion, mechanical and physical-chemical filter function, runoff regulation function and the Müncheberg Soil Quality Rating. The required soil information is obtained from the freely available nationwide soil map at a scale of 1:200,000 (BÜK200). Information from CORINE CLC 2018 from the Copernicus Land Monitoring Service is used as land use data. All relevant climate data comes from the German Weather Service. The relief parameters are derived from the Digital Elevation Model with a grid size of 10 m. The cumulative imperviousness layers from 2006 to 2018 from the Copernicus Land Monitoring Service are used to identify and quantify areas with high land loss and to qualitatively determine what kind of soils are lost.
In the years from 2006 to 2018 approximately 0.5% of the total land area of Germany have been sealed. In the federal state of Lower Saxony, for example, more than half of the newly sealed areas were previously agricultural soil. The evaluation of these soils revealed that for the most part valuable agricultural soils with good or better rating of soil functions and potentials are affected by land loss. Further results of the soil evaluation are presented nationwide, while the consideration of risk areas with highly rated soils and high rates of land loss is exemplary shown.

Keywords: soil loss, soil functionality, Copernicus Land Monitoring Service, agriculture

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Nature-based solutions as building blocks for the transition towards climate resilient and circular food systems

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Abstract

Food systems—encompassing food production, transportation, processing and consumption, including food losses and waste—are currently not delivering what is expected or needed to ensure their full contribution to societal well-being and ecological sustainability. The literature has defined a set of food systems failures related to the functioning of the biosphere, society, and economy (including governing structures). In this paper, our hypothesis is that Nature-Based Solutions (NBS) can form the building blocks for a transition pathway to climate-resilient and circular food systems. We develop a conceptual framework to assess how NBS contribute to such transitions. Three types of NBS are evaluated: intrinsic NBS which make use of existing ecosystems; hybrid NBS which manage and adapt ecosystems; and inspired NBS which consist of newly constructed ecosystems. The evaluation of these three types supports our hypothesis is valid, and shows that inspired NBS in particular will increase opportunities to achieve sustainable development in food systems. We identify the knowledge gaps that impede the development of NBS to support a transition towards climate-resilient sustainable food systems.

Keywords: foodsystem transformation, climate change adaptation, ecosystem services, benefits and challenges

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Effects of vegetation restoration on soil physicochemical properties are achieved by the coupling contributions of biological synusium on the Loess Plateau

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Abstract

In past decades, large-scale vegetation restoration was performed to improve the fragile ecological environment of the Loess Plateau. However, the effects of long-term vegetation restoration process on soil properties remain unclear. Here, we detected the differences and effects of biological attributes and soil physicochemical qualities among three vegetation types (Pinus tabulaeformis plantation forest, PTPF; Robinia pseudoacacia plantation forest, RPPF; and natural secondary forest, NSF), after long-term (30 years) vegetation restoration in the western Loess Region, China. Our results indicated that (1) arbor synusium biomass of plantation forest was twice more than NSF, and NSF with a 50% higher near-surface synusium biomass than plantation forests; (2) soil nutrient contents of plantation forest were lower (30%) than secondary forest; (3) the soil bulk density (BD) , organic matter (SOC) , total nitrogen (TN) and phosphorus (TP) were positively relate to arbor and shrub biomass for all restoration; (4) soil physicochemical properties were mainly explained (47.67%) by the joint effects of four biological synusiums. These findings may provide scientific support and a theoretical basis for reforestation and ecological restoration practices on the Loess Plateau region, which may also be expanded to areas with similar environmental context in the future.

Keywords: Loess Plateau, Vegetation Restoration, Vegetation Attributes, Soil properties, Vegetation Types

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Hydrological monitoring on different managements vineyards to access shallow slope failures susceptibility and water stress phenomena

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Abstract

Vineyards cultivated in steep terrains are widespread all over the world, constituting the main economic activity and the main landscape element of many territories. However, these vineyards can be affected by several problems, mainly water stress in dry periods and shallow slope instabilities during very intense thunderstorms or prolonged rainy periods. Sustainable managements of the inter-rows, which limit or exclude tillage operations in soils, can represent a useful solution to reduce the phenomena of water stress and of the triggering of shallow slope failures. Since they act to the soil layers and could modify the soil hydrological behaviors, a continuous-in-time soil hydrological monitoring is required to highlight differences on soil moisture along different dry and wet periods between vineyards managed in different ways. The aim of this work is to present the results of a field hydrological monitoring carried on vineyards managed with different practices to highlight differences on soil water content trends in different seasons. The results of this monitoring can infer to different responses in terms of possible water stress phenomena and susceptibility towards shallow slope failures. Some test-sites were selected in northern Appenines, two important Italian wine districts very prone to water stress and slope instabilities. The field monitoring is carried out with a set of soil water content sensors, installed at different depths in the soil profile and in inter-rows characterized by different soil managements, both with traditional tillages and sustainable practices (permanent grass cover, alternation between grass cover). Soil water content trends collected at the same depth in different test-sites allow to highlight the impact of the different practices in soil hydrological behaviors and on the probability of low soil moisture (predisposing factor to water stress) or saturated conditions (predisposing factor to slope instaibilities). This work is realized in the frame of VIRECLI (funded by Regione Lombardia) and LIFE-DRIVE projects.

Keywords: Vineyard, landslide, soil monitoring

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Are nature-based solutions a sustainable and efficient treatment option for olive oil mill wastewater?

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Abstract

In 2019/20 the worldwide olive oil production exceeded 3 million tons. As olive oil production keeps rising, environmental pollution caused by olive oil mill wastes is also a growing problem. Olive oil mill wastes include solid, such as olive pulp and pits, and liquid wastes, named olive oil mill wastewaters (OOMW), whose production is estimated to be 0.5 to 1.5 m^3 per 1000 kg of olives. Depending on a variety of factors, these effluents are characterized by its dark color, strong odor, high acidity, and have in its composition high contents of organic matter, complex and recalcitrant substances, and phenolic compounds, being highly toxic to biota. Another problem is its seasonality since olive oil production is carried out in a limited time (2 to 3 months). Also, in most of the Mediterranean countries, the production usually tends to be carried by small family businesses without the necessary capital to make investments in treatment plants, so most of the time, the effluent is discharged into the soil or natural water bodies, leading to soil and water pollution and underground infiltration, or is lost by evaporation in sedimentation ponds. The discharge of OOMW into natural water bodies can cause severe damage to aquatic communities, such as oxygen depletion and eutrophication, development of grease films on the surface, and enhanced toxicity. Constructed wetlands (CW) are a low-cost green technology with easy maintenance that seem to be the most sustainable approach to deal with OOMW, by adsorbing or mineralizing compounds when the effluent passes through the substrate and plant roots. In this study, we developed lab-scale vertical flow CW units composed of a substrate of sand, expanded clay and gravel and with *Iris pseudacorus*plants, with the aim to test the efficacy of this green technology to treat OOMW, improving its physicochemical properties and reducing its toxicity to aquatic organisms. Results showed an improvement of the effluent's quality, as well as a reduction of its toxicity to aquatic organisms when ecotoxicological assays with *Allivibrio fischeri* and *Daphnia magna* were made. Moreover, considering the seasonality of the OOMW production and in a circular economy

perspective, the possible use of the CW substrate as a natural soil fertilizer will also be studied in parallel with the evaluation of its safety for soil organisms through ecotoxicological assays.

Keywords: Olive oil production, Constructed Wetlands, Ecotoxicological assays, Substrate valorisation

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Using Black Soldier Fly technology to turn livestock waste into profitable products

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Abstract

Black soldier fly (BSF) farming is an emerging industry that can be used to convert food waste and other agricultural wastes to environmentally and economically valuable resources, thus aiding a transition towards circular food production systems. BSF are non-biting, non-invasive, non-pest fly species that do not eat, but their larvae can be reared on a range of animal, cropping, food, and abattoir waste. Using BSF to process agricultural wastes into high-quality fertilisers or feed can reduce greenhouse gas emissions from food waste (6% of global emissions, Poore and Nemecek 2018) or livestock manures (1.5% of global emissions; Gerber et al. 2013). The larvae produce castings residue ('frass') that could be used as a fertiliser or soil improver, thus providing an alternative for inorganic fertilisers. In this presentation, we report on an interdisciplinary project that demonstrates the potential for BSF technology to drive a transition to a circular food production system through the BSF's capacity to convert a wide variety of organic waste streams into high value products, reduce waste and its associated biosecurity and environmental problems, and contribute significantly to enhancing the sustainability of agriculture. We show that rearing BSF larvae on livestock manures can reduce manure volumes by up to 80%, eliminate the emergence of pests such as Stable Fly, and significantly reduce greenhouse gas emissions and odour nuisance from manure storage. The BSF larvae and frass are further processed to develop a slow-release, granulated fertiliser product. Pot trials and field experiments show that the BSF fertiliser product can increase crop yields and reduce nutrient leaching, thus potentially reducing agriculture's reliance on synthetic fertilisers. In a national of Australian farmers, we also gauged the interest of producers to use BSF-based products. The majority of producers agreed that BSF farming would improve the sustainability of the agricultural sector, and at least half of the surveyed producers were interested in adopting BSF products as a fertiliser, soil improver, or soil amendment on their farms. We explore the barriers to scaling up BSF technologies in food production systems, such as biosecurity risks associated with manure processing, a lack in regulatory clarity of BSF products, still unknown environmental and agronomic impacts, and the need for in-depth benefit-costs analysis.

Keywords: Insect farming, circular economy, manure management, sustainable farming, Black Soldier Fly

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Remote sensing monitoring of beach cliff vegetation and shallow landslides in Catterline Beach, Scotland

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Abstract

The aim of this study was to delineate erosion features and evaluate the distribution and characteristics of vegetation cover in relation with such features. This was expected to provide a reference to evaluate the location and functioning of multiple interventions to stabilize the soil mass through the improvement of vegetation cover.
Satellite remote sensing, being able to provide timely and long-term monitoring of bio-geophysical variables and indicators at landscape scale, was selected to support in situ monitoring within the H2020 OPERANDUM project where Nature Based Solutions (NBS) have been co-designed, co-developed and deployed in nine Open Air Laboratories (OAL).
This study is focused on the OAL-UK at Catterline bay (Aberdeenshire, Scotland), an area prone to shallow landslides and erosion. In this area a system of vegetation-based NBS has been co-designed and co-deployed to reduce erosion and landslide hazards. The effect of this NBS system will only become apparent after some time, thus requiring long-term monitoring of NBS functioning and of performance towards risk mitigation. Since the NBS at OAL-UK will impact on the plant-soil compartments, optical and microwave remote sensing measurements can provide relevant, timely, and consistent monitoring of areas vulnerable to erosion. The analysis was carried out on a time series of Worldview 2 satellite images (2011 to 2016).
To identify active mass movements and areas most vulnerable to landslides, we have applied machine learning classification to very high-resolution remote sensing data. The latter enabled detailed mapping of the evolution of bare ground patches (i.e., landslide scars) and of the vegetation cover. Such monitoring of the evolution of vegetation can help capture the benefits of NBS past their implementation by, for example, observing a reduction in vulnerable areas or an increase of the extent of stable vegetation.
The analysis showed the presence of different landslide scars at OAL-UK. The extent and shape of the landslide scars has changed over time, showing an expansion of the exposed soil areas in the period prior to implementing the NBS. Land cover maps created prior to NBS deployment showed areas vulnerable to landslides. The analysis of vegetation cover and of erosion features suggests that the system of deployed NBS was designed in a way appropriate to mitigate the erosion risk in the area. Land cover maps show the pattern of patches with stable (shrubs) and temporary (grass) vegetation cover helping to identify

areas with relatively stable ground, i.e. less vulnerable to shallow landslides.

Keywords: Remote Sensing, Nature Based Solutions, Erosion, Landslides, Land cover.

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Monitoring gully erosion in a coastal slope with Nature-based Solutions using terrestrial laser scanning

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Abstract

To monitor the effectiveness of Nature-based solutions (NBS) against gully erosion, terrestrial laser scanning (TLS) can be used. TLS is a remote sensing technique that determines the distance from the instrument to objects in the surrounding environment by analysing a laser return from the object's surface. This technique allows for a rapid acquisition of accurate 3D digital terrain models (DTM). Herein, a novel method is presented to extract terrain information from point cloud data and to identify and monitor gully erosion. TLS was conducted at a site where NBS against gully erosion have been implemented, so the performance of the NBS can be assessed by quantifying erosion rates before and after NBS implementation.
After filtering non-ground points from the point cloud, a digital terrain model (DTM) was created, from which a slope aspect map was derived. In this map, gully erosion was clearly identified. To quantify actual erosion, we compared multiple point clouds acquired over time using a 3D change detection method, i.e. the M3C2-algorithm.
To improve the potential value of the results, we suggest combining the TLS data with other remote sensing resources, such as high-temporal satellite imagery or photogrammetry.

Keywords: Terrestrial Laser Scanning, point clouds, erosion gully, DTM, 3D change detection, nature based solutions

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European Joint Program Agricultural Soils under Climate Change

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Abstract

The EJP SOIL is building a sustainable European integrated research community on agricultural soils in order to develop and deploy a reference framework on climate-smart sustainable agricultural soil management. This framework forms the enabling environment to maximise the contribution of agricultural soils to key societal challenges such as food and water security, climate change adaptation and mitigation, biodiversity preservation and prevention of soil degradation. On the operational level, this will be achieved by strengthening the European research community on agricultural soil management through an alignment and implementation of research, training and capacity building, and promotion of the harmonized agricultural soil information systems to achieve global consistency and applicability of agricultural soil information. On the policy level, the programme will support the adoption of evidence-based recommendations for policy makers on agricultural soil health and adequate agricultural practices through a multi-actor approach and intersociety dialogue, as well as uptake of climate-smart sustainable agricultural soil management practices by practitioners. On the scientific level, the programme has co-designed and started the implementation of a 5-year roadmap for agricultural soil research by developing new insights on climate-smart agricultural soil management and carbon sequestration in agricultural soils under different conditions across Europe. This contribution provides an overview of EJP Soil activities and summarises recent scientific insights obtained through the work in the work packages.

Keywords: Soil, carbon sequeatration, European Partnership

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Assessment of the performance of implemented NBS in the IJssel delta, The Netherlands – land cover and biodiversity

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Abstract

One of the goals of the RECONECT-project is to demonstrate and further upscale large-scale NBS. Therefore, monitoring and evaluation procedures that can be applied to different types of NBS have been developed concerning flood risk, land use, biodiversity and social and economic benefits. In this study, a procedure to monitor shifts in land use and biodiversity is presented including the first results from four subareas of the IJssel delta.

Land use and cover

The NBS have changed part of the land cover from mainly forest and shrub area to grass- and farmland, because around 30% of the vegetation had been either removed or converted into grass-/farmland. In another 30% the forest is crowned and thicket/shrubs is removed from the reeds, forming mainly riverbanks covered with reeds. In addition, dykes had been relocated and secondary channels had been constructed. Changes in land cover area were detected from Sentinel-2 MSI and Landsat-8 OLI imagery using a classification tool (the 'Vegetation monitor') developed by Deltares. The study areas (i.e. floodplains) were classified into water, paved or unpaved and unvegetated area, grasslands, roughness, forest and shrubs. The situation one year before the NBS was compared to the situation two years after the NBS and in 2021.

Biodiversity

Although the NBS led to the removal of vegetation to allow for a better water discharge, it may have caused unintended (yet potentially positive) effects on biodiversity. The potential number of species present in the study areas was estimated using detailed ecotope maps (Rijkswaterstaat) from before and after the NBS, which were coupled to Natura 2000 habitat types (where possible). Natura 2000 habitats contain species that are exclusive or characteristic for those habitats. Using estimations of the required habitat area per individual derived from literature, positive or negative effects on the potential number of species in the study areas were calculated.

Keywords: NBS, evaluation, land use, biodiversity, satellite imagery, foodplains, ecotope maps

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What triggers a socio-ecological transition? Lessons from the Early Middle Ages.

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Abstract

Facing the environmental challenges of today we need to shift our land-use and food-production strategies and make them more sustainable and ecologically informed. As local communities can sometimes be very traditional, economic stimuli do not always provide enough impetus. To make transitions truly sustainable, a change in attitude and values by the people that are directly involved is also needed. Throughout history there are examples of communities that had very different attitudes towards the land, the production of food, surplus and over-production. And although the term 'ecology' is relatively new, what can we learn from societies that were technologically able, but chose to de-intensify their land-use and agricultural productivity?

When we look at the Roman period we see an age of technological, economic and political innovation, making an optimal and in some respects already mechanized agriculture possible. The following early medieval period is usually characterized as arduous and primitive, with people living difficult and harsh lives on the edge of poverty. Yet, based on archaeological evidence we see an age featuring a rich cultural life, where even the remotest communities were connected to a truly global exchange network. Archaeological evidence therefore begs us to revisit our interpretations of the economy of the early medieval period.

In this paper I will review the latest evidence on Early Medieval land-use. This discussion will lead to the conclusion that post-Roman communities were able to lead culturally rich and abundant lives and yet did not make optimal use of their land and available technology. The main question we can then start to ask is: what were the main drivers and mechanisms for this change? Clearly, both the Roman and Medieval population had no conscious notion of ecology the way we have nowadays. Yet still it seems that there was something happening between the Roman and Medieval period that made people organize their way of life more 'ecologically'. I will try to find out what that trigger was, and perhaps what we can learn from this in the context of today's challenges.

Keywords: historic socio-ecological transitions

FI: Paradigm shifts in wildfire management

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Approach for Selection of Fire Risk Assessment, Reduction and Adaptation Products for Demonstration Within FirEURisk Project

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Abstract

The aim of FirEURisk project is to develop, evaluate and disseminate a science-based integrated strategy toward wildfires risk assessment and reduction for adaptation of fire management to expected future climate and socioeconomic changes. Under umbrella of the project 38 partners from European and world research institutions, companies and NGOs are developing a number of products to support wildfire risk assessment, reduction and adaptation (more than 50 products in total) and their policy and management implications. Selection of scalable products for regional and pan-European levels is one of the important goals of the project. There are next main criteria for the selection: end-user requirements, scalability and availability of products, coverage of EU territory and others. Each of the product aimed in different fire management components (prevention, mitigation, preparedness, response, recovery and rehabilitation) and has their own methodology, architecture, input data and limitations. There is no clear, structured and rational approach for fire management products selection in the literature. Based on analysis of use of scientific products for fire management in the Australia, Canada, US Forest Service and other countries, the concept of future European classification of data sets, apps and web-platform for fire policy, science and management was proposed based on 9 groups: 1) fire behavior; 2) fire danger assessment; 3) fire effects; 4) fire risk; 5) firefighter safety; 6) fuel management; 7) fire weather monitoring; 8) references and guidance; 9) datasets. According to the coverage criteria, the developed products are classified into 4 groups : demonstration area coverage (DA), pilot site (PS), pan-Europian territory (ET) and products without coverage. We are considering the future developing of the methodology with the usage of fuzzy quality function deployment (QFD) and multiple criteria decision-making (MCDM) techniques, analytic hierarchy process (AHP), VIKOR and other methodologies. This approach will help us considers both End-Users needs and product selection criteria to build a hybrid decision making solution.

Keywords: FireEURisk, wildfire risk assessment, reduction and adaptation

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Mapping canopy base height using GEDI relative height metrics for wildfire simulation models

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Abstract

Multispectral satellite data have proven efficient for the generation of fuel types layers used in wildfire simulation models, however, their performance is limited when the characterization of forest canopy fuels is necessary. In this study, we tested the GEDI lidar data to map canopy base height (CBH) across the Chornobyl Exclusion Zone. Our work-flow utilized three steps that were fully implemented in the Google Earth Engine (GEE) cloud-based platform: 1) random forest classification of land cover types using the CCDC algorithm (Zhu & Woodcock, 2014) and Landsat time series; 2) the gradient nearest neighbor (GNN) imputation (Ohmann & Gregory, 2002) of canopy relative height (RH) metrics for a given date using the GEE GEDI L2A asset; and 3) extraction of CBH using the predicted distribution of RH metrics at the pixel level. Our mapping approach utilized coefficients and derivations (i.e., phase, amplitude) of the CCDC harmonic functions fitted to all cloud-free spectral data from 1984 to 2022, thus canopy metrics could be predicted for any date within this period. First, we created land cover classification using the CCDC algorithm. Within the forest mask, we extracted a set of GEDI's RH metrics corresponding to the 10^{th}, 20^{th}, ..., 90^{th}, and 98^{th} percentiles of energy return heights and used them as response variables in the imputation model. The GNN modeling (k = 7) was tested on July 15^{th}, 2021 using three independent data sets of 1000 random GEDI's observations collected in coverage, power, and both beam modes. Because we used in the GNN model a multivariate response that is analogous to the complex representation of the vertical structure of forest stands, we were able to predict the RH metric at 5 % intervals. The per-pixel CBH was defined as a height for which the larger difference between the predicted RH metrics was observed starting from the RH10. The R-square values were higher for the GNN model that utilized GEDI data in both beam modes. We observed the lowest accuracy for RH10 (R^2 = 0.04) which systematically increased towards RH80 (R^2 = 0.30) followed by slightly decrease at RH98 (R^2 = 0.21). We found that CBH within the study area on average varied between RH30 and RH60 and was higher for coniferous stands. This work demonstrated that GEDI data in combination with Landsat time series can be efficiently used to improve the data layer updating process for wildfire simulation using FARSITE or FlamMap models.

Keywords: Wildfire simulation, canopy fuel, imputation

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Land management strategies to reduce wildfire risk across Europe

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Abstract

Wildfire plays an important role in many landscapes and ecosystems globally. Climate and land-use change are, however, affecting fire regimes across the globe. In Europe, places which previously experienced fire may be facing more extreme or larger fires, while areas which previously rarely experienced fire may find it a new, regular event. Land-use planning is a key factor in reducing fire severity, risk, and exposure of population and assets. Current land management strategies (LMS) aimed at reducing fire risk and fostering natured-based solutions include prescribed burnings, silvo-pastoralism, brush clearing, forest-based bio-economies, and replacement of vegetation. As these strategies are not equally appropriate for all parts of Europe, this research evaluates each LMS for its ecologic, economic, and social impacts. The LMS have first been evaluated by way of a systematic literature review which has identified gaps in the literature, best practices, and relevant information for the successful implementation of the LMS to reduce fire risk in Europe. Because LMS and fire risk are as much a social question as an environmental one, the literature has also been analysed to identify socioeconomic barriers and constraints to LMS success. We also demonstrated how socioeconomic models can be used to identify strategies to improve uptake of LMS within the context of fire risk reduction. Finally, we discuss examples of adopted approaches for the design of guidelines for the respective LMS such as daily prescribed burning maps. The outcomes of this analysis will be enriched through engagement with the target audiences at local, regional, and pan-European levels withing the scientific community, first responders, landowners and managers, policy implementers, industrial stakeholders, civil society organisations, and the general public.

Keywords: wildfire, management, landcover, land use, risk management

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Nature-based Soil Bioengineering Solutions for Post-fire Response and First Erosion Control

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Abstract

Drought-related fires have become a raising issue not only in traditionally exposed Mediterranean but also in Central European regions. In Austria for example, a huge forest fire destroyed 115 ha last year in a mixed protection forest, making this the largest national forest fire in the last sixty years.
Such events are posing major challenges not only to the ad-hoc fire and crisis management, but can potentially cause severe post-fire risks, additionally to the vast loss of ecosystems and destruction of fauna and flora habitats. Already sensitive sites with erosion-prone conditions are specifically exposed, as fire burns litter and humus, destabilising surface stones and connected aggregates. Lacking tree canopy and ground cover vegetation, rainfall is no longer intercepted resulting in soil structural damages, and setting off erosion and leaching. Bare soil also has higher evaporation rates, leading to higher soil surface impermeability. The consequences are raising surface runoff and rill erosion, specifically on steep slopes (Letey 2001), with sometimes temporally and spatially downstream mud and debris flows.
Soil and water bioengineering (SWB) techniques offer a broad spectrum of nature-based engineering solutions for various concerns and specifically for slope stabilisation and erosion control (Bisquetti et al. 2021). As rigid live plant materials are used for constructive engineering designs they provide instant mechanical stabilisation, before the plant reproduction processes induce root and sprout growth. Basically, SWB mimics nature and designs are inspired by plants' natural processes and responses on several levels respectively in several stages. SWB nature-based solutions have long been acknowledged to render great services for ecosystem restoration, for re-establishing natural features and processes while delivering tools for ecological engineering and slope stabilisation (EFIB 2015).
In many cases silvicultural or technical measures are lacking strategies for making post-fire forests erosion-proof within a reasonable period. This can be compensated by introducing SWB techniques in post-fire management, specifically for first actions and quick response with a reasonable effort, setting the path for site reconstruction and forest rehabilitation, and for long-term mitigating management.
This contribution introduces several SWB approaches and alternatives for nature-based post-fire erosion protection, that contribute substantially to the quick and sustainable reintroduction of stable sites and balanced vegetation covers. Effective designs for quick erosion barriers are provided by e.g. slope fascines, willow fencing and diamond grids, vegetated contour logs, live palisades or live sills. The use of live stakes and longer stem

cuttings or rooted deciduous woody species applied in layered designs achieves upper soil stabilisation, a more rapid bush development and closed canopies than using conventional silvicultural tree planting techniques. These nature-based engineered techniques are easy to install and flexible in application, in combination with hydro or mulch cover seeding, fast erosion protection for stand re-establishment is accomplished.

Keywords: soil and water bioengineering, post-fire erosion protection, response and mitigation management, nature-based engineered solutions, ecosystem restoration, forest reconstruction

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Greenhouse gas emissions risk management in forest fires (Interreg Sudoe REMAS)

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Abstract

Our forest ecosystems accumulate a huge carbon emission risk. The development of prevention, management and action guidelines based on solid scientific knowledge is essential to initiate a significant change in policies and strategies at regional and European level. Given the proliferation of forest fires in the SUDOE area, REMAS (2019-2022) develops a greenhouse gas emissions risk model for forest fires, considering mainly three factors: the spatial and temporal risk of a high intensity fire occurring in the territory, the amount of carbon stored in ecosystems, both in vegetation and soil, and finally, the vulnerability of these ecosystems to fire. REMAS also works in the establishment of standardised post fire protocols. The measures envisaged will focus on minimising damage and enhancing the recovery of carbon stocks. Due to these actions, REMAS develops a transnational action plan to include emissions risk in the planning in the participating regions. This plan is considering the existing emissions risk and carbon stocks in the different regions, determining which are the most vulnerable and preferential areas to be included in territorial management measures, taking into account measures to safeguard and increase carbon stocks. The work of REMAS is based on transnational cooperation and thanks to this, the risk management is tackled with a multidisciplinary and integrative character, laying solid bases with proven results in the different regions. In this way, REMAS provides solutions based on scientific analysis to identify critical areas with the highest emission risk in order to focus prevention,

management, extinction and restoration efforts.

Keywords: carbon, emissions, fires, risk, management

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Interreg Sudoe REMAS project; Greenhouse gas emissions risk management in forest fires - Gestión del riesgo de emisiones de gases de efecto invernadero en incendios forestales. Project co-financed by the Interreg Sudoe Programme through the European Regional Development Fund (ERDF) | Project code SOE3/P4/E0954

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Native soil microalgae and cyanobacteria consortium as a nature-based solution for the immediate protection of burnt soils

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Abstract

Forest fires are an environmental problem that has assumed serious proportions in Mediterranean countries whose severity and frequency are expected to increase under the forecasted heatwaves for this region. Depending on the wildfire severity, the soil properties, microbial communities, and functions are affected in different ways, being the increased potential for soil erosion is one of the most concerning aspects. Photosynthetic microorganisms are known to promote the formation of biocrusts improving the soil properties, strongly protecting soils from water erosion, and allowing the re-establishment of microbial communities. Thus, the main aim of this work was to evaluate the ability of a native soil microalgae/cyanobacteria consortium to colonize soils affected by wildfire and ultimately contribute with a nature-based solution for the immediate protection of these soils. To achieve that, native cyanobacteria and microalgae were isolated from soil/biocrusts and well-characterized for the selection of soil conditioners and plant growth enhancers. Additionally, the soil was collected at Mortágua Municipality (Centre Portugal) and burned it under controlled conditions in the Forest Fire Research Laboratory (University of Coimbra) to simulate a low-intensity fire (max. air temperature 823.8ºC, max. soil surface temperature 64.3ºC). Despite being a low-intensity fire, a higher

hydrophobicity was noted in the burned soil, soil pH increased, and no adverse impacts were observed for other soil properties. To follow up on the development of the soil crust, a 90-day microcosm experiment was carried out with the burned soil which was inoculated with the selected consortium grown in BG11 medium (3 filamentous and 2 heterocystous cyanobacteria, 1 filamentous microalga), with and without perlite used as growth substrate, along with three different control treatments without consortium added (moisture adjusted with H_2O, BG11 medium and perlite+BG11). The soil crust was monitored every week using a smart handheld spectrometer (LinkSquare®), and chlorophyll-a content was measured every three weeks. Preliminary results showed an increase in the content of chlorophyll *a* during the experimental time (0.12-18.56, 0.20-55.69, and 0.75-52.4 mg chlorophyll a g^{-1} soil after 3, 6, and 9 weeks of inoculation, respectively). The maximum values for chlorophyll a were observed in soils treated with the consortium (with and without perlite). At this time, no significant differences were detected between treatments with and without perlite as substrate after 9 weeks of exposure. Physicochemical and biochemical properties are being assessed, and complementary analyses of the selected consortium in the different treatments are being followed using metabarcoding.

Keywords: biological soil crusts, cyanobacteria, microalgae, forest fire, microcosm experiment

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Total Carbon content assessed by UAS near-infrared imagery as a new fire severity metric

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Abstract

The ash produced by forest fires is a complex mixture of organic and inorganic particles with various properties. Ash and char are known as broad indicators for evaluating the impacts of fire on nutrient cycling and ecosystem recovery. Numerous studies suggested assessing fire severity by changes in ash characteristics. Traditional methods for fire severity are based on in situ observations, and visual approximation of changes in the forest floor and soil which are time-consuming and subjective. These measures primarily reflect the level of consumption of organic layers, the deposition of ash, particularly its depth and colour, and fire-induced changes in the soil. Numerous recent studies on fire severity suggested using remote sensing techniques combined with field observations via machine learning and spectral induces approaches to obtain applicable tools for assessing the fire effects on ecosystems. While index thresholding can be easily implemented, its effectiveness over large areas is limited to pattern coverage of forest type and fire regimes. The machine learning algorithms, on the other hand, allow multivariate classifications, but in the case of processing space-time series analysis, learning becomes complex and time-consuming. Therefore, there is no complete agreement on a quantitative index that determines the severity metric. Considering that wildfires play a major role in controlling forest carbon storage and cycling in fire-suppressed forests, this study examines that there is potential for low-cost multispectral imagery across visible and near-infrared regions collected by the unmanned aerial systems to determine fire severity according to the colour and chemical properties of vegetation ash. The use of multispectral imagery data might reduce impreciseness caused by manual colour matching and produce a vast and accurate spatial-temporal severity map. The suggested severity map is based on spectral information used to evaluate chemical/mineralogical changes by deep learning algorithms. These methods quantify total carbon content and assess the corresponding fire intensity that is required to form a particular residue. By designing different learning algorithms for two datasets the multispectral prediction results show an excellent performance, which shows that the deep network-based near-infrared remote sensing technology has a future potential to become an alternative and reliable fire severity monitoring method.

Keywords: fire severity, post-fire environment, total carbon, spectral model, machine learning, unmanned aerial system multispectral imagery.

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Modeling forest fire risk in southern Corsica and development of a decision support tool for local authorities and land protectors

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Abstract

Forest fires significantly affect natural ecosystems, often causing considerable economic losses and threats to human life and natural capital. With the progression of climate change, the intensity, the frequency, and the severity of fires are expected to increase. As wildland urban interfaces are becoming greater, infrastructure is often extending into fire zones. Subsequently, the increasing number of assets at risk is causing significant losses, while multiplying exposures, sensitivities, and vulnerabilities. In the case of South Corsica, the extension of electric poles into fire zones is a polarizing topic. For some, these poles aggravate fire risks and are therefore perceived as dangerous. In the area located between Porto-Vecchio and Bonifacio, a series of linear high voltage electric poles for rallying electric currents is being planned and implemented. To increase the public acceptance of this project, and for securing the region's electrical infrastructure, remotely sensed data was used to create a tool for monitoring/analyzing forest fires. First, a regression model using meteorological data, topographic layers, vegetation combustion data, vegetation and soil fuel moisture indices, and proximity to road networks for deriving forest fire hazards was built. Each of the above-mentioned factors was assigned a specific weight. Using Principal Component Analysis, socioeconomic vulnerability was also integrated. Then, fire hazards were coupled to the analysis of the territorial vulnerability using an Analytic Hierarchy Process. Subsequently, the future evolution of fire hazards with climate change was projected using meteorological data from COPERNICUS. Finally, using the derived hazard layer, the position of the poles with respect to different hazard levels was studied. Then, to extend further beyond a simple characterization, several poles in specific locations (e.g. proximity to strategic assets such as firefighting stations) were chosen to be mounted with thermal cameras at 25 meters of height. That way, the height and location of the poles would be used as a lever for early fire detection. Through this approach, not only are the poles protected, but also a form of an on-field "early warning system" is installed. Accordingly, the use of poles as warning systems is expected to increase the acceptability of the project, in the sense that they can contribute to proactive firefighting instead of multiplying its risks. While the study is concentrated in Southern Corsica, the methods presented within can be replicated in Mediterranean settings. Currently, the study is under implementation, and preliminary results are expected to provide a more hazard-informed infrastructure

expansion.

Keywords: Forest Fires, Risk, Corsica, Decision Support Tool

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The use of weather types to foresee future runoff and soil loss activation in Mediterranean burned Shrublands

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Abstract

The use of weather types combined with individual surface pressure data at different atmospheric heights can be considered to analyze soil erosion processes (Nadal-Romero et al., 2014; Peña-Angulo et al., 2019), even in Mediterranean burned ecosystems. At the hillslope scale, it was not still tested this possibility with a long-term dataset (Rodrigo-Comino et al., 2019). As study area, we selected a representative Mediterranean burned shrubland in the Sierra de Enguera (Spain). More than 200 precipitation events were monitored during the period 2010-2014 period. To put in context this research, the mean average annual precipitation was 544 mm, summarizing a total of 2,720.1 mm. Our results showed that a total of 34.4% of the registered precipitation events ranged 10 to 29.9 mm, 23.5% from 30 to 49.9 mm, and 15.9% from 50 to 99.9 mm. The dynamic low-pressure with fronts was found to generate the highest precipitation amount reaching 60.6% of the total precipitation (105 of the 213 events). Over a third of the rainfall events occurred during Eastern weather type, which accounted for 48% of the total precipitation with average values of 17.6 mm per event. From the total runoff, 65.6% was related to the combined Eastern and cold drops, which accounted for 25.3% of the total volume. The highest sediment concentration event was found for the southern one under thermal low-pressure reaching 51.65 g L^{-1}, followed by anticyclones with the Eastern weather type.

Keywords: Rainfall, soil processes, fire management, human ecosystems, regional issues.

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Adapting wildfire management to climate and global changes: A paradigm shift for the European Union

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Abstract

Wildfires can either mediate or endanger forest ecosystem services and ecological processes. If left uncontrolled, wildfires can cause severe damage and negative cascading effects. For example, atmospheric pollution, health issues, soil erosion, landslides, biotic damages, and ecosystem degradation. The undergoing climate changes across Europe and worldwide are linked to extreme fire events that greatly exceed the response capacity of firefighters and civil protection services. In this context, policies and strategies must be agile and adaptive to prevent, alert, and mitigate unwanted fires based on their potential environmental and socioeconomic risks and vulnerabilities. Current wildfire management is often associated with high-cost suppression operations. The lack of a standard regional protocol is preventing decision-makers from adopting cost-effective fire management practices aimed at prevention on a large scale. To overcome these issues, the Horizon 2020 FirEUrisk project promotes a paradigm shift to a new approach based on risk-based assessment, reduction, and adaptation. The project considers ground-breaking and science-based technical solutions, training, guidelines, and policy recommendations. The aim is to improve wildfire management, reduce the most harmful effects; and adapt fire management strategies to socioeconomic contexts, climate scenarios, and land use change projections for the European territory. The multidisciplinary consortium of 38 partners from 18 countries is joining forces to learn from past experiences and develop bespoke solutions across Europe following an integrated approach. The team will engage researchers, professionals, legislators, and citizens via workshops, surveys, and interviews in compliance with the EU General Data Protection Regulation. The proposed solutions will be tested in 26 locations, upscaled to six sites, and showcased in six regional events in Kalmar County (Sweden), Central Europe (Brandenburg and Saxony in Germany, Bohemia in the Czech Republic, and Silesia in Poland), Central Portugal, Barcelona (Spain), and Attica (Greece). A special event is also planned to show the results of the project at pan-European level. The knowledge acquired over this four-year project will be used to propose alternatives for tackling the challenges posed by current wildfire conditions and those forecasted for the upcoming decades in Europe.

Keywords: climate change, wildfire management, risk assessment, risk reduction, risk adaptation

CO: Environmental Resilience and Nature Based Solutions: Communication, Science, Policies

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Describing the potential of nature based solutions for urban groundwater remediation in the Griftpark by the use of storytelling

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Wageningen University

Abstract

The Griftpark is a historically polluted location located in Utrecht, the Netherlands. The pollution responds to the former presence of three gas plants which were operated in this area until the seventies (Oesterholt, Pluim, & de Vries, 1997). At the end of the 90s the pollution in the 1st aquifer was isolated by construction of a cement bentonite wall in combination with pumping and treatment of the excess precipitation to a wastewater treatment outside the park. As pump & treat will be everlasting, a more cost efficient approach by in-situ nature based solutions for the remediation of tar-aromatic compounds is also being evaluated by a scientific consortium. One of the challenges on the application of nature based solutions in a groundwater polluted site is how to visualize a complex process in a straightforward way to the general public. The citizens perception and support plays an important role in acceptation of such innovative concepts. In order to create awareness and develop principle knowledge of the general public about the relevance of NBS, a transparent, concise communication is developed by storytelling combined with a visual abstraction of microbial processes.
To facilitate the visualization of the underground, a Winogradsky column, where different soil layers are colonized by different types of bacteria is proposed. In such column the presence of various microorganisms at different redox conditions can be readily observed by the naked eye as different color bands. These color bands demonstrate how different environmental conditions result in different microbial communities. In the past, quite some media attention was given to “special Griftpark bacteria”, which is a simplified idea of what actually happens in the ground (Gemeente Utrecht, 2021). For that reason, we aim for emphasizing how the unique environment of the Gritpark resulted not in unique bacteria, but in a unique microbiome.
The Griftpark microbiome plays a key role in the natural attenuation of the dissolved contaminants in the groundwater product of the former gas plants. Natural attenuation potential is being studied in the laboratory at different depths and therefore different redox which can be visualized in the Winogradsky column. In the future, Griftpark’s microbiome activity may also be stimulated by the addition of specific electron acceptors and/or specific degrading bacteria.
The overall goal of the developed storytelling and visualization is to be able to showcase the potential of naturally present microorganisms to mitigate contamination in the Griftpark.

Keywords: Science-communication, underground, microbiome, natural-attenuation

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Is the resilience frame of wildfires gaining momentum in mainstream media? Exploring narratives in Spain

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Abstract

The communication of environmental resilience in the media has gained ground in recent years. Given the seriousness of the climate change situation, the concept of "resilience" has crept into the agenda of various international organizations. With regard to forest fires, there is more talk of "adaptation", and the concepts of "management", "recovery" or "mitigation" are increasingly appearing in the narratives of experts and political agents. For the specific case of wildfires, the resilience frame has a tough competitor in the mainstream media. In this research we called it the "suppression frame" and it has been hegemonic in Spain and in a wide variety of other contexts. Suppression frame put emphasis in extinction and fighting fires. This presentation identifies the elements of these two interpretive frameworks, which clash when the media reports on forest fires. Based on previous studies on the definition of media framing and how these frameworks are applied to the journalistic coverage of forest fires (Castelló and Montagut 2019; Paveglio, Norton, and Carroll 2011; Seijo 2009), the presentation explain the results of a computer-assisted qualitative data analysis of pieces published (n=656) in three major Spanish newspapers over a five-year period (2017-2021). The results indicate that the interpretative framework of resilience has gained prevalence, especially in the last two years (2020 and 2021). Even so, the data indicates that the discourse of suppression is still predominant, especially in years when forest fires have a greater impact. The study identifies elements or frame devices that mark the presence of suppression and resilience frames, including aspects of language and lexical uses, rationality and explanations about the causes of the fires, policy making and management or the role of the communities affected. The author argues that environmental resilience communication is gaining space in the media and explains this in part as a process of mediatization of wildfires and their management. However, suppression and resilient frames are not always opposite and have some common devices related to 'fire damage'. The author also holds that there are some under-developed aspects of the resilience frame about the role of local people and that the evolution of media framing is related to a process of mediatization (Hjarvard, 2008). The paper ends by describing the opportunities and challenges presented by the communication of environmental resilience in the mainstream media, not just for wildfires but also for other climate and natural disasters.

Keywords: resilience communication, wildfires, media coverage, Spain, resilience frame, stakeholders communication, resilient society

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Revisiting wildfire resilience from a territorial perspective: Insights from Mediterranean Spain

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Abstract

Wildfires are increasingly being recognized as complex socio-ecological issues by scholars and policymakers alike. The influence of resilience thinking in wildfire research and management is undeniable (Abrams et al., 2015), and in the call for building resilient territories is arising as major policy objective (Lelouvier et al., 2021). However, resilience ideas have been criticised by social science scholars due to their limited capacity for engaging with important issues such as ethics, social dynamics as well as power imbalances and competing value systems (Cote and Nightingale, 2012; Kaika, 2017). Additionally, its unquestioned reliance on system's thinking (largely through its engagement with the idea of socio-ecological systems) has also raised concerns due to its lack of attention of the constitutive entities of the system (Turner, 2014). In this research we take on board this criticism, while acknowledging the relevance of the notion of resilience as a useful boundary concept for interdisciplinary dialogue.
More specifically, our main goal of the paper is to identify the different territorial elements and dynamics which contribute or hinder the resilience building process in Mediterranean, fire-prone territories. We do that by building upon the socio-politically sensitive understanding put forward by (Rodríguez Fernández-Blanco et al., 2022), that highlights the idea of resilience as a process, which is also territorially embedded. We examine this territorial dimension, through a careful engagement with the notion of territory as understood by non-Anglo-Saxon scholars (Del Biaggio, 2015; Raffestin, 2011), who put forward the idea of territory as the "product" of social and power dynamics, in interaction with the biophysical environment. Such perspective allows us to move beyond system's thinking, while retaining the core idea that divisions between the natural and societal are somehow "artificial". We use these theoretical underpinnings to put forward a working definition of what fire-prone territories are, in order to explore the socio-political, socio-ecological and power dynamics underlying the wildfire issue arise in a more clear way. Upon applying this analytical perspective to the region of Valencia (Mediterranean Spain), we discuss how these elements enhance or hinder the resilience building territory in the region.

Keywords: Wildfire, territory, resilience, Mediterranean, fire-prone

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Toward a nature-based future: A vison for a nature-based future for The Netherlands

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Abstract

Nature-based solutions are promising solutions for the climate and biodiversity crisis. Many studies have shown the potential of NBS for climate mitigation, adaptation and restoring biodiversity. Despite upcoming attention, large scale implementation of NBS is still staying behind. Wageningen University & Research developed a nature-based vision, visualising how The Netherlands will look like in 100 years, when NBS is being implemented on a very large scale. This nature-based vision receive large attention in the Dutch media and by policy makers.
The vision was developed by a research by design approach. Experts from several disciplines were brought together to discuss and design a desired nature-based future. Based on 5 guiding principles a new approach for long term spatial planning was developed. The natural system, water and soil, was the starting point for redesigning The Netherlands. The result was presented as a new map showing a county with more room for water, more forest and wetlands, regenerative agriculture, energy and food production at sea en greener cities. This hopefull vision for the future put nature-based solutions on the map. It showed to be an effective approach to gain more attention for the potential of NBS.

Keywords: nature based solutions, climate adaptation

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Baptist & hattum et al. (2019) A nature-based future for the Netherlands

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Nature Based Solutions for climate adaptation in the Netherlands

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Abstract

Climate change already results in more extreme weather like more frequent droughts and also more heavy rainfall events in the Netherlands. Especially in the east and south of the country this asks for structural measures like more water retention during wet periods to ensure water availability in dry periods as well as managing water excess. In the north and west of the country also other problems like increasing salinization and soil subsidence have to be dealt with. In some areas this may require adjusting land use. This illustrates the complexity of the problem involving not only adaptation of soil and water management and future land use but also societal and economic aspects.
In several projects we try to address these issues by a) working with stakeholders to design possible sustainable future soil, water and land use management options and goals, b) performing scenario analyses to give insight into ways to achieve these goals and also clarify which choices have to be made now in relation to long term goals and c) conducting field trials and demonstrating possible soil, water and land use management options.
At the TERRAenVISION conference we would like to focus on soil and water as leading principles in designing future land use, thus elaborating the meaning of ‘nature based solutions’ in this context. The presentation will include project results like the use of tools to simulate the effect of water management or land use change on agriculture or water use, but will also show the results of field experiments and the use of serious gaming to help stakeholders realize how development towards a sustainable future might take place.

Keywords: soil and water management, climate change, land use

UR: Nature based solutions for urban and industrial areas (land and water management and spatial planning)

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Stormwater control benefits of urban tree canopy via rainfall interception and intensity reduction

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Abstract

In an urbanized environment where impervious surfaces facilitate the transformation of rainfall into a stormwater runoff, tree canopies provide an important pathway for urban stormwater management by directing the precipitation to various components of the hydrologic cycle. In this study, we explored the benefits of urban trees in controlling runoff on an event basis by quantifying the rainfall interception of the open-grown birch tree (Betula pendula Roth.) canopy and its potential influence on rainfall intensity attenuation. Gross precipitation, throughfall, and stemflow were measured from August to December 2021 in an experimental plot in the city of Ljubljana, Slovenia. Simultaneously, the intensity and microstructures of rainfall were obtained using optical disdrometers installed in an open environment and beneath the birch tree canopy. The preliminary findings of the event-based analysis revealed that foliated birch tree canopy intercepted on average 22.4% of the precipitation from August to September 2021. During this period, it was also observed that the average 15-minute peak intensities of rainfall were reduced by up to 33.6%. Meanwhile, the retention capacity of the birch tree in its dormant season decreased significantly, i.e. to 9.9% of the gross rainfall from mid-October to December 2021. The average 15-minute intensity reduction for these events was about 25.7%. In an early-autumn extreme storm event on September 29, 2021, with an accumulative rainfall of 87.6 mm within 7.6 hours, birch tree canopy was able to intercept 19.5% of the rainfall and attenuate the maximum 15-minute intensity by 31.7%. Furthermore, the number of raindrops under the canopy for all rainfall events is higher than those in the open field condition but comprises primarily of smaller drop sizes (i.e., < 1 mm) and lower median-volume drop diameter (D50). The reduction in rainfall intensity along with canopy interception may be beneficial in slowing down the stormwater runoff which promotes infiltration and delay in peak discharge, thus reducing the incidences of urban flooding. The results show that the ability of urban birch trees to intercept rainfall and reduce its intensity provides a benefit in controlling the flow mechanisms of stormwater runoff.

Acknowledgments: Results are part of the CELSA project entitled “Interception experimentation and modelling for enhanced impact analysis of nature-based solution” and research programme P2-0180 supported by the Slovenian Research Agency (ARRS).

Keywords: urban tree, stormwater runoff, interception, intensity

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None

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Floodplain land uptake: Cental-European perspective

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Abstract

Floods continue to represent the major hazard in the Central European regions, causing fatalities, significant monetary losses, and environmental impacts over the last decades (e.g. in 1997, 2002 or 2013). The ongoing efforts to prevent and mitigate the impacts of flooding are based on new spatial planning policies, which emphasize such floodplain uses that may support ecosystem functions and natural flood management in floodplains. The actual impact of these policies on reducing land uptake in floodplains remains unclear, however. In this poster, we present our analysis of long-term Land Use/Land Cover (CORINE) change in floodplains for five Centra-European countries (Austria, Czechia, Germany, Poland, Slovakia). We found the increase of artificial surfaces up to 4.7 percent point within floodplains over the period 1990-2018, with the newly developed artificial areas located predominantly in near proximity of the previously developed areas. This indicates the continuing sub- and peri-urbanization pressures on floodplains, therefore limiting water retention potential in floodplains and increasing exposure of human assets to floods. At the same time, the analysis also pointed to important methodological issues that needs to be addressed by further research. To show the adequacy of the spatial and thematic data scale, in particular, we present the cases of its (in)sufficiency based on examples along with the possible future directions that could be of help improving precision the analysis.

Keywords: land uptake, floodplains, LULC change, spatial resolution

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Potentials of circular and engineered soils for advancing and re-establishing nature-based retentive functional surfaces

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Abstract

In urban, peri-urban and even in rural areas, natural soils have been dramatically vanishing, and adverse consequences of soil consumption and sealing have become a widespread and serious issue. Austria, for example, is European champion in soil sealing activities and sacrificing 11,5 ha of healthy natural soils and their associated ecosystem services on a daily basis. From 2001 to 2020, the yearly loss has ranged from 38 up to 104 km² (Umweltbundesamt GmbH 2020).
When building paved areas, prudent drainage planning is of great importance. Especially in road construction, rapid drainage of surface water is crucial for traffic safety reasons. However, increasing heavy rainfall events often cause precipitation peaks leading to local flooding. Adversely, drainage of rural roads is predominantly above ground and often channelled into receiving watercourses. However, these roadside ditches have some disadvantages. The most serious issue is that continuous input of fine material from the seepage water increasingly worsens the infiltration performance. This leads to silting, the drainage bodies lose their infiltration function and cause unwanted overflows or flooding.
To counteract these problems, we have been exploring specifically designed engineered soils in two-layer designs with advanced hydraulic performance. The aim of our research was to develop and analyse innovative green alternatives to conventional impervious (road) surfaces ensuring load-bearing capacity and trafficability for maintenance measures, permanent infiltration capacity, high water storage capacity, verifiable purification of pollutants, and simple production with predominantly regional materials. This nature-based approach has great potential for a wide range of applications and surface reconstructions in both rural and urban settings: gravel turf, roadside surfaces, parking lots and various pervious path constructions with transient traffic loads.
This is further highly promising for applications according the newly introduced Circular Soil concept (Minixhofer et al. 2022), which aims to tackle the imminent loss of valuable soil resources at large construction sites. The excavated materials, such as soil, sand, gravel, are reused on-site to produce engineered soils for landscape construction purposes. Instead of losing associated ecosystem services due to landfill deposition of the excavated materials and further sealing, engineered soils support the (re)establishment of pervious surfaces, green infrastructure and infiltration and rainwater storage capacities. The engineered soils can be pre-modelled and adapted to fit any required landscaping purpose with the amendment of preferably local additional soil components.
We present these innovative practices for advancing retentive functional surfaces and, thus, for compensating hydro-meteorological risks by using NBS. In a simplified six-step

approach, the Circular Soil concept can be implemented on any large construction site, contributing to a circular economy using nature-based solutions and supporting climate change adaptation measures.

Keywords: nature-based retentive surfaces, Circular Soil, engineered soils, sustainable landscape designs, climate change adaptation

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Implementation aspects of NBS in the subsoil

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Abstract

The subsurface soil and groundwater in most cities is contaminated to some extent. Cleanup is expensive and not always adaptable within the existing situation. However, when redeveloping urban areas, nature based solutions can very well included. However, Aquifer Thermal Energy Storage(ATES), phytoremediation and Monitored Natural Attenuation (MNA) give opportunities to integrate nature based solutions, which improve soil and groundwater quality. The technology of these subsurface NBS have a sound scientific base. However, implementation of these effective combinations are new to design, planning, organization and financial aspects.

How can subsurface Nature Based Solutions properly be implemented in sustainable urban areas?
Three concrete cases of Nature Based Solutions will be presented: ATES+, Phytoremediation and Monitored Natural Attenuation (MNA)
Based on these introducing examples the attendees and panel participants will discuss:

1. How to organize the long term NBS on a consistent and sustainable manner?
2. Can Urban Living Labs function as catalyst in stacking functions?
3. Which parties should initiate redevelopment cases?
4. How to interest relevant stakeholders in societal business cases on wicked topics?

Keywords: Aquifer Thermal Energy Storage, Phytoremediation, Monitored Natural Attenuation, Urban Living Lab

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How to sustainably implement and operate community gardens: Understanding the motivation of community garden coordinators

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Abstract

Nature-Based Solutions (NBS) have become a popular tool for solving many problems in urban environments. To be effective, they usually require more space than conventional measures. This can be problematic for their implementation in the context of competing land uses (Hartmann et al., 2022). Community gardens (CG) may be classified as both NBS and urban agriculture, which means that they also contribute to solving challenges other than climate change adaptation such as food self-sufficiency or development of local communities. Growing crops in CGs has become increasingly popular in European cities in recent years. Their advantage over conventional NBS is that they combine several benefits at once, can be temporary or, e.g., can be established on the roofs of houses. In Czechia and in other Central European countries the majority of CGs are created through a bottom-up process. The role of garden coordinators is very important. In addition to establishing the garden and community, they oversee organizational, promotional, communication and motivational activities (Stluka et al., 2019). CG development can be supported by local decision-makers or spatial planners when making decisions on the use of public spaces in cities by, e.g., the provision of municipal land. However, to support long-term functioning and provisioning of EC, the focus should also be on the coordinators themselves. The paper addresses the issue of sustainable functioning of community gardens from the perspective of coordinators. This contribution answers the research questions: (1) What are the motivations of people to become a community garden coordinator in Czechia? (2) How can coordinators be motivated to perform the role of coordinator in the long term? Qualitative research in the form of 20 structured interviews with current and former coordinators across Czechia was used in this paper. The interviews were analysed using open coding. The results show that the main motivations for people to become a coordinator are an opportunity to socialise, long-term interest and positive attitude towards gardening, creating space for spending leisure time, improving the quality of life for the residents, growing crops, enjoying the gardening. The results also indicated that the motivations that would keep a coordinator in the position long-term include financial rewards and the opportunity to organize other garden-related activities. The position of garden coordinator is most often a voluntary and unpaid activity. There are frequent cases of coordinator burnout or reduction of activities. In some cases, coordinators have indicated that they would be willing to

pursue coordinating professionally and cater to multiple gardens at once if financially rewarded. The results can clarify to city councillors what incentives should be introduced to enable coordinators to develop their garden in the long term and to extend this type of NBS in cities.

Keywords: community garden, motivations of coordinators, well being, sustainability, Czechia

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Soil and Water Bioengineering in urban fluvial rehabilitation and in flooding prevention: The Estepona RiVER

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Abstract

Soil and Water Bioengineering (SWB) is a Nature based discipline that offers sustainable solutions face to the challenges of mitigation and adaptation to climate change.
SWB is a discipline than combines technology with biology, making use of native plants and plant communities as construction material and erosion control in degraded environments. The term "Engineering" refers to the use of technical and scientific data for constructive, stabilization and erosion control purposes and "bio" because the functions are related to living organisms, mainly native plants with biotechnical characteristics and with the purpose of restore ecosystems and increasing the biodiversity
This discipline, well applied, is as a real alternative to classical engineering, and is especially relevant in the fluvial restoration in urban areas
During the presentation we will present various examples of urban fluvial rehabilitation performed with Soil and Water Bioengineering techniques , and more concrete the project in the Estepona River in Bakio , as example or rehabilitation and flooding prevention wiht use of SWB. The municipality of Bakio, located on the Biscayan coast, suffers significant floods due to the confluence of the effects of the Estepona river floods with the equinoctial tides, affecting an important part of its urban area. In order to mitigate the adverse effects and in order to improve the resilience of the area to the climatic emergency, the project consist in open and de-channelling a section of the river ,allowing the current flood plains (4 has) to laminate the avenues and to protect the homes located in proximity , with the urban integration as a new floodable park. This project is one of the actions presented to LIFE IP URBAN KLIMA 2050
It has been approved by the European Union in the area of LIFE Integrated climate change mitigation and/or adaptation project
Fluvial rehabilitation projects in urban areas require, in addition to hydraulic comprehension and landscape solutions, a multidisciplinary interaction, an active public participation, the necessary dissemination exercise, as well as an adaptive management, recognizing that the solution is not always unique and absolute, and the responses of the system must be permanently evaluating.

Keywords: Nature based Solution,adaptation, climat emergency , flood abatement, urban mitigation

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Integrated modelling for urban runoff

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Abstract

The consistent increase in urban areas, the increase in population density in cities and the conversion of open lands to impervious areas (e.g., roads and parking lots) pose complex hydrological and environmental responses, including urban flooding sewage overflow, pollution and environmental nuisance. These occur every year in cities as a result of the inconsistency between the capacity of the urban drainage system and the actual flow characteristics**.** The main goal of this study is to develop a platform for modelling urban runoff based on surface characteristics, rainfall-runoff relationship and hydrological processes, through the integration of engineering model, hydrological model, and GIS, as a tool for dynamic urban drainage planning and better estimation of urban peak flows, flow volumes and response time of urban catchment. The study offers a new tool for quantifying and modelling (temporal and spatial) urban surface runoff designed by: measuring surface runoff at sub-basins scale examining and constructing hydrometric and engineering database for model development; estimating flow rates and rain-runoff-drainage ratios in urban basin in real time; examining and calibrating the conventional soil classification coefficients; combining and integrating hydrological model (engineering model and geographic information systems) as a tool for assessing peak flow, flow volumes and concentration time of rainfall events in the urban space. The study thus is aimed to measure, quantify, and model the urban surface runoff pattern in space and time in as demonstrated in the previous (2016) burnt basin of the Shazar-Dakar grove. The annual report presents the results of the first measurement year, 2019-2020, in which 861.3 mm of rain was measured, the mapping products and the first hydrological findings from the research basins. The innovation in the work will reflect the ability to assess a momentary situation using a linked array of sensors - both hydrologically and technically, so that the concentration time (rain until the beginning of monitoring runoff in the river) and the accumulation of volumes flowing along the urban drainage route will reflect the momentary situation during a rainstorm.

Keywords: Urban runoff, hydrological model, runoff-rainfall ratio, HEC RAS, SWMM

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LIFE CO2SAND Using clay to make farmland climate proof

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Abstract

As a result of climate change we increasingly see longer periods of drought or, on the other hand, extreme rainfall. This has a great impact on farmers on sandy soils. Clay soil enhances the resilience of sandy soil, strengthening its capacity to handle extreme weather conditions. Clay can also increase the fertility of sandy soil. In the LIFE CO2SAND, Rijkswaterstaat, (the Dutch Directorate-General for Public Works and Water Management) and the Province of Gelderland match the supply and demand of clay soil. We are applying the 'clay-in-sand' principle in 5 demo fields. Farmers, area managers and land designers are welcome to visit these 'field labs' and make use of this technique for their own soil. Clay for sandy soil: demand finds supply Farmers need to improve the quality of their farmland. There is a surplus of clay soil, which is not used at this time. In lowland areas, clay is extracted in nature restoration works and area development for road & house building. This clay is suitable to improve drought-sensitive sandy soils of farmers. The clay particles enable the soil to retain more water, organic matter and minerals. More organic matter in the soil goes with a reduction of greenhouse gasses in the atmosphere. This helps slowing down climate change. Expected LIFE CO2SAND results

- Water conservation of 10 mm per drought period;
- In the long term an extra capture of 1.9 tonnes of CO2-equivalents per hectare per year;
- Higher crop yield;
- Reduced leaching of fertilisers and minerals;
- Circular use of extracted top soil;
- Shared knowledge with farmers, researchers and authorities, business consultants and agricultural schools.

Other sectors can use available clay as well. By applying clay to peat lands, peat oxidation slows down and soil subsidence is reduced. Clay can also bind organic

substances in compost or bokashi so they decompose more slowly. LIFE CO2SAND received financing from the LIFE programme of the European Union. Rijkswaterstaat is project partner.

Keywords: Topsoil, Climate, Resilience, Farmers, Circular

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Infrastructure vulnerability assessment and NbS recommendations

Dr Didier Soto et al

Project manager

Abstract

The anthropogenic impacts as well as climtate change impacts are accelerating land degradation. Land erosion, such as moving sand dunes due to degradation creates threats to infrastructure. In a context of cold deserts, industrial infrastructures are exposed to different hazards, particularly erosion and silting of pipelines and industrial facilities. These natural processes can affect the infrastructure and facilities and cause significant damages. Moreover, climate change impacts can lead to changes of wind direction and intensity and strengthen wide daily, monthly and annual variations.
RESALLIENCE has been responsible to provide to its customer a GIS-based risk assessment of its facilities. RESALLIENCE has evaluated the aggressiveness of the environment on the pipeline and identified the most vulnerable sections.
For this purpose, we conducted field mission to collect data on land degradation and its impact on infrastructure. We used a GIS-based risk assessment combining Digital Elevation Model of the studied area, regional climatic context including an analysis of meteorological data from Copernicus Reanalysis database, assessment of wind sand direction and determination of the most exposed areas to conduct the vulnerability assessment of the industrial facilities. For the most vulnerable areas of the infrastructure, we proposed NbS and hybrid solutions in order to reduce the land degradation and thus, the impact on the infrastructure.
The project is currently ongoing and several results can be presented during the training.

Keywords: Climate change, resilience, soil erosion, risks, GIS, NbS

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A methodology leveraging satellite data to support urban resilience planning through nature-based solutions: Application to the city of Ouagadougou in Burkina Faso

Dr. Philippe Sohouenou et al

Project manager

Abstract

Urban areas in developing countries face unprecedented challenges, including rapid growth, ecological transition and vulnerability to climatic hazards such as floods, droughts, and windstorms. Green spaces and green infrastructures could be used to increase the climate resilience of these urban areas. However, areas intended for green sites in many urban areas of developing countries are often illegally occupied and diverted from their initial use. For example, the Government of Burkina Faso estimated that 27% of green spaces where illegally occupied in 2012 in the National Landscaping Strategy. To address these challenges, decision-makers and urban planners of developing countries need updated information on land use and climate hazards to plan and implement protection, beautification and enhancement interventions of green spaces and infrastructures. The presentation will introduce a methodology leveraging satellite data to support urban resilience planning through nature-based solutions. This methodology has three steps: i) territorial and geo-spatial diagnosis of the studied city through satellite technologies, ii) identification of sites and definition of their use in consultation with local stakeholders, iii) preparation and presentation of a portfolio of urban green Infrastructure for the studied city. This methodology is under implementation in Ouagadougou (Burkina Faso) with a focus on flood and urban-heat-island issues. First results of the case study will be presented to illustrate the methodology.

Keywords: Climate change, Resilience, City, NbS

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Past, Present and Future Predictions – Understanding the behaviour of contamination at a complex former manufactured gas plant

Suzanne Faber

Utrecht University

Abstract

Background/Objectives. The Griftpark, located in the city of Utrecht, is a large former manufactured gas plant (FMGP) site. In 1990, the area, heavily contaminated with coal tar, was encapsulated by a slurry wall to prevent the spread of contaminants further downstream. Groundwater is constantly pumped from the contained zone to prevent leakage through the slurry wall or leaky aquitard underlying the first aquifer. In the current research, the potential of (stimulated) bioremediation as an alternative to the current contain-and-manage measures is modeled and tested. Exact locations of DNAPL source zones are largely unknown as the subsoil is highly heterogeneous, also, due to the containment barrier, there is no regional groundwater. Therefore, there is no clearly defined contaminant plume along which the concentration profiles can be obtained and biodegradation indicated. This research therefore focuses on how to develop biodegradation remediation strategies at contained sites.
Approach/Activities. A wide range of techniques was employed to better locate the source locations and demonstrate the occurrence of biodegradation in the absence of an identifiable contaminant plume in the contained zone. Contaminant concentrations were measured by GC-MS. Membrane interface probing (MIP) at suspect locations and sonic drilling were performed to study source locations and better understand the soil stratification and possible migration pathways of pure-phase coal tar. To prove the occurrence of biodegradation in the field, a combination of metabolite analysis with LC-qTOF-MS, analysis of redox conditions with ICP-OES, microbe DNA extraction and qPCR analysis, as well as multi-element compound specific isotope analysis (CSIA) were employed. Next to these activities, a series of laboratory batch studies were performed to further investigate the conditions under which biodegradation can occur in the field and the potential for biostimulation.
Results/Lessons Learnt. The GC-MS analysis revealed that, beside the BTEX and naphthalene components as usually expected at FMGP sites, high concentrations of trimethylbenzene, styrene, indane and indene. The MIPs and sonic drillings have given an improved idea of source locations and soil stratification. Combined analysis of metabolites, redox conditions, DNA analysis and laboratory batch studies, has shown that biodegradation conditions occurs under sulphate- and iron reducing as well as methanogenic conditions. Furthermore, the batch studies have indicated high potential for stimulation of biodegradation with oxygen, but not for nitrate and chlorate. Due to the

high complexity and uncertainties in predicting flow streamlines, the CSIA analysis was not interpretable. Future work includes building a 3D model to explore possible scenarios for the future management of the site.

Keywords: Gas factory, coal tar, biodegradation, bioremediation, urban, contain-and-manage

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Retention of microplastics by green urban spaces vegetation

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Abstract

Plastic pollution is a worldwide problem: plastics are commercialized in large quantities and it takes a long time for them to decompose. Small plastic pieces (microplastics - MPs) have been found in different environments and they are linked to human health problems. Urban areas represent a strong source of pollution, and it is expected that pollutants such as MPs are transported from the sources through different pathways such as wind and rain. Therefore, the control and treatment of these pollutants still represent a global concern. Green areas are pointed out by experts as natural filters for contaminants in cities, through their capacity of retention by leaves and soil. They thus reduce the load of pollutants transported through wind or runoff. However, not much is known about MP pollution and transport in the atmosphere, or their retention by vegetation.
The present work aims to clarify the capacity of different trees to retain MPs through their leaves with two case-studies located in Coimbra (Portugal) and Wageningen (Netherlands) cities. The influence of a rainfall event in washing the particles from the leaf to the soil is also analysed.
Three leaves samples of five different tree species (eucalyptus, pine, oak, willow and cedar) were collected from Coimbra. Totally, 15 samples were collected. In Wageningen, 24 leaves samples were totally collected from two different tree species (holly and cedar), two different tree heights (lower level and 1.5m) and two different weather conditions (before and after rainfall). Each sample is constituted by 5 leaves. All the samples were analysed by washing the leaves using distilled water, filtration of the particles, extraction of microplastics following the density separation using Sodium Phosphate as solution ($\sim 1.4\ g\ cm^{-3}$), and the visualization and identification of the particles under a microscope.
First results show high levels of microplastics in different tree species. It is expected that larger leaves located at a greater tree height, before a precipitation event, present the highest microplastic levels. Characteristics such as leaf area index, road proximity and

intense precipitation episodes could influence the quantity of microplastics in the vegetation of green areas and therefore they should be considered in future studies. In order to control the entry and the concentration of microplastics in the environment, especially in cities, it is essential to defining and evaluating nature-based land-use scenarios, considering the role of green urban areas in filtering small particles.

Keywords: Microplastics, Atmospheric deposition, Green urban areas, Tree leaves.

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Increase of sustainability of urban forests by prevention of land degradation

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Abstract

An urban forest includes trees and shrubs, but these vegetative structures can be also found in parks, gardens and along streets within urban areas. In many regions, urban forests are the most extensive, functional, and visible form of green infrastructure in cities and have an important place in the combat against climate change, preservation of forest ecosystems. Urban forests are safe islands for biodiversity and play a key role in preserving human health and raising the quality of life in the city.
The Kosutnjak urban forest, Belgrade, Serbia, occupies a total area of 305.32 ha, from which 83% is forested. Altitude varies in the range of 75 to 217 m above sea level and the climate is temperate-continental. In 2014, 93% of the area was declared a Monument of Nature "Kosutnjak Forest" while the remaining 7% of the forest is intended for recreation and general cultural and educational functions. The coniferous natural hardwood covers almost 70% of the total area. Generally, trees are characterized by poorly developed canopy, often rotten. The forest was seriously affected by the snowfall in December 2021. A large number of trees fell, broke and bent. The general condition of the forest is unfavorable, the assembly is interrupted and damaged. Due to steep slopes and generally poor condition of vegetation on the entire surface of the Kosutnjak forest, erosion processes are observed in the form of leaching, furrows, ravines and local movements of soil masses. Other forms of physical land degradation are compaction associated with occurrence of tracks.
The aim of this study is to determine the connection between the productivity of forest ecosystems and soil quality. Soil physical- chemical characteristics contribute to determining the sensitivity of the soil of the Kosutnjak urban forest to degradation processes and the connection between the state of vegetation and soil quality. Furthermore, three potential climate scenarios were tested and contribute to understanding the need for adapting the Kosutnjak urban forest to degradation processes and soil nutrient losses exacerbated by climate change. This knowledge will aid in determining proposed measures and strategies to mitigate the effects of land degradation processes based on the principle of environmental engineering.

Keywords: urban forest, ecosystem, soil quality, land degradation, environmental engineering

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Land Stewardship at industrial sites; a chance to enhance societal ánd natural value

drs. A.J.M. Schelwald-van der Kley

Envision-S BV/ Co-chair

Abstract

In the autumn of 2020, the European Industrial Network NICOLE* published its 'quick guide to Land stewardship at Industrial sites'; a roadmap for sustainable land management 2.0. Earlier, in 2018, NICOLE explored the concept of Land Stewardship together with Common Forum, (European policy makers). Building on that, the more recent guide provides guidance on how to optimize the natural, social, and economic value of (industrial) sites, in a balanced way.

LS, by definition, has a long-term horizon, ensuring usability and health of the land for future generations. To realise its full potential, industrial site owners need to look beyond the site boundaries and involve multiple stakeholders. Whereas soil stewardship focusses on the vitality of soil, land stewardship also has an eye for the value of social and industrial use of land.

As such LS can contribute to some of the grand societal challenges facing Europe and the rest of the world. Think of climate change, loss of healthy soils and biodiversity, and positive transitions towards renewable energy and more health and well-being of people. Nevertheless, keeping in mind the necessity of using the land for production of food and goods, or for the creation of employability. These themes are all interconnected. Acting on one of them, has a multiplier effect. E.g., restoring soils, forests, and wetlands, will increase absorption of $CO_{2,}$ and make our living environment more resilient to climate change, at the same time improving our living conditions.

During the presentation some examples of Nature Based Solutions in relation to LS at operational and former industrial sites will be shown. Making use of the power of nature and enhancing its potential by creating more natural value, greatly contributes to solving the societal challenges facing us all!

Keywords: Land Stewardship, value creation, industrial sites, nature based solutions

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Can the EU Taxonomy help upscaling investments into urban nature-based solutions?

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Abstract

In this paper we analyze the finance mobilization function of the EU Green Taxonomy (ET) with regards to upscaling investments into urban nature-based solutions (UNBS). UNBS are particularly challenging for private investors as they offer dispersed benefits to different stakeholders and are often connected to public infrastructure or public space. The ET in contrast is very climate-focused putting measurable impacts at the core. Our mapping analysis of past investments in UNBS and areas covered by the ET finds that overall public and public-private constructions are used to finance the majority of UNBS in Europe, especially parks and (semi) natural urban green areas. A significant level of corporate investments that are covered by the ET goes towards external building greens (green roofs, facades and walls) which represent opportunities for scaling up, especially through funding by institutional investors. Potentially interesting UNBS assets for private investments not yet covered by the ET are urban green spaces that are connected to grey infrastructure and food production areas. Including these would legitimize them as asset classes and allow for standardized reporting and comparison which is crucial for an uptake by private investors. Based on our findings we recommend investigating sustainability guidelines for UNBS not currently covered by the ET and incorporating common ET metrics in UNBS investments to allow for comparison with existing asset classes such as clean energy.

Keywords: urban NBS, EU Green Taxonomy, sustainable finance, investment enablers, barriers

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Phytoremediation: a nature-based remediation solution and a means for improving underground and above ground biodiversity

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Abstract

TAUW is working on the treatment of soil contaminated by hydrocarbons, on a site in the south-west of France used as a storage facility for soil contaminated with oil drilling mud. The site is to be restored for functional use and, if possible, towards agricultural use.
Nature-based solutions were chosen because of the isolated location of the site, the absence of water and electricity, the large volume of soil to be treated, and the need to return the plot to its primary use, i.e agriculture. 2 on-site solutions were tested: biodegradation in biopiles and vegetation-assisted biodegradation in rhizopiles. The aims for the remediation were to achieve pollution abatement, to limit operating costs and to regenerate soil of good agronomic quality, suitable for cultivation. Where biopiles play on activating existing bacterial communities, rhizopiles introduce new living beings (plants), which favor exchange and transfer of nutrients, water and oxygen, and a cohort of microorganisms (bacteria, fungi) that grow a the locally modified environment, i.e. the rhizosphere.
The plants sown on the rhizopiles (alfalfa and rye grass) were chosen based on the complementarity of their root systems (tapping root + fasciculate roots) and their agronomic qualities (atmospheric nitrogen fixation, soil cover). These are species cultivated locally facilitating crop management and ensuring their adaptation to regional pedo-climatic conditions.
When building the piles, the characteristics of the soil contaminated by sludge were corrected with the addition of topsoil, compost and lime for some conditions. The cultural operations consisted in: working the soil at the surface of the piles, inoculating the alfalfa seeds with Rhizobium leguminorasum, sowing with a specific seeding density, adding an NPK fertilizer as a "starter".
At the end of the test (50 months), 90% reduction in TPH concentrations were achieved. Nematodes (soil microfauna), sensitive to disturbances, have seen their population grow from 6 months after sowing in the rhizopiles, and with time the Nematodes also showed a higher diversity in the rhizopiles. The plants on the rhizopiles, after a few months of slow growth regained levels comparable to the control plot (weight of aerial biomass, omega 3 index). Wild plants (Echinochloa crus-galli, Apiaceae species) have established spontaneously on the rhizopiles.
Phytoremediation is a mean of increasing biodiversity, at microbial scale, of the microfauna, and at the surface of the rhizopiles. The regeneration of healthy, structured

and living soil is ultimately a condition for the development of biodiversity. To do so, phytoremediation must be managed by combining "traditional" remediation techniques for contaminated sites and agronomic approaches… and old farmer's wisdom.

Keywords: phytoremediation, nature-based solution, soil biodiversity, agricultural practices, hydrocarbons

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Evaluation of selected factors affecting the water capacity of small-leaved linden (T. cordata Mill.)

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Abstract

In the presented work, it was observed how the location associated with the degree of leaf contamination and the degree of honeydew coverage affect the water capacity of small-leaved linden. Samples were taken in 3 locations differing in the degree of contamination and in 3 dates allowing to record different degrees of leaf coverage with honeydew typical for this tree species. Water capacity was measured in a rain simulation experiment under laboratory conditions.
The conducted analyzes clearly show that both the honeydew coverage of the assimilation apparatus and the degree of leaf contamination play a key role in the process of water retention by small-leaved linden.

Keywords: honeydew, phytoremediation, urban forests, retention

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Bringing the Wood and Scrub to the Mediterranean Urban Park

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Abstract

Harmonizing the interaction of humans and nature in the urban environment is a major challenge for modern societies. Urban green space (UGS) can mitigate the adverse effects of urbanization for both humans and nature by upgrading ecosystem services (ESS) and improving the quality of urban life. Especially in arid regions, native vegetation UGS have a vast potential to offer superior and cost-effective regulatory ESS (i.e., water and carbon) (Guillen-Cruz et al., 2021) and offer natural climate adaptation solutions. Regrettably, UGS is not always equally distributed within cities, which is an intense problem in Mediterranean countries such as Greece, where UGS coverage is only 2%. Furthermore, UGS planting choices are typically based on aesthetic value rather than ecosystem regulation effectiveness or abiotic stress tolerance (Kurz & Baudains, 2012). In this context, we revisit an electronic survey of over 700 residents of urban and peri-urban areas of Crete, Greece (Christoforidi et al., 2022), which showed the urgent necessity for public UGS (88% of participants consider extremely necessary for their prosperity). In addition, highlighted the overall dissatisfaction with the current green infrastructure of the island (79% considered local UGS inadequate and 93% consider them inaccessible to people with mobility problems or young children). Notably, this public demand for more and better quality UGS is also focused on native vegetation. Here we show that most participants (98%) prefer native plants of Crete in UGS and 78% prefer green spaces only with native plants. The majority of respondents 75% appeal to non-material benefits of native plants, such as their relationship with the island's cultural heritage and their compatibility with the natural environment. The limited water, nutrient, protection requirements and the medicinal value of native plants are the most important factors (60.8%) of respondents in plant selection for UGS. Results show that, apart from being a weapon of choice for developing climate-smart UGS, contrary to past trends native plants are also widely popular among citizens. This outcome calls for a shift in the local UGS development and planting strategy from the fragility of exotic vegetation to the resilience and seamless integration of Mediterranean wood and scrub with the local ecosystem.

Keywords: Urban green space, Crete, native plants, ecosystem services, planting strategy

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CC: Circular Economy and Carbon Farming

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Orchid City

Dico van Aalderen

Except Integrated Sustainability, The Netherlands

Abstract

The built environment, and our interactions with it, is by far the most important driver of climate change. For many countries major concerns that require an answer include: a housing challenge, climate change, healthy and sustainable living together, care and education. Many of these challenges come together in the city. How we design and build our cities today will have a major impact on the future sustainability of our cities, especially in the areas of transport, agriculture and industrial production.

It is time to develop visions that go beyond one-dimensional solutions, that address the essential foundations of how we live, work and produce. We have yet to see physical examples that demonstrate and produce such long-lasting, globally supported and systemic social change. Today's future-oriented city designs, such as Masdar, NEOM and Toyota's Woven city, are too focused on emerging technology for solutions and fall short. They provide few answers to the question of how people can live affordably, in harmony with our environment.

Enter Orchid City: Orchid City is the world's first blueprint for an affordable, climate-adaptive, sustainable city. Here we rediscover how we live together with nature, and with each other. Orchid City offers solutions to challenges in energy, circular resource and, sustainable food, transportation, and social programmes. It provides affordable bio-based housing in a new foundation for a healthy community, where living, working, caring, learning, and relaxing come together. Orchid City creates an ecosystem that is resilient, stronger than the sum of its parts, climate-adaptive and future-proof.

Orchid City offers solutions to challenges such as energy, circular resources, sustainable food, transportation, and social programmes. It provides affordable bio-based housing in a new foundation for a healthy community, with living, working, caring, learning, and relaxing together. The housing aims to create a diverse and inclusive community with affordable, future-proof housing, a combination of villas, social housing, student housing and elderly care. Orchid City is applicable to different communities, climates, locations and cultures, and is scalable from a small neighbourhood of 500 inhabitants to cities of 50,000+ inhabitants, from low- to high-tech outfits. Orchid City scales with the available space, the ambition of the partners, and the local demand for sustainable developments. Using a systemic integrated approach, it tackles multiple problems at once, and realizes a new way of healthy and future-proof living.

Keywords: Sustainable city, climate-adaptive, resilience, regenerative nature, systemic development

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What does the circular and climate neutral household of the future look like?

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Wageningen University and Research

Abstract

This paper presents four visions of what the household in the future could look like. Furthermore, the household is put in two perspectives: firstly, how does the household contribute to the climate neutral circular society directly, taking into account food, energy and waste. The second perspective is the indirect impact of the household on sustainable use of our planet. In this research a combination of expert interviews and literature review has been used to make the assessment of the direct and indirect impacts and interactions of households on a climate neutral and circular society. Interviewees are selected to represent different socio-economic backgrounds. They were asked for their aspirations, their vision on how their future climate neutral household would look like. The different visions are evaluated and compared for overlap and contradictory stakes. Lastly, innovation needs, and trade-offs are identified to create the enabling conditions for a sustainable society for the environment, agriculture, industry and citizens.

Keywords: circulair bioeconomy, future-vision, circular agriculture, renewables, commodity sharing, recycling

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Enabling carbon farming: presentation of a robust, affordable and scalable method

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NMI Wageningen, Wageningen University

Abstract

The main hurdle in instrumentalizing agricultural soils to sequester atmospheric carbon is a development of methods to measure soil carbon stocks on farm level which can overcome socio-economic barriers related to cost, usability and accessibility. We present the Wageningen Soil Carbon Stock pRotocol (SoilCASTOR), a method for soil carbon stock assessment using satellite data, direct soil measurements via mobile soil sensors and machine learning which can help overcome these socio-economic hurdles. The method has a low cost per hectare and uses plug-and-play tools (soil scanner), which lower the threshold users need to overcome. The method has been tested and applied for multiple farms in Europe and the United states on agricultural fields with variable crop rotations, soil types and management history. Results show that the estimates are precise, repeatable and that the approach is rapidly scalable. Carbon stocks in the top 30 cm range between 1.8-6.1 kg C/hectare and resolution is up to 10x 10 meters. The precision of farm C stocks is below 5% enabling detection of SOC changes desired for the 4 per 1000 initiative. The assessment can be done robustly with as few as 0.5 samples per hectare over a range of scales, for farms varying from 20 to 200 hectares. These findings can enable the structural and widespread implementation of carbon farming.

Keywords: SOC, soil carbon, soil organic carbon, carbon sequestration, carbon farming, climate change mitigation, spatial statistics, machine learning, 4 per 1000.

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Leveraging legacy data to lower implementation thresholds for carbon farming

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Abstract

Key challenges in implementing carbon farming involve (socio-economic) factors related to cost, the level of decision-making and ease of implementation. These barriers may be lowered if legacy (i.e. pre-existing) datasets on soil (carbon) properties are leveraged. However, there are challenges when using legacy data concerning data availability, harmonization and integration. The Wageningen Soil Carbon Stock pRotocol (SoilCASTOR) is a method for soil carbon stock assessment using satellite data, direct soil measurements via mobile soil sensors and machine learning. This approach is applicable at the farm-level (>60 ha), i.e. the level where decisions on soil management are made. The approach of this method is modular: the ingested (satellite) data can be adapted and also include other local databases. Thus, if legacy data is available it can be ingested. In this study we show the impact of leveraging legacy data to get soil carbon stocks estimates for three farms in the Netherlands. Results show that by leveraging existing datasets (i.e. data from previous sampling campaigns and information on soil properties) we can reduce carbon stock estimate uncertainty. Furthermore, in some cases the amount of samples needed for robust estimates can be reduced if legacy data is available. These results indicate that legacy data can help reduce the cost and potentially increase the gains of carbon farming.
Key words : carbon farming, satellite covariates, SOC, soil carbon, soil organic carbon, carbon sequestration, carbon stocks, climate change mitigation, spatial statistics, machine learning, 4 per 1000.

Keywords: carbon farming, satellite covariates, SOC, soil carbon, soil organic carbon, carbon sequestration, carbon stocks, climate change mitigation, spatial statistics, machine learning

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Climate Knowledge Agenda: Synergies and trade-offs of Wageningen Climate Solution

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Abstract

The changing climate is posing challenges for the use of resources, land and for food production. Strategies for climate adaptation often need tailor made solutions and interventions in different regions and societies. Climate solutions are needed to reach the EU goals to be climate neutral and resilient by 2050. Opinions differ on which solutions are the best or most urgent. Society does not have the time to figure out what is the best solution nor to understand the synergies and trade-offs of every potential solution.
Wageningen University & Research (WUR) has a large track record on climate and climate-change research by exploring the impact of climate change on society, agriculture and ecosystems, and developing evidence-based solutions for mitigation and adaptation. Within WUR we have the expertise on urban areas, agricultural areas, forest and nature areas and water bodies. When a solutions is applied to an area, it triggers synergies and trade-offs of solutions and intervention with the objective of other areas. With the unique availability of diverse expertise, WUR can understand synergies and trade-offs of climate solutions on different areas. A climate knowledge agenda has been set up to define the vision of WUR on climate research: *Combine solutions, synergies and trade-offs to create integrated approaches towards a climate neutral and resilient Europe*.
To achieve this vision, WUR aims to increase the understanding of synergies and trade-offs by looking through the eye of other people and to make the synergies and trade-offs insightful through a multidisciplinary approach. Ultimately, we as OneWUR will be able to advice decision makers on the interpretation of the synergies and trade-offs for selected interventions to contribute on a circular and climate neutral food system.

Keywords: climate solutions, synergies, trade-offs, drought, food production, food consumption

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ORCaSa project

Suzanne Reynders

INRAE

Abstract

CIRCASA (2017-2021) a Coordination action supported by the European Commission and led by INRAE brought together over 100 key stakeholders and 500 scientists from around the world who formalised an interest in establishing an International Research Consortium (IRC) on Soil Carbon built around an initial strategic research and innovation agenda (SRIA) focusing on agricultural soils. This IRC needs to further mobilize the international community of stakeholders working on agricultural soil carbon but also other land uses (forests, pastures, public areas for recreation including in urban settings) and therefore the initial SRIA needs to be expanded and supported by an implementation plan as well as a central knowledge platform offering services to this community. To do so, the European commission launched a 2nd Coordination action call for the establishment of the International Research Consortium on soil carbon. A consortium led by INRAE responded to this call with the ORCASA project that has been accepted. The main goal of the ORCaSa project coordinated by Suzanne Reynders (INRAE) is to launch and roll out the initial operational phases of the IRC on Soil Carbon so that by 2024 the IRC has established an international position as the coordinator of soil carbon research and innovation at global level offering a unique SRIA and implementation plan, a supporting knowledge platform for the benefit of a wide range of stakeholders beyond the scientific community and enabling the preparation of a disruptive low-cost, internationally-recognized monitoring, reporting and verification (MRV) system. In order to reach the international scale expected in this project it was crucial to reinforce the initial EU consortium with International partners in a position to engage their own institution and country but who are also able to reach out to other countries of their region. Therefore, six regional nodes coordinators will contribute through their enlarged network and workshops. Their role will be crucial in consulting with key local actors, in connecting and engaging with regional funders, in identifying actors at regional level that can contribute to revising the SRIA (non-agricultural soils) and help define the implementation plan taking on board any regional constraints/expectations.

Keywords: Carbon, International Research Consortium, knowledge platform, Strategic Research and Innovation Agenda

Workshops

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Nature-Based Solutions (NBS) by applying Nature-based design

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Abstract

The ‘Nature-based design’ principle means that natural processes are used to strengthen the design. Working with nature instead of against nature. This will help prevent unintended negative side effects and result in additional benefits, for instance in terms of nature values. It may also result in cost savings. The ‘Nature-based design’ principle requires engineers to gain insight into the natural processes occurring in a project environment by determining their physical, chemical and/or biological characteristics. Negative effects on these processes can then be avoided in the design phase, while such processes can also be used to create additional benefits. This principle is called ‘Building with Nature’. It is applied by performing a system analysis to consider the project in a broader context. Such an analysis involves determining the dominant processes, identifying key factors that can influence these processes, and finally identifying effective measures targeted at those key factors.

When applying the sustainable design principles, system analysis is a much-needed ally. A water system, a soil system, a financial system, a computer system or a social system – taking effective measures that will influence a system in the right way is not possible until you understand how the system works. A system analysis involves looking at the condition a system is in relative to any processes that influence that condition.

For Terra Envision we provide 2 cases related to this design principle:

Case 1 Nature-Based Solutions Quickscan

The Nature-Based Solutions (NBS) Quickscan contributes to achieving project ambition regarding climate resilience and biodiversity. The NBS Quickscan provides insight into which NBS can promote climate adaptation and biodiversity in a project and how NBS can offer various social secondary functions.

The NBS Quickscan follows the integral design method of Witteveen+Bos by first providing insight into the goals we want to achieve in the project and the context with a system analysis. With the help of the function analysis, the desired functionalities of the project are explained. The variant study then provides insight into various ways in which NBS can fill desired functions. Finally, the the costs and benefits of the NBS are

assessed, resulting in an advice on how NBS can be of added value for the project.

NBS Factsheets provide an overview of functionalities, practical application, advantages and disadvantages of the NBS that appear to be of value to the project. After the NBS Quickscan, together with the client, we decide which NBS offer added value to the project and are applied in the design.

Case 2 Nature-Based Integrated Costal Protection of Java

Our project along the north coast of Java (Indonesia), that provides coastal protection and sustainable aquaculture production, materialised the transition to climate resilience and circularity. The coastal zone that consists of coastal waters, mud flats, mangroves and aquaculture ponds provide multiple services and have strong interrelation. By restoring the mangrove green belt besides the coastal protection, the water quality is increased and as well as the size of habitats resulting in a larger fish population resulting in more fish catch. With sustainable aquaculture the production increased as well as the water quality strengthening the co-benefits already stated. These results are achieved in strong involvement of the local communities and governments.

Keywords: Building with Nature

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Support to the EU Mission “A Soil Deal for Europe”: How to engage actors, close R&I gaps and set up Living Labs and Lighthouses

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Abstract

The project “Soil Mission Support” (SMS) takes the audience along the objectives and activities of the European Soil Mission “A Soil Deal for Europe”. The goal of the Mission is to lead the transition towards healthy soils by 2030. The Mission has set “operational objectives”: 1) R&I; 2) soil literacy; 3) monitoring; 4) Living Labs and Lighthouses (LL&LH), and 8 specific objectives on soil threats, EU global footprint on soils and soil literacy.

SMS presents for three operational objectives its activities and discusses after each presentation what helps to implement the soil mission in practice:

R&I; SMS presents the gap analysis per mission objective

Discussion: Do you miss gaps? What are effective ways to close these gaps? How can we reach specific regions with specific challenges?

Soil literacy: SMS presents the actor engagement guide, actor value propositions and ontology

The audience is asked to add examples to make different actor groups enthusiastic for healthy soils

LL&LH: SMS developed criteria, characteristics, success factors for LL(-network)s

We discuss: What topics/mission objectives fit in a LL setting? What business models are effective? How to engage actors in LL?

Discussion results will be used in the SMS Roadmap for the Mission.

Keywords: Soil Deal for Europe

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Challenges and opportunities for the upscaling of successful climate buffers

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Coalitie Natuurlijke Klimaatbuffers

Abstract

The concept of ‘climate buffers’ has been put in practice in several successful field pilots. Climate buffers typically realize different important aims at the same time: CO_2 sequestration, water retention, coastal safety, biodiversity improvement, better quality of the landscape, and more. Despite this potential, it remains a question how this concept can be upscaled to become common practice, and how it can best be integrated in land use planning. In order to use the momentum of climate mitigation, additional knowledge is needed how CO2 sequestration can be optimized by climate buffers without increasing methane emissions. The financing options and land use planning options for climate buffers also need more work. How can we make opportunity maps for climate buffers in different landscapes such as the marine coast, wetlands, or high & dry nature types? What stakeholders need to be involved to put it into practice? This is not only interesting from a scientific point of view, but also urgently needed from a societal point of view, as both the clocks of climate change and biodiversity loss are ticking more loudly than ever.
Session format: We propose a series of short (5-10 min) presentations, in which each presenter lists relevant challenges and opportunities at the end of their presentation. After that a group discussion is held to analyse if we recognize patterns in the challenges and/or the opportunities, and how this could be addressed in the future.

Keywords: climate buffers

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Scaling Nature-based Solutions for climate resilient food systems: What works and what not?

Annemarie Groot, Cora van Oosten, Wijnand Sukkel and Vincent Linderhof

Wageningen University and Research

Abstract

Food systems are currently not delivering what is expected or needed to ensure food security, an affordable, safe, and healthy diet for all people, ecological sustainability and resilience. Climate change and biodiversity loss add stresses on food systems. Many exemplary projects have demonstrated that nature-based solutions can contribute to climate resilient food systems, if they are implemented in the right place, and are well adapted to the spatial conditions. Spatialising nature-based solutions has implications for the way in which they are applied, accelerated and scaled. This workshop will discuss different experiences with the scaling of nature-based solutions, and their different levels of success.
First, Vincent Linderhof and Jeroen Veraart will share their experiences with nature-based solutions that are inspired by or make use of natural processes. They will share their work in Ghana and The Netherlands, where spatial approaches are used to scale nature-based solutions of rainwater harvesting and wastewater management. In both cases a software tool has been used to combine expert knowledge with spatial and statistical data to identify feasibility and scaling opportunities of nature-based solutions within a specific area.
Second, we will learn from Seerp Wigboldus how a transition perspective can help to support the scaling of nature-based solutions in food systems. Seerp will help us to use a transition lens for reflecting on the opportunities and barriers to scale nature-based solutions in different climate zones and socio-spatial contexts.
Finally, Simkje Kruiderink from the Dutch Ministry of Agriculture, Nature and Food Quality (LNV) will focus on nature-based solutions from a policy perspective, and highlight the different challenges that exist for the design and implementation of policies around nature-based solutions in food systems".
The presentations will be followed by an interactive session during which the panel members will interact with the audience. The audience will be challenged to share their own experiences with nature-based solutions, and give recommendations with regard to their scaling. The panel members will then react on the audience's experiences and recommendations from a scientific, an implementation and a policy perspective.

Keywords: climate resilient food systems

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Interaction between society, problem owner and regulator on brownfield redevelopment

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Abstract

In this session we would like to focus on several aspects of the redevelopment of contaminated sites/brownfields into healthy soils. Part of the aspects is linked on the different topics of healthy soils (sealing, organic matter, contamination,….), part of them is linked to stakeholder engagement. We will include the views of the different partners in those redevelopments : regulator, consultant, redeveloper, problem owner. The following presenters are invited:

- Paul Van Riet(Nicole, the European Network for sustainable land management of industrial sites) : setting the scene

- Lydie Sombre (Brussels Environment, Belgium): What is for the regulator a healthy soil in an urban area?

- Anne Delos (Ma Friche Urbaine, France): How to include the neighbors in the redevelopment process?

- Lida Schelwald-van der Kley (Nicole): Land Stewardship at industrial sites; a chance to enhance societal and natural value (see also the abstract attached

Keywords: society

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