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Keynotes

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Ecosystem Services: Connections to Soils and Human Health

Eric Brevik

Dickensen state University, Department of Natural Sciences, Dickinson State University, Dickinson, ND, USA

From providing nutritious food products to the filtration of water, exchange of gases, and regulation of the soil biome, soils are now recognized as providing a number of services that are critical to human health and well-being. The 2005 Millennium Ecosystem Assessment recognized four categories of ecosystem services: 1) provisioning, 2) regulating, 3) cultural, and 4) supporting. Each of these categories exhibit strong ties to the soil-human health nexus. The provisioning services are crucial in the supply of adequate food and fresh water for human consumption as well as wood, fiber, and fuel for shelter, clothing, and heat that are required to provide safe living conditions. The regulating services are important in erosion regulation to avoid soil degradation, sequestration and/or neutralization of contaminants that might harm human health, regulation of pathogenic organisms, control of floods that may damage crops and properties or spread disease, and in gas exchanges with the atmosphere that can influence climate change issues. Cultural services are important to human health through recreation, which can promote good physical health, as well as through the provision of aesthetic landscapes that can assist both physical and mental health. Finally, the supporting services are important through nutrient cycling which is critical to provide nutritionally complete food products and support of biodiversity that is critical in the control of soil pathogens. Therefore, the ecosystem services provided by soils are vital to overall human health.

Keywords: ecosystem services; soil and human health; soil degradation; climate change; physical health; mental health

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Greenhouse gas removal through carbon sequestration in vegetation and soils

Pete Smith

Institute of Biological and Environmental Sciences, University of Aberdeen, 23 St Machar Drive, Aberdeen, AB24 3UU, Scotland, UK

A majority of IPCC scenarios show that often very significant amounts (20 Gt CO2e/yr) of Greenhouse Gas Removal technologies (GGRs) are required to reach a 2°C target by 2100. Given that most models fail to reach a 2°C target without GGRs, it seems impossible that the aspirational target of 1.5°C of the Paris Agreement could be met without GGRs. The global potential, feasibility, barriers and impacts of GGRs need to be assessed. The global implications of widespread implementation of GGRs on land competition, greenhouse gas emissions, physical climate feedbacks (e.g. albedo), water requirements, nutrient use, energy and cost, have recently been assessed. It appears that sequestration in soils and vegetation have significant potential for GGR, and may do so with much less competition for land, water and nutrients than, for example, Bioenergy with Carbon Capture and Storage (BECCS). In addition, soil and vegetation-based GGRs could help deliver other Sustainable Development Goals (SDGs), particularly 1, 2, 13 and 15 (poverty, hunger, climate and life on land). Yet constraints due to high uncertainties about the level of GGR achievable, the need for site-specific options and incentives, social and ecological impacts, and the risk of impermanence have limited the implementation of soil and vegetation-based GGR to date. In this paper I will provide an introduction to the issues that will be covered by talks in a conference session examining some of the challenges and opportunities presented by land-based GGR options.

Keywords: Soil Climate change, carbon sequestration

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The EU Globaqua Project on Multiple Stressors in Rivers under Water Scarcity and Global Change. A Reconnaissance Study in Selected European River Basins and the Water-Energy-Food Nexus

Damia Barcelo Culleres

Catalan Institute for water Research, ICRA, Girona, Spain and IDAEA-CSIC, Barcelona, Spain

Most ecosystems are exposed simultaneously to several stressors, in the so-called multiple-stress situations. Some stressors such as water scarcity can limit biodiversity and economic activities in entire regions. In addition of being a stressor on its own, water scarcity can drive the effects of other stressors acting upon river ecosystems. It leads to intermittency in water flow, and therefore has implications for hydrologic connectivity, negative side-effects on biodiversity, water quality, and river ecosystem functioning. Water scarcity can amplify the effects of water pollution by reducing the natural diluting capacity of rivers Interactions between stressors may be exacerbated by climate change. For instance, warmer temperatures and reduced river flows will likely increase the physiological burden of pollution on the aquatic biota, and biological feedback between stressors (e.g. climate change and nutrient pollution) may produce unexpected outcomes. Degradation of drainage basins, destruction of natural habitats, over-exploitation of fish populations and other natural resources, or the establishment of invasive species, are factors whose impacts combine and may give rise to synergistic effects, especially during periods of water shortage. The effects of these stressors are very relevant for the chemical and ecological status of water bodies as well as for the sustainability of ecosystem services they provide

Water scarcity is a key stressor with direct and indirect effects. The relevance of water scarcity as a stressor is most important in semi-arid regions such as the Mediterranean basin, characterized by highly variable river flows and the periodic occurrence of low flows and even no-flows. Climate change previsions forecast an increase in the frequency and magnitude of extreme events Although extremes are part of the normal hydrologic behaviour in Mediterranean-type rivers, many already show a consistent trend towards decreased discharge.

This presentation will show different examples on the risk of emerging contaminants and nanomaterials in Mediterranean river catchments affected by water scarcity. For example the relevance of environmental factors (light, temperature, water flow) and chemical stressors (nutrients, pharmaceuticals, endocrine disruptors, pesticides, perfluorinated compounds and heavy metals) in the structure and functioning of epilithic biofilms in four Mediterranean watersheds, Ebro, Gualdalquivir, Jucar, Llobregat and Evrotas will be shown. Relevant data en Emerging

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Contaminants and Nanomaterials on three other European river catchments; Adige , Sava and Evrotas will be reported too. Stressors co-occur and interact in specific manners, and the respective relevance of one or another in the response of the biota may be altered also by the flow regime.

Finally, new tools like MALDI-TOF MS were used to better understand the river functioning. The experiments start using standard polymeric materials exponed to natural aquatic envrionments . Afterwards structural changes related to degradation process of the polymeric surface are monitored by MALDI TOF IMAGING.

Keywords: Water Scarcity, global change, Rivers

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Wildfire in a Changing World: Climate, Human Activities and Adaptation

Deborah A. Martin

U.S. Geological Survey, Emeritus

Recent analyses have highlighted warming temperatures and recurrent droughts as key climate-related drivers of increasing wildfire size, severity and frequency in some regions. Human activities such as land use, ignitions, and management decisions play a critical role in the enhancement of wildfires and their impacts on humans and ecosystems in many parts of the globe. A growing cadre of scientists, decision makers and citizens are advocating new approaches to increase adaptations and resilience to the new realities of wildfire in our landscapes and built environment. These approaches require (1) clear definitions of values at risk and potential outcomes that result from the interaction of wildfire and humans, (2) insights into where gaps exist in our understanding of processes, complex interactions among disturbances, spatial and temporal scales and the persistence of wildfire effects, and (3) of paramount importance, the ability to convey clear information to decision makers and the public. This talk will explore proposed mitigations and adaptations that increase our resilience to wildfire in the context of a world transformed by changes in climate and human activities.

Keywords: Wildfire, climate, land use, adaptations, resilience, communication

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When the smoke clears the waters muddy – vegetation fire impacts on water resources and how science can help.

[1]Stefan H. Doerr, [2]Joao P Nunes, [3]Gary Sheridan, [1]Jonay Neris, [1]Cristina Santín, [4]Monica B. Emelko, [5]Uldis Silins, [6]Peter R. Robichaud, [6]William J. Elliot and [7]Jacob Keizer

[1]*Swansea University, UK*
[2]*University of Lisbon, Portugal*
[3]*University of Melbourne, Australia*
[4]*University of Waterloo, Canada*
[5]*University of Alberta, Canada*
[6]*US Forest Service, USA*
[7]*University of Aveiro, Portugal.*

Vegetation fires are amongst the most hydrologically-significant landscape disturbances, affecting ~4% of the global vegetated land surface annually. Fire-prone ecosystems provide ~60% of the water supply for the world's 100 largest cities and many of the areas critical for water supply are exposed to increasing fire risk due to increases in fire weather severity, extended fire seasons and fuel build-up.
The science community has made much progress in unravelling the impacts of fire on soil and hillslope processes, but research has only recently begun to focus on the linkages between on-site and downstream impacts of fire on water quality, and treatability of contaminated water following fire events. The presence of highly erodible ash combined with enhanced runoff and erosion responses following fire can lead to the rapid transfer of many contaminants, including sediment, and nutrients into stream networks. These impacts can be exacerbated following prolonged droughts because contaminant dilution is reduced when water levels are low. Such events have led to drinking-water restrictions affecting large cities and substantial direct costs for restoring ecosystem services and managing drinking water treatment. Climate change will likely heighten risks of water contamination events through anticipated increases in droughts, fire frequency, intensity and extent, and intensity of post-fire rainfall events.
This presentation aims to provide (i) an overview of the key impacts of fire on water resources and (ii) introduces a framework aimed to assist scientists and land managers to identify and mitigate risks for our water resources arising from vegetation fires.

Keywords: Wildfires, forest fires, water quality, risk assessment, pollution, mitigationEnter description here.

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Firefighting in action: How we can transform uncertainty into creativity!!!

Marc Castellnou

Pau Costa Foundation, Barcelona, Spain

The Fire Ecology and Management Foundation Pau Costa Alcubierre (FPC) was born in January 2011, after a year of preparation, and with the ambition to be an information platform on forest fire management, as well as an instrument to divulge and investigate in fire ecology. The history of institutions related to forest fires and the specialists in forest fires (research centres, extinction services, society in general, etc.) has evolved in the last years. Many of these people and institutions have come into contact this last decade, exchanging knowledge and experiences in conferences, congresses, master classes and training courses. These exchanges would converge many times in common needs: the need for agility in the communications among the forest fire community, the needs of exchanges among the different institutions and at different levels to improve the management of forest fires, and to capitalize on the accumulated experience. In order to cover these needs in the field of forest fires, experts from Spain and other countries recommended the creation of common platform, which has now become a reality: the Fire Ecology and Management Foundation Pau Costa Alcubierre.

The objectives are the research in the field of forest fire ecology, the creation of knowledge, tools and techniques for the management of forest fires, and the dissemination of this knowledge to the technical world through training and dissemination instruments.

Although the Foundation has been established in Catalonia, a land of recurring wild land fires, it wants to be projected to the entire country, and internationally as well. The Foundation has collaborators from different European countries, with a long history in forest fires, including Portugal, France, Germany, Italy, and Sweden. The scope of the Foundation has therefore an international perspective, aiming to reach also countries which have no access to this fire information and knowledge, including developing countries. This involves establishing links with various organizations, both governmental and private, to make the Foundation known and expand its influence.

The objective of Pau Costa Foundation is to reach three major groups around the wildfire community: the social world, the operative world and the academic world. Linking these three worlds is part of the task and objective of the Pau Costa Foundation.

Keywords: Fire fighting, operators, fire ecology, management

TERRAENVISION Abstracts
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Soil erosion modelling: from European to Global scale

[1]Panos Panagos, [2]David A. Robinson, [1]Emanuele Lugato, [1]Cristiano Ballabio, [3]Pasquale Borrelli and [1]Luca Montanarella

[1]*European Commission, Joint Research Centre, Italy*
[2]*NERC–Centre for Ecology and Hydrology, United Kingdom*
[3]*University of Basel, Switzerland*

Nowadays, soil erosion is known as one of the most critical forms of soil degradation and a major threat to agricultural soil productivity and this may create societal problems in many regions of the world. More than 99% of the world\'s food supply comes ultimately from land-based production depending on soils and this should be considered carefully taking into account the population increase to 9 billion by 2050. Given the expected increase of extreme storm events and the agriculture intensification to face the population grow, soil erosion is expected to increase in the next 30 years. In the European Union, the Soil Thematic Strategy (COM(2012) 46) and the Common Agricultural Policy (CAP) promoted management practices to better manage our soils, decrease soil erosion and increase soil organic carbon in agricultural soils. At global scale the Land Degradation Neutrality, the Sustainable Development Goals (SDG 15) and the 4 per mille initiative are the main policy drivers for promoting best management practices against soil erosion and soil organic carbon accumulation.
The JRC in collaboration with University of Basel and Centre for Ecology and Hydrology (NERC) have proposed a new global soil erosion map which can be a starting point for policy support at global scale. This recently published assessment of global soil erosion (Borrelli et al., 2017) is coupled with advanced geo-statistical modelling and measured data on rainfall erosivity. A second advancement is the incorporation of land use changes, cropping management systems and spatial distribution of global croplands. The global study investigates global soil erosion dynamics by means of high-resolution spatially distributed modelling (250?×?250?m cell size). The modelled area is ca. 85% of earth surface ($125 * 10^6$ Km^2) covering 202 countries. The new global erosion assessment was necessary to cover a knowledge gap, as reliable global soil erosion estimates were missing and the most well know and cited ones, dated in late 1980s and early 1990s, were based on expert knowledge. Compared to those estimates, the current publication estimates a considerably lower amount of soil loss by water erosion (35.9 Pg yr^{-1}). However, there is an increasing trend of around 2.5% between 2000 and 2012 mainly due to decrease of forestlands. The highest erosion rates and the most accelerated erosion increase is noticed in Africa and South America. Moreover, the study estimates that conservation practices, if applied correctly, could save over a billion tonnes of soil per year. Conservation agriculture currently covers about 15.3% of the observed cropland globally, reducing soil erosion by an estimated 7%.
This new study addresses also interesting aspects such as the linkage between soil erosion and national wealth, land use dynamics and carbon fluxes. Finally, new modelling framework can

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further be developed to include soil erosion changes into other important ecosystem processes such as carbon dynamics in Earth System Models.

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Keywords: Land use change; Global erosion map; Integrated modelling; Soil loss; Conservation.

TERRAENVISION Abstracts
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The Soil; the engine behind the realisation of the SDGs

[1]Saskia Visser, [2]Saskia Keesstra, [3]Jan de Leeuw, [4]Gerben Mol and [4]Erik van der Elzen

[1]*Program Leader Sustainable Land Use, Environmental Sciences Group, Wageningen University and Research, Wageningen, the Netherlands*
[2]*Wageningen University*
[3]*Senior Scientist Land Restoration, ISRIC World Soil Information, Wageningen, the Netherlands*
[4]*Senior Scientist, Environmental Sciences Group, Wageningen University and Research, Wageningen, the Netherlands*

The soil is currently the basis under the worlds economy, and literally the basis under human life. This paper shows that the soil is the basis of our economy and explores the idea of healthy soils being the primary answer to the sustainability challenges as formulated in the 17 Sustainable Development Goals Furthermore this paper shows that knowledge of the soil, availability of practical solutions, and collaboration between scientists, local population and authorities and NGOs, can actually have a large contribution to the SDGs at local level, and have a large potential for scaling.

At this moment in time we have all required carts in our hands; scientific knowledge on soils, success stories with impact, funding opportunities through the Land Degradation Neutrality Fund, smart business models like the CommonLand 3 zones 4 returns approach and worldwide sense of urgency to act. Hence, acknowledging that the soil is the basic driver of our economy, and the engine behind the required transitions, the soil scientific community can kick-start the engine and assure realization of the SDGs in 2030.

Keywords: Soil functions, SDGs transitions

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Wetlands as large-scale nature-based solutions: Protecting Kristianstad city from flooding and reduce nutrients before rivers reach the Baltic Sea

Zahra Kalantari

Department of Physical Geography & Bolin Center for Climate Research, Stockholm University, SE-10691 Stockholm, Sweden

Nature-based solutions are defined as the use of natural ecological functions to address societal challenges, such as economic damage costs of extreme hydro-meteorological events. Nature-based solutions can be flexible and multi-beneficial measure alternatives that will not only prevent and mitigate climate-related risks but also improve human well-being and further pave the way towards a more resource efficient, competitive and greener economy. Kristianstad municipality in the Helge River basin is one of the front-runners in Sweden when it comes to Nature Based Solution for hydro-meteorological risk management. Situated in the middle of a wetland area, Kristianstad city has both struggled with and developed together with the Helge River. Flooding is a problem in both rural and urban areas. Kristianstad is the most flood prone town in Sweden due to natural and historical reasons. The city is continuously working with strategies to prevent flood, mainly with structural measures (e.g. embankments). The new strategy called adaptive river management ("living with floods"), a new approach in which flooding is allowed in certain areas, but land use is adapted to minimize the adverse impact of flooding, but it also means synergies with nature and landscape development, having the "river as a partner" and benefiting from ecosystem services.

Keywords: Nature Based Solutions, river management, wetlands

TERRAENVISION Abstracts
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Re-Naturing urban and peri-urban areas: strategies to enhance human resilience and mitigate climate change impacts

Carla S. S. Ferreira

Research Centre for Natural Resources, Environment and Society (CERNAS), College of Agriculture, Polytechnic Institute of Coimbra, Coimbra, Portugal

Increasing population and expansion of urban areas have been leading to environmental degradation and decreasing capacity of ecosystems to provide services, such as food and protection against hazards. Natural disasters such as floods and landslides are increasing in number and intensity, taking human lives and infrastructures, but most of them are exacerbated by poor development planning and human-caused vulnerability. Over the last years, a paradigm shift from grey infrastructures (e.g. dykes and concrete walls), considered fundamental to enhance wellbeing and provide human safety, to solutions which bring back nature to the cities has been rising. Nature based solutions are actions inspired by nature and implemented in order to promote urban sustainability. Examples of nature based solution projects implemented in several cities and peri-urban areas all over the world, and their efficiency, will be discussed, namely the role of wetlands to provide storage space for flood waters and the relevance of urban forests for slope stabilization. Emphasis will be provided in how to integrate grey with green and blue infrastructures (e.g. sustainable urban drainage systems, green roofs), in order to improve urban regeneration and well-being, develop climate change adaptation and mitigation, and improve risk management and resilience. Several researchers argue that natural solutions are less expensive to install and maintain, and often more effective than physical engineering structures if adapted to local conditions. But there is still a lack of quantitative analysis to monitor the impact of nature based solutions and their multiple functions for the society, as well as cost-benefit analyses. Integrating the conservation, improvement and restoration of nature, natural functions and processes into spatial planning and territorial development is still a research and societal challenge.

Keywords:

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How Soil Biodiversity Govern Ecosystem Services

Ruiter, Peter de

Institute for Biodiversity and Ecosystem Dynamics (IBED) Universiteit van Amsterdam, Faculty of Science

Soil ecosystems contain extremely species rich communities consisting of microbial populations (bacteria, fungi), microbial grazers (protozoa, nematodes, insects, mites), predators (nematodes, insect, mites), and all other kinds of animals, mostly feeding on several trophic levels, such as enchytraeids and earthworms. Together these organisms create complex networks of trophic interactions in the form of soil food webs.

Apart from this high biological diversity, soil food webs have a high ecological functionality, as the feeding rates among the trophic groups are the basis of major pathways in the global cycling of energy, materials and nutrients.

In my talk I will define the energy and nutrient flows that pass through the soil food web and how these flows determine important soil ecosystem processes like carbon mineralization and sequestration and nutrient cycling. In particular, I will show how soil ecosystem processes can be realistically quantified by means of relatively simple food web models.

Keywords: Soil ecosystems, species, nutrient flows

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Effects of human-driven water stress on river ecosystems: from small to larger scales

Sergi Sabater

University of Girona (UdG) and Catalan Institute for Water Research (ICRA), Girona, Spain

The forcing of the global water cycle is not negligible at the Planet scale, and manifestations are particularly dramatic in areas of poor water resources. Water stress affects river ecosystems when water resources demands impede their natural functioning. River ecosystems under water stress shift towards non-natural water regimes, associated to intensive management and regulation. Hydraulic infrastructures and water-abstraction schemes have the capacity to modify river hydrological regimes, its geomorphological dynamics, and the concentration of nutrients and pollutants. The direct and indirect effects of water stress may expand to biological communities, as well as to the overall downstream ecosystem functioning, expressed in significant changes in the nutrient uptake, organic matter decomposition, and primary production and respiration. These effects can be perceived at the local scale, but show reproducible patterns in rivers of different climates, sizes and contaminant influences. I will show the extent and significance of these effects to river ecosystems, as well as the relevance of co- stressors occurring with water stress.

Keywords: water stress, river ecosystems, upscaling

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Unlocking sustainable finance through public-private partnerships for nature based solutions and ecosystem services

Simone Quatrini

UNCCD

Over the past two years, the international community adopted a number of important policy frameworks that laid the foundations for national, regional and global initiatives to foster an inclusive green economy that acknowledges the value of ecosystem services, protects natural resources and promotes a sustainable future. This includes the Sendai's disaster risk reduction framework, the Addis Ababa Action Agenda on financing for development, the Agenda 2030 and the ambitious Sustainable Development Goals and targets – among which, Land Degradation Neutrality – and the Paris Climate Agreement. Without finance, all these objectives and commitments will remain on paper. The estimated funding needs to achieve the SDGs by 2030 keep skyrocketing — from billions to trillions of dollars annually. There is no shortage of capital in the global economy, most of which in the private sector. Yet, the global financial system is not channelling it effectively towards investments for sustainable development. Despite progress made since 2015, the 2017 report of the UN Task Force on Financing for Development indicates that many implementation gaps remain. One particularly underexploited instrument is a form of public-private partnerships called blended finance. Most blended finance structures have been used for infrastructure investment, as a means to share risks and rewards. But there is a large untapped potential in other sectors that require large investments, e.g. to scale-up nature-based solutions and other green infrastructures. The Land Degradation Neutrality Fund (LDN Fund) "*provides a rare case study of how the UN system can undertake meaningful, deep engagement with the private sector*", according to an independent evaluation. This talk will conclude with an overview of the key characteristics of this innovative financial instrument, spearheaded by the UNCCD Global Mechanism since 2014. It will also illustrate the process that led to the launch of the LDN fund from its inception, highlighting some key success factors and the underlying theory of change.

Keywords: Climate change economy, LDN fund, SDGs

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The Global Soil Partnership

Lucrezia Caon (NRL)

Global Soil Partnership, Food and Agriculture Organization of the United Nations

The Global Soil Partnership was established in December 2012 as a mechanism to develop a strong interactive partnership and enhanced collaboration and synergy of efforts between all stakeholders. From land users through to policy makers, one of the key objectives of the GSP is to improve the governance and promote sustainable management of soils.

Since its creation, the GSP has become an important partnership where global soil issues are discussed and addressed by multiple stakeholders. Key outputs demonstrate that the partnership was needed to fill an existing gap in the promotion of sustainable soil management. Among those outputs are: (i) the establishment of the Intergovernmental Technical Panel on Soils, (ii) the submission of the proposal for a UN World Soil Day (5 December) and the International Year of Soils 2015, (iii) the preparation of the revised World Soil Charter,(iv) the production of the Status of the World's Soil Resources (SWSR) report, (v) the establishment of Regional Soil Partnerships, (vi) the establishment of national soil information systems and (vii) the development of Voluntary Guidelines for Sustainable Soil Management (VGSSM), which were endorsed by the FAO Council in December 2016. Ultimately, a series of global symposiums on the ten soil threats identified in the SWSR are being annually organized by the GSP as a mean to implement the VGSSM.

Additionally, the GSP is posing great attention on capacity building on digital soil mapping in developing countries, which is needed also to report on the Sustainable Development Goals (SDGs). In this regard, the year 2017 was dedicated to organize trainings on digital soil organic carbon (SOC) mapping resulting in the development of national SOC maps and the first-ever global soil organic carbon (GSOC) map, produced using a bottom-up approach and needed to report on SDG 15.3.1.

Keywords: Global Soil Partnership, Soil governance, Soil threats, Sustainable Development Goals, Sustainable Soil Management, Voluntary Guidelines for Sustainable Soil Management.

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Chemical Pollution in Mediterranean Iberian River Basins: Ecotoxicological risk assessment and effects on the aquatic ecosystems

[1]Antoni Ginebreda, [1]Maja Kuzmanovic, [2]Damià Barceló and [2]Sergi Sabater

[1]*Dept. of Environmental Chemistry, IDAEA-CSIC, Barcelona, Spain*
[2]*Catalan Institute for Water Research (ICRA), Girona, Spain*

The extensive and intensive use of chemicals in our developed, highly technological society includes more than 100,000 chemical substances. Significant scientific evidence has led to the recognition that their improper use and release may result in undesirable and harmful side-effects on both the human and ecosystem health. To cope with them, appropriate risk assessment processes and related prioritization schemes have been developed in order to provide the necessary scientific background for regulatory procedures.

In this context, the aims of this study were to perform an environmental risk assessment for 200 organicmicropollutants including both regulated and emerging contaminants (pesticides, alkylphenols, pharmaceuticals, hormones, personal care products, perfluorinated compounds and various industrial organic chemicals) monitored in four rivers located in the Mediterranean side of the Iberian Peninsula, namely, the Ebro, Llobregat, Júcar and Guadalquivir rivers; (b) to prioritize them for each of the four river basins studied, taking into account their observed concentration levels together with their ecotoxicological potential; (c) to assess the ecotoxicological risk and explore the possible relationship between the chemical and ecological status in the studied basins .

For this purpose, the toxic units (TU) approach was used to assess the risk of individual compounds based on the measured concentrations of the chemical in each river and its ecotoxicological potential (EC50 values for algae, Daphnia sp. and fish) and the concentration addition model (CA) to assess the site-specific risk. A prioritization approach was developed for each compound and indicator species, taking into account both their distribution and intensity in each river basin. The dataset included more than 200 emerging and priority compounds measured at 77 sampling sites along four river basins studied. The toxic units (TU) approach was used to assess the risk of individual compounds and the concentration addition model (CA) to assess the site-specific risk. The link between chemical pollution and aquatic macroinvertebrate communities in situ was examined by using four biological indexes; SPEAR ("Species at Risk Index") as the indicator of the decline of sensitive species in relation to general organic (SPEARorganic) and pesticides (SPEARpesticides) pollution; and Shannon and Margalef biodiversity indexes.

The results of the study suggested that organic chemicals posed the risk of acute effects at 42% of

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the sampling sites and the risk of chronic effects at all the sites. Metals posed the acute risk at 44% of the sites. The main drivers of the risk were pesticides and metals. However, several emerging contaminants (e.g. the antidepressant drug sertraline and the disinfectant triclosan) were contributing to the chronic effects risk. The decline of sensitive macroinvertebrate taxa expressed in terms of SPEAR index was correlated with the increase of toxic stress related to organic compounds. Biodiversity indexes were negatively correlated with the metals and the urban land use type in the catchment.

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Keywords: Pollution, water, rivers

TERRAENVISION Abstracts
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When wildfires and watersheds collide

Gary Sheridan, Patrick Lane, Christoph Langhans and Petter Nymann

The University of Melbourne, Australia

Storms after wildfire can result in untreatable and undeliverable water, however there is enormous variability between different watersheds. Responses vary from almost no change after fire, through to major long-term contamination events affecting city water supplies for months or years. How can you determine if any particular water supply is at risk? How big is the risk? And more importantly, can you do anything about it? After decades of research by the global fire, hydrology, and geomorphology community, answering these questions remains a challenge. In this presentation I will draw on the pyro-hydro-geomorphic literature, and our own Australian post-fire erosion research, to step through the unique and fascinating processes and system properties that drive global patterns in risks when wildfires and watersheds collide.

Keywords: post fire, erosion, contamination, water quality, watershed, wildfire.

CC1/2: Greenhouse gas removal through carbon sequestration in vegetation and soils / Organic matter the key to climate change mitigation?

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Organic matter, key to climate change mitigation?

Heike Knicker

University of Seville, Spain

The availability of soil organic nitrogen (SON) determines soil fertility and biomass production to a great extent. SON and SOC are coupled via biomass production and degradation and the narrow C/N ratio of mature soil organic matter (SOM) shows that SON is a major contributor to the humified SOM, determining not only the size of this pool but also its chemical composition. More and more evidences are published showing that black nitrogen (BN) produced during natural and prescribed fires represents an additional source which affects the nature and amount of SON and the turnover rates of SOC in fire-prone regions. Although there is increasing awareness of the impact of the nitrogen (N) cycle on the carbon (C) cycle, the extent of this interaction and the implications for SOM dynamics are still under debate. Comparably, the direct impact of SON on plant growth has become an area of high interest. Therefore, in the present session, we intend to discuss advances concerning the knowledge about the inter-relationships of the soil cycles of C and N, the interaction between SON and plants as well as current ideas about the nature of SON and the mechanisms of its stabilization. The discussed subjects will include progress in:

1. Methodologies to reveal the nature of SON
2. The impact of different N-sources (microbial, plant, fire, fertilizer) on size and nature of SON

The role of SON for C-sequestration

1. Understanding the mechanisms controlling the interaction between C and N cycling in soil
2. Understanding the role of SON for the N-competition between plants and microorganisms
3. Modeling the interrelationship between C sequestration and N availability and vise-versa

Keywords: soil organic nitrogen

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LIFE COOP2020: Pilot for rural smart grids through optimisation of energy use and innovative renewable biomass sources

[1]Katherine Franco, [1]Sven Kallen and [2]Priya Devasirvatham

[1]*TRANSFER CONSULTANCY S.L*
[2]*VOLTERRA ECOSYSTEMS S.L*

The Quercus-based silvopastoral systems of the Mediterranean basin biome (for example dehesas, montados and meriagos that cover up to 6 mln ha in the EU) are in rapid decline [1]. Estimates show that dehesas currently produce a deficit of 200€/ha. Prices for their products are similar to those 30 years ago, and land owners face losses of up to 500€/ha due to phytophtora-related diseases. It is estimated that these agro silvopastoral lands have lost up to 20% of their value and currently lose millions of euros in productivity each year [2].
Simultaneously, agro-subsidies are steadily decreasing. In 2015, farmers in Andalucía reported up to 60% of cutbacks in CAP subsidies [2]. Regional subsidies in this area now only cover about 8% of landowners [3]. In Sardinia, rural abandonment has caused an increasing of the number of rented and leased farms and the loss of local typical micro-economies.
Many anthropogenic and environmental factors challenge the survival and sustainability of these valuable ecosystems. The younger generation inheriting these broken systems needs to transform current production models into cost-efficient operations that work with nature, not against it. They will have to lower input costs, find alternative sources of income, recycle resources, stimulate natural regeneration, improve soil and increase farm productivity so that their land can become economically and environmentally sustainable.
LIFE Regenerate\'s main objective is to demonstrate that these SMEs can become self-sufficient and profitable based on resource efficiency principles and incorporating added value products, both at a demonstration and a larger scale.
The project has the following specific objectives:

1. Combat the loss of natural regeneration and soil degradation in 100 ha of degraded silvopastoral areas by providing effective, mosaic landscape management procedures and improving soil quality;

2. Recover the practice of multi-species rotational grazing, adapted to improve natural capital and optimize commercial advantages;

3. Recycle biomass waste within the farm, reducing external input of fodder and creating

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alternative sources of income;

4. Replicate the project's best practices to 5,000 ha in Spain, Italy & Portugal, proving it is a representative, effective model;

5. Integrate new technologies and monitoring of project advances;

6. Influence policy-making and involve external stakeholders to promote replication and long term Sustainability.

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[3] G. Donaire, «Los ganaderos advierten de la rebaja del 60% de las ayudas en la dehesa,» El País, 26 April 2015.

Keywords: silvopastoral systems, mosaic landscape management, rotational grazing, improving soil quality.

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Image Analyses as A Tool for Measuring Weathering Rates

[1]Milica Kašanin-Grubin, [1]Srdjan Petrovi?, [2]Luobin Yan and [2]Hua Peng

[1]*University of Belgrade, Institute of Chemistry, Technology and Metallurgy, Njegoševa 12, 11000 Belgrade, Serbia*
[2]*School of Geography and Planning, Sun Yat-sen University, Guangzhou, Guangdong, China*

Weathering is a process during which chemical, physical and mineralogical properties of rocks exposed on the surface of the Earth are altered. Laboratory experiments are powerful method to obtain information in controlled conditions, however, obtained weathering rates are mostly one to two orders of a magnitude larger than field rates and the results have to be scaled down. A specific challenge conducting a weathering experiment is to find a way to determine the rate of surface change during weathering cycles without disturbing the sample. The aim of this paper is to show how image analyses can be used in determining the rate of disintegration of erodible sediments on two distinct examples. In the first case change in size and shape of fragments of sediment sample that dominantly undergoes physical breakdown during the weathering experiment was measured and quantified. In the second example image analyses was used to quantify the changes in surface crust formation, particularly cracks, of the clay-rich sediment during wetting-drying simulation.
Image analyses proved to be a very useful tool in both selected cases. In the first example image analyses enabled counting of fragments after each weathering cycle. It was determined that the size of the fragments decreases after each cycle and that the shape of the fragments as they decreased in size, were, on average, becoming narrower and longer. In the second example it was determined that the surface cracks vary in size, shape and connectivity and influence material response to wetting and drying and are highly dependent on the clay mineral composition. Smectite-rich sediments developed denser crack networks, while on illite-rich sediments more uniform surfaces with thin and long cracks were formed. Significant correlation was obtained between fractal properties and lacunarity on the surface crust seen during field work and crust obtained during laboratory weathering experiments.

Keywords: weathering, image analyses, quantify, surface cracks, fragment properties

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Does the application of microalgal slurries increase soil carbon?

[1]Evan A.N. Marks, [2]Olimpio Montero and [1]Carlos Rad

[1]*Composting Research Group UBUCOMP, E.P.S. La Milanera, Universidad de Burgos 09001 Burgos*
[2]*Centre for Biotechnology Development (CDB-CSIC), Avenida Francisco Vallés 8, E47151 Boecillo*

Active microalgae biomass from wastewater treatment may be given added value as a biofertilizer, but little is known about how this may affect soil nutrient dynamics and biology. If the goal is to recycle waste nutrients and matter, live algae applied in a liquid slurry to soil may add both organic carbon and nutrients while providing other benefits such as biological carbon fixation. What will be the fate of photosynthetic microalgae applied to the soil in large quantities, and what effects will it have on soil biology and chemistry? Our research team has addressed this question in two stages of laboratory bioassays. In the first, application of a Chlorella sp. slurry clearly increased soil respiration, though the impacts on soil C and N remained inconclusive. In a second study, separating the algae from the slurry leaving only bacteria and other smaller microorganisms (<2.5 μm), soil respiration was only increased in the unfiltered slurry with algae. Soil C was the same for bacterial (<2.5 μm) and algal slurries, which were both greater than a sterile filtrate. Also, soil N was increased after applying the algae slurry. The results of this work show that microalgae alone did not appear to cause a net increase in soil C in the short term, but rather acted as a biostiumulant, increasing soil heterotrophic microorganism density and activity. These results are of relevance for soil protection measures in agriculture and ecological restoration of arid lands.

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Keywords: arid lands, ecological restoration, carbon storage

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The 4 per mille initiative is promoting the implementation of sustainable development goals through science-policy-practice interactions

[1]Cornelia Rumpel, [2]Farshad Amiraslani, [3]Claire Chenu, [4]Magali Garcia Cardenas, [5]Martin Kaonga, [6]Lydie-Stella Koutika, [7]Jagdish Ladha, [8]Beata Madari, [9]Yasuhito Shirato, [10]Pete Smith, [11]Brahim Soudi, [12]Jean-François Soussana, [13]David Whitehead and [14]Lini Wollenberg

[1]*CNRS, Institute for Ecology and Environmental Sciences, Thiverval-Grignon, France*
[2]*Department of RS/GIS, Faculty of Geography, University of Tehran, Tehran, Iran*
[3]*AgroParisTech, UMR Ecosys INRA,AgroParisTech, 78850 Grignon, France*
[4]*Faculty of Engineering. Universidad Mayor de San Andrés, Bolivia.*
[5]*Cambridge Center for Environment, Cambridge, UK*
[6]*CRDPI, Av. Ma Loango Moe Poaty BP 1291, Pointe-Noire, Republic of the Congo*
[7]*Department of Plant Sciences, University of California, Davis, Davis CA 95616, USA*
[8]*Brazilian Agricultural Research Corporation, National Rice and Beans Research Center (Embrapa Arroz e Feijão), Santo Antônio de Goiás, Brazil*
[9]*National Agriculture and Food Research Organization, Tsukuba, Japan*
[10]*Institute of Biological & Environmental Sciences, University of Aberdeen, 23 St Machar Drive, Aberdeen, AB24 3UU, UK*
[11]*Institut Agronomique et Vétérinaire Hassan II, Rabat, Morocco*
[12]*INRA, Paris, France*
[13]*Landcare Research, Lincoln, New Zealand*
[14]*Gund Institute for Environment, University of Vermont and CGIAR Research Program on Climate Change, Agriculture and Food Security, Burlington, Vermont, 05482 USA*

The 4 per mille (4p1000) initiative was launched in 2015 by the French minister of agriculture at the conference of parties of the United Nations Framework Convention on Climate Change. Its goal is to increase soil organic carbon (SOC) sequestration in managed soils or reduce SOC losses as much as possible through economically viable and ecologically sound agricultural practices. Increasing SOC sequestration under the framework of the initiative is intended to benefit food security and to mitigate climate change. Two years after its launch, the 4p1000 initiative is on its way with 281 partners, including 39 countries. Soil organic carbon has received a broad recognition among stakeholders and policy makers as being important for soil health and in terms of potential sequestration of atmospheric CO2. The 4p1000 initiative directly addresses three sustainable development goals: SDG2 'No hunger', SDG13 'Climate action', and SDG15 'Life on land' and indirectly concerns several others. In order to be successful, promising region and context specific agricultural management practices must be defined, tested and put into practice. For evaluation of impacts of these practices, ex-ante assessment and ex-post monitoring, reporting and verification (MRV) strategies have to be developed and tested. Finally, there is the need to

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quantify and demonstrate the economic impact of increased SOC sequestration to businesses, stakeholders and farmers. This once again requires multi-stakeholder collaboration at the science-policy interface. The 4p1000 initiative is thus an excellent example of how collaboration among actors at the science-policy interface, and science-policy-practice interactions, can be used to address sustainable development goals in an integrated way.

Keywords: Sustainable Development goals, Science-Policy interface, Carbon sequestration, Food security, Climate change mitigation

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Ungulates Effects on Soil Organic Carbon Accumulation and Bulk Density

[1]Miguel Ibañez, [2]Antonia Romero-Munar, [3]Carles Cardona, [2]Jaume Vadell, [1]Jordi Bartolome and [4]Emanuel Serrano

[1]*Departamento de Ciencia Animal y de los Alimentos. Facultad de Veterinaria. Universidad Autónoma de Barcelona. 08193 Bellaterra (España).*
[2]*Departamento de Biología. Universidad Autónoma de las Islas Baleares (España)*
[3]*Centre Forestal de les Illes Balears. Institut Balear de la Natura (IBANAT). Gremi Corredors, 10 (Pol. Son Rossinyol) 07009-Palma de Mallorca. Spain.*
[4]*Universidad Autónoma de Barcelona. 08193 Bellaterra (España)*

The intensification of human activities and major changes in climate has dramatically altered the distribution, composition and density of large herbivores on the planet. Although these alterations are considered important components of global change, their consequences on the diversity and functioning of ecosystems are not necessarily equivalent in different regions of the world. Uncontrolled increase of ungulates in those habitats where they are considered invasive species could be an ecological threat. In Mallorca Island (Spain) the abandonment of farming during the 1960s, when tourism began to develop intensively, contributed to increase feral goat populations. The negative effects of these populations in several endemic plant species have been reported but less is known about their effect on the soil. The aim of this study is to approach the gap in this field by showing the effects of ungulates on soil characteristics by quantifying organic carbon content (SOC), litter accumulation and bulk density in four different areas of Tramuntana mountain range. In each of these areas was selected three fenced plots, in which, there has been no ungulates activity for at least five years, then it was compared with similar plots where ungulates are present. We found and important spatial variation in soil characteristics since the area and the plot explain important part of the variability found in the measured variables. Ungulate pressure only affects soil characteristic at determinate blocs in some areas. Consistently the use of vegetation by ungulates decreased the bulk density. However, its effect on the accumulation of organic carbon varied between zones. In spite of the localized effect of the ungulates on the soil, this should be considered in the management plans of goats populations, since the soil characteristics analyzed are intimately linked to their function as a carbon sink and their water retention capacity. Indications of a possible reduction in resilience to climate change of forest soils with overgrazed in Mallorca are shown.

Keywords: feral goat, soil degradation, ungulate pressure, carbon sink, ecosystem systems.

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Carbon sequestration on abandoned crops in Mediterranean humid areas

[1]Carla Juvinyà, [1]Pere Rovira and [2]Hassan Lotfiparsa

[1]*Centre de Ciència i Tecnologia Forestal de Catalunya (CTFC). Solsona, Spain*
[2]*Department of Soil Science, Bu-Ali Sina University. Hamadan, Iran*

Enhancing carbon sequestration in soils is a main path for climate change mitigation, as shown by the 4 per mil initiative. In Catalonia (NE Spain), significant carbon sequestration in soils depends on land use changes, in particular the recolonisation of abandoned crops by secondary forests. Here we study an example of such a change.
Work is carried out at the county of Pla de l'Estany. From the comparison of aerial images of 1956 and 2015, we selected 22 plots, classified as follows: (i) old forest (> 60 years old); (ii) reforested fruit trees (forest <60 years old); (iii) recolonized fruit trees (forest <60 years old); (iv) recolonized crops (forest <60 years old) and (v) crops (crops in 1956, crops today). Plots were sampled from topsoil to 30cm depth with a volumetric core. Litter layers (L, F, H) were collected, too.
Litter layers accumulate substantial amounts of carbon, between 1.01 kg C/m2 in reforested fruit trees plots, to 2.99 in recolonized fruit trees plots. Leaving aside crops (devoid of litter layers) no significant differences in total C stocks were observed, related to land use. Apparently, litter layers reach their highest stock within 60 years.
Mineral soils under crops accumulate about 5.44 kg C/m2, down to 30 cm, whereas in old forest this figure goes up to 7.48 (37.5 % higher). New forests have intermediate values: 5.76 in reforested fruit trees, 6.62 in recolonized fruit trees, and 6.8 in recolonized crops. The latter are apparently where C sequestration is most active. However, it is still significantly below the old forest, meaning that C sequestration has still a way to go across.
From our data, net C sequestration occurs mainly in the litter layers and in the first 15 cm of soil. Net C sequestration below 15 cm depth is barely detectable.

Keywords: Mediterranean, Soils, Carbon sequestration, Crop abandonment, Secondary forest, Land use change.

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Aridity decreases soil micronutrient availability in global drylands

[1]Eduardo Moreno-Jiménez, [2]César Plaza, [3]Hugo Saiz, [1]Rebeca Manzano, [1]Maren Flagmeier and [3]Fernando T. Maestre

[1]*Department of Agricultural and Food Sciences, Faculty of Sciences, Universidad Autónoma de Madrid, 28049, Spain*
[2]*Departamento de Biología y Geología, Física y Química Inorgánica, Universidad Rey Juan Carlos. C/ Tulipán s/n, 28933 Móstoles, Spain and Instituto de Ciencias Agrarias, Consejo Superior de Investigaciones Científicas, Serrano 115 bis, 28006 Madrid, Spain*
[3]*Departamento de Biología y Geología, Física y Química Inorgánica, Universidad Rey Juan Carlos. C/ Tulipán s/n, 28933 Móstoles, Spain*

Currently, drylands are the largest terrestrial biome in Earth and their extent and socio-ecological importance will increase in the near future due to the forecasted increases in aridity as a consequence of climate change1,2. Despite the essential role of metallic micronutrients (Cu, Fe, Mn and Zn) in life chemistry and ecosystem functioning, it is virtually unknown how their bioavailability changes along aridity gradients at the global scale3. In this work, we studied soil total and available Cu, Fe, Mn, and Zn in 143 drylands from all continents, except Antarctica, covering a broad range of aridity and soil conditions, and we evaluated the influence of several geochemical parameters (clay, pH and organic matter) and aridity on metals in soils. We found that total and available micronutrient concentrations in dryland soils were low compared to common ranges in soils of natural and agricultural ecosystems globally4,5, and Fe and Zn seemed more limiting for plant growth than Cu and Mn. Aridity negatively affected the concentration of all micronutrients, mainly through indirect effects on soil pH and, mainly, soil organic matter. Noteworthy, the available Fe:Zn ratio decreased exponentially as aridity increased, pointing to stoichiometric alterations. Our results show that increased aridity conditions can limit the availability of essential micronutrients for organisms, particularly Fe and Zn, which may threat key ecological processes and services such as biomass and food production in drylands worldwide.

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Keywords: Arid soils, Metallic micronutrients, Geochemical drivers, Climate change.

WR1: Analysis and Fate of Emerging Contaminants in Water Soil and Plants

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Emerging pollutants in sewage sludge

Rodrigo Alvarez Ruiz and Alejandro Cuñat Yolanda Picó

Food and Environmental Safety Research Group (SAMA-UV), Desertification Research Centre (CIDE-UV, GV, CSIC), University of Valencia, Av. Vicent Andrés Estellés s/n, 46100, Burjassot, Valencia, Spain

The sewage sludge is generated in the wastewater treatment plants (WWTPs) because of wastewater treatment. This water contains several anthropogenic contaminants, and part of these end up in the sludge. The occurrence of emerging contaminants in the influents and effluents of the treatment plants has been widely studied, but not in sewage sludge, which due to its high organic matter content is use as organic amendment in agricultural soils. In fact, in Spain, the 80% of the sewage sludge is used as a fertilizer for the crops, being of great interest to know the different compounds present in them and asses the environmental risk of their utilization. The sludge samples are from 8 WWTPs with different treatments. Samples were extracted using a Methanol-McIlvaine Buffer (4.1) mixture and assisted by ultrasound, the supernatant was cleaned up with solid phase extraction (SPE) using Strata^{TM}X cartridges and then the analytes were eluted with methanol at gravity flow. To identify as many compounds as possible and obtain high quality information, non-target identification was used with a liquid chromatograph triple quadrupole time-of-flight (LC-QqTOF). As overall results, 50 different compounds were identified with high degree of confidence belonging 31 of them to the group of the pharmaceuticals. Several human metabolites (nucleotides, amino acids, etc.) were also detected. Other compounds were tentative identify but further study is still needed to increase the degree of confidence in their identification. In conclusion, this method is suitable to identify emerging contaminants in sewage sludge, which could suppose and environmental risk in the areas where they are utilized.

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Keywords: sewage sludge

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Laboratory study of the dissipation mechanism and kinetics of prosulfocarb in unamended and organically amended soils

Victor Barba, Jesús M. Marín-Benito, Carlos García-Delgado, José M. Ordax, María J. Sánchez-Martín and M. Sonia Rodríguez-Cruz

Institute of Natural Resources and Agrobiology of Salamanca (IRNASA-CSIC), 40-52 Cordel de Merinas, 37008, Salamanca, Spain.

Application of organic amendments to improve soil quality, increasing organic carbon content, is a frequent agricultural management practice which can modify the behavior of pesticides in soil. The aim of this work was to assess the dissipation mechanism and degradation kinetics of the herbicide prosulfocarb, at rates of 4 and 10 mg kg^{-1}, in unamended and green compost (GC)-amended soils under laboratory conditions (40% water holding capacity and 20^{o}C in the dark). Also, the same treatments were stablished using sterile unamended and amended soils in order to assess the influence of biological and chemical degradation on the dissipation of the herbicide. The determination of mineralized, extractable (in aqueous and organic medium) and non-extractable fractions and degradation kinetics for prosulfocarb were studied in both unamended and GC-amended soils over time during 62 days. The dissipation curves of prosulfocarb were adjusted to kinetic models and the half-life (DT_{50}) was determined from the amount of prosulfocarb extracted at different incubation times between 0 and 42 days. The degradation curves of prosulfocarb in unamended and amended soils were fitted to single first-order kinetic model. The degradation rates were faster in unamended soils and DT_{50} values were higher in amended soils for both application rates. The effect of herbicide dose on the dissipation rates was different in unamended and amended soils. The dissipation mechanism recorded the highest mineralization in the unamended soil and the highest formation of non-extractable residues in the amended soils, especially when the high dose of herbicide was applied. Bound residues increased with incubation time in both amended and unamended soils, although the formation rates of non-extractable residues was higher in unamended soil. The application of GC and herbicide dose determined the dissipation mechanism of prosulfocarb in soil, suggesting that GC modified the retention and bioavailability of the herbicide in GC-amended soils.

Keywords: Herbicide, soil, green compost, dissipation mechanism, degradation kinetics

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Consumption reduction over sanitation upgrades to mitigate pharmaceuticals impact on global freshwaters

[1]Francesco Bregoli, [1]Vicenç Acuña, [1]Damià Barceló, [1]Lluis Corominas, [2]Antoni Ginebreda, [3]Mira Petrovic, [4]Ignaci Rodríguez-Roda, [1]Sergi Sabater and [1]Rafael Marcé

[1]*Catalan Institute for Water Research (ICRA). Carrer Emili Grahit 101, 17003 Girona, Spain.*
[2]*Department of Environmental Chemistry, Institute of Environmental Assessment and Water Research (IDAEA-CSIC), Carrer Jordi Girona 18-26, 08034 Barcelona, Spain.*
[3]*ICREA, Passeig Lluís Companys 23, 08010 Barcelona, Spain.*
[4]*Laboratory of Chemical and Environmental Engineering (LEQUiA), University of Girona, Girona, Spain*

Pharmaceuticals are widely consumed and released in the environment but their effects on river ecosystems are undervalued. Some of these compounds have shown recognized threats and have been targeted as contaminants of emerging concern by several governmental agencies such as the European Union and the US Environmental Protection Agency. Human and veterinary uses lead to high concentration of pharmaceuticals in waste water which is often not or not-sufficiently collected and treated in wastewater treatment plants, thus poured in fluvial network. The chemical behavior of these contaminants in freshwater has been well studied, but its environmental fate is unknown at global scale. However it is of primary interest for the prediction of future scenarios of global changes and the formulation of mitigation measures. We have developed a global model to identify hotspots of pharmaceuticals high concentration in the environment. The model accounts for the hydrology, the rivers and lakes hydraulics and the contaminant behavior in wastewater treatment plants as well as in rivers and lakes. The model is applied to the case of diclofenac as typical pharmaceutical for human use and then generalized to other compounds. Current and future scenarios of runoff and population are used to calculate and predict the current and future dilution on freshwater ecosystems. If no actions are taken, the model shows that the environmental threat will increase by 65% in 2050. We propose feasible mitigation strategies related to (1) consumption reduction, (2) sewer connection and (3) treatment technology improvements. Particularly strategies 2 and 3 are inspired by the Sustainable Development Goal 6 (UN General Assembly Resolution A/RES/70/1, 2015). We find that the technological improvement alone will not be sufficient even to recover the current concentration levels. The pharmaceutical consumption reduction together with sewer connection and treatment technology improvements might potentially mitigate the risk in highly contaminated river segments likely situated in urbanized areas. However large part of the river ecosystem will not be sufficiently secured, if a substantial consumption reduction will not be implemented.

Keywords: Pharmaceuticals, Freshwater, Global Model, Diclofenac, Future Scenarios, Mitigation.

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Degradation of two herbicides on a sandy loam soil: Effect of the temperature and the organic amendments

M.J. Carpio, J.M. Marín-Benito, M.J. Sánchez-Martín and M.S. Rodríguez-Cruz

Institute of Natural Resources and Agrobiology of Salamanca (IRNASA-CSIC), 40-52 Cordel de Merinas, 37008, Salamanca, Spain.

The degradation of pesticides in soils can be affected by agricultural practices, such as the application of organic amendments, and by weather conditions. Therefore, the objective of this work was to study the degradation kinetics of two herbicides with different hydrophobic character, flufenacet and chlortoluron, in an agricultural soil unamended and amended with two organic residues, green compost (GC) and composted spent mushroom substrate (SMS), under laboratory conditions at two different temperatures (6ºC and 16ºC). Experiments were carried out under laboratory conditions and the unamended and amended soils were taken from the surface horizon (0-10cm) of 9 experimental plots (3 replicates per treatment) located in an agricultural farm. SMS and GC were applied in situ to the natural soil as organic amendments at rates of 140 and 85 t residue/ha, respectively. Samples of soil+herbicides (14 mg chlorotoluron + 5.5 mg flufenacet kg-1 dry soil) were adjusted to 40% of the maximum soil water-holding capacity and incubated in the dark at 6 °C or 16 °C. The herbicides were extracted from the soil with acetonitrile (ratio 1:2) and quantified by HPLC-DAD-MS. The degradation kinetics was fitted to single first-order or first-order multicompartment models. The degradation of flufenacet, the most hydrophobic herbicide, was slower than that of chlortoluron in all treatments. The application of the organic amendments to the soil increased the half-life time (DT50) values for both herbicides incubated at 6 °C (1.6-2.1 times) and 16 °C (1.5-1.7 times) due to their higher sorption and lower bioavailability of the herbicides to be degraded. The herbicides showed a faster degradation at 16 °C (1.4-2.8 times) than that observed at 6 °C due to the increased microbiological activity with the temperature. The DT50 increased for both herbicides in amended soils in the order S<S+SMS<S+GC at 6 °C and S<S+GC~S+SMS at 16 °C, but effect of amendment was different.

Keywords: degradation, herbicide, soil, spent mushroom substrate, green compost, temperature

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Isolation of rhizobacteria from agricultural soils contaminated with pesticides in the Meknes Region, Morocco

Mohamed MALDANI, Fatima Zahra ALIYAT, Laila NASSIRI and Jamal IBIJBIJEN

Environment & Soil Microbiology Unit, Faculty of Sciences, Moulay Ismail University B.P. 11201 Zitoune, Meknes, Morocco

Soil quality covers the physical, chemical and biological aspect. The interactions between them result in efficient operation in terms of production. In agricultural soils, contamination by pesticides has become an alarming environmental problem. This problem influences primarily on the biological properties of soils particularly on the microbial community in these soils. Several studies have shown that the excessive use of pesticides has a toxic effect on the microbial flora of the soil. The objective of our study was to isolate rhizobacteria from 17 agricultural soils, previously cultivated by legumes and cereals, from the agricultural zone of Moulay Idriss (Meknes, Morocco), and subsequently tested their tolerances and degradation of pesticides. From these soils we isolated 300 strains of bacteria, after the tolerance test we isolated 57 bacterial strains tolerating a high pesticide concentration. These strains will be identified.

Keywords: Soil, Rhizobacteria, Pesticides,Degradation, Morocco.

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Accumulation and metabolism of ibuprofen by the annual herbaceous legume Vigna unguiculata

[1]Yolanda Picó, [1]Rodrigo Alvarez-Ruiz, [2]Leonard Wijaya, [2]Ahmed H. Alfarhan, [2]Mohammed Alyemeni and [3]Damià Barceló

[1]*Desertification Research Centre CIDE (CSIC-UV-GV), University of Valencia, Valencia, Spain.*
[2]*Department of Botany and Microbiology, King Saud University, P.O. Box 2455, Riyadh 11451, Saudi Arabia*
[3]*IDAEA-CSIC, Jordi Girona 18-26, 08034 Barcelona, Spain*

Ibuprofen is frequently detected in water, sediment and soil due to its release in effluents and sludges from wastewater treatment plants, which may pose impacts on living organisms.

The bioaccumulation and metabolism of ibuprofen in the annual herbaceous legume Vigna unguiculata were studied though laboratory studies with a graduated treatment regime at 0, 400, 800, 1600 and 2000 mg L-1. Ultra-high performance liquid chromatography – quadrupole – time of flight mass spectrometry (UHPLC-QqTOF-MS/MS) determination of ibuprofen and its two main oxidation metabolites in V. unguiculata was performed simultaneously to the identification of other metabolites.

The distribution of ibuprofen and its metabolites in V. unguiculata was established in 5 days germinated seed and in plant roots and tales harvested at 25 and 50 days. Both phase I and phase II metabolites were observed. As for the Phase I metabolites, 1 and 2-hydroxyibuprofen and dihydroxyibuprofen were found to be the major metabolite in V. unguiculata, whereas the metabolite carboxybuprofen was undetectable. Most important Phase II conjugates are with methyl, monosaccharides and malonyl or acetyl monosaccharides. Germinated seeds also present an important percentage of amino acid conjugates. The findings of this work represented that the accumulation and metabolism of ibuprofen in V. unguiculata were predominantly oxidative, and V. unguiculata incorporate ibuprofen to its structures as monosaccharide conjugates.

Acknowledgements

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Keywords: Emerging contaminants, Plant uptake, Metabolism and Translocation.

WR2: Data-mining and methods for modeling and assessing state and fate of soil water

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Trees shifting from competition to facilitation due to apparent climatic change

[1]Aristides Moustakas and [2]Tim G. Benton

[1]*Institute for Applied Data Analytics, Universiti Brunei Darussalam, Brunei*
[2]*School of Biology, University of Leeds, Leeds, UK*

Soil water is a key component of ecosystems, modulating ecohydrological cycles across scales. Coupled ecological-hydrological data can provide key insights in understanding long-term population dynamics as well as the role of water resources in tree survival strategies over time. While the role of soil water is elementary for vegetation growth and survival, its importance is often hard to quantify due to differing time scales of long-lived plants such as trees. Thus the role of soil water availability or reciprocally tree mortality and competition under water stress are hard to quantify. Recent technological advancements regarding digital imagery and remote sensing, as well as significant progress in data analytics and data mining, have provided large spatio-temporal datasets as well as computational power and novel techniques for their analysis. Here we generate a long-term dataset (spanning from 1984 to 2001) using remote sensing techniques to identify tree individuals through time and couple it with Normalized Difference Vegetation Index (NDVI), Soil Moisture Index (SMI), and monthly precipitation data. Using this dataset of trees following over 100,000 tree individuals over time in the Kalahari, Southern Africa, we quantify tree survival as a function of soil surface water and tree density. During the same period, rainfall decreased as well as the variance in precipitation values increased. This resulted in soil water availability becoming both lower and more unpredictable throughout the duration of the study. Our analysis indicates that trees were initially competing with their nearest neighbours, as indicated by decreasing probability of survival with decreasing distance to the nearest neighbouring trees, and this coincided with the period of high soil water availability. During the latest period when soil water availability decreased, tree survival increased with decreasing distance to the nearest neighbouring trees i.e. trees that were initially competing against each other were latter on facilitating each other's survival. The suggested mechanism for driving facilitation is increased soil water availability at locations where trees form patches. The implications of these results are discussed both in terms of tree mortality as well from an ecohydrological perspective under climatic changes.

Keywords: tree survival strategies, soil moisture

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Tall trees safeguard biodiversity under climatic changes: assessing the effect of tree size, soil moisture, and vegetation density on tree survival

[1]Aristides Moustakas and [2]Tim G. Benton

[1]*Institute for Applied Data Analytics, Universiti Brunei Darussalam, Brunei*
[2]*School of Biology, University of Leeds, Leeds, UK*

Soil water availability is a major limiting factor to drylands' vegetation worldwide. Soil water is among other factors related to precipitation and both factors in turn drive both animal and plant diversity. In arid lands, trees in particular are keystone species for other plants as well as animals providing shelter. In addition, trees in arid locations protect the soil through their rooting system, deterring land degradation and maintain soil and soil moisture. Climatic changes are impacting arid areas and this effect is predicted to become more pronounced in the near future. Therefore, survival of trees in arid areas is crucial for ecosystem functioning as their death is likely to introduce cascade effects on other species as well as in soil surface water availability. Arid lands are poorly studied ecosystems as they often lay far from developed areas and the human population density is low; however, this makes them ideal study areas for climatic changes and eco-hydrological functioning. A large spatio-temporal dataset containing data on soil water availability, precipitation, and a very large number of tree individuals followed one-by-one over a period of 30 years was derived in the Kalahari, Africa, a place where water is scarce. Here we show with these data, that during the past 30 years rainfall has been both reduced in magnitude but increased in variability. Monitoring long-term tree survival indicated that while rainfall was uniformly distributed across the study areas, soil water was higher in the vicinity to tall tree individuals. This result became more pronounced as rainfall decreased. Tree survival was also higher closer to tall tree individuals and this result became more pronounced as both rainfall and soil water availability on bare ground (i.e. away from tree canopies) decreased. These result indicate that tall tree individuals are keystone species for plant survival safeguarding biodiversity in arid lands. Maintaining or establishing tall tree species in such areas facilitates other vegetation under water stress.

Keywords: biodiversity, climatic changes, soil moisture

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DRIP: Development of an Advanced Precision Drip Irrigation System for Tree Crops

[1]Ioanna Petousi, [1]Ioannis N. Daliakopoulos, [2]Theofilos Matsoukas, [3]Nikolaos Zotos, [4]Ioannis Mavrogiannis and [1]Thrassyvoulos Manios

[1]*Department of Agricultural Technology, Technological Educational Institute of Crete, Heraklion, Greece*
[2]*Landco Ltd, Athens Greece*
[3]*Future Intelligence Ltd, Athens Greece*
[4]*Anelixis Consulting SA, Heraklion, Greece*

Water resources are under constant pressure due to increasing demand, climate change and water pollution, both globally and locally, with the agricultural sector consuming 70% of the world\'s water abstractions. This creates a great environmental and financial incentive to increase the efficiency of irrigation systems and the adoption of advanced precision irrigation technologies that incorporate scientific information on soil, plant, and water interactions. DRIP aims to develop an innovative, efficient, and competitive product to reduce irrigation water consumption and promote sustainable water management while supporting and sustaining the agricultural production and the rural economy. To achieve this, DRIP will collect experimental data from a set of free lysimeters and an experimental olive grove, use them to calibrate the state-of-the-art soil moisture model HYDRYS 2D/3D and then apply its output to the development the DRIP system, an integrated operational system for data collection from environmental sensors, data evaluation based on soil moisture models, and command forwarding to irrigation actuators. Data transmission between sensors, processing, and control systems of DRIP will utilize Internet of Things (IoT) technology. DRIP will focus its actions on the island of Crete, Greece, where the irrigation of the very popular olive tree is mainly empirical and often without scientific background or professional guidance, thus leading to losses. The main expected results of DRIP will be the development of a state-of-the-art fully automated experimental lysimeters, an operational IoT system that can function in the harsh agricultural environment, a state-of-the-art soil-plant-water modeling system, an integrated irrigation system (DRIP), and its evaluation as a commercial product.

Keywords: Smart agriculture, Internet of Things, lysimeter, HYDRUS, soil moisture

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Unraveling the net effect of human induced climate change to the evolution of soil water resources

Manolis G. Grillakis and Aristeidis G. Koutroulis

School of Environmental Engineering, Technical University of Crete, Chania, Greece

Recent advances in climate science enabled the detection and attribution of anthropogenic climate change impacts on hydro-climatological regimes [1]. Impacts of climate change on soil water resources are already evident, largely dominating vegetation changes [2]. These changes are foreseen to be increasingly pronounced with the increase of global mean temperature [3], [4] posing significant rink in global food safety and security. Here we examine the net effect of anthropogenic climate change induced changes in the state of soil water resources for the majority of food producing areas. We use results from the state of the art global hydrology and land surface models of the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP2b). 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 climate change to unravel future trends under a variety of mitigation pathways. Preliminary results show that historical Greenhouse Gas Emissions has significant impact on the extent of hydroclimatic stressed areas, while projections suggest further expansion of those areas. Increasing soil water stress could lead to considerable implications of food security from local to regional and global scales.

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Keywords: Soil water, Human climate change, ISIMIP2b

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Estimating Soil Moisture Content with Means of Earth Observation and Artificial Neural Networks

Dimitrios D. Alexakis, Filippos-Dimitrios K. Mexis, Anthi-Eirini K. Vozinaki, Ioannis N. Daliakopoulos and Ioannis K. Tsanis

School of Environmental Engineering, Technical University of Crete, Chania, Greece

This study aims to research the potential of Earth Observation (EO) products, such as Synthetic Aperture Radar (SAR) (Sentinel-1), and Landsat 8, in estimating volumetric Soil Moisture Content (SMC) in support of hydrological modeling. Ground SMC data were collected during 2015 from a gauge station network established in Western, Crete, Greece. Satellite data were downloaded and preprocessed, and parameters such as Normalized Difference Vegetation Index (NDVI), thermal infrared temperature, backscattering coefficient and incidence angle were calculated to calibrate ground collected SMC data. Both *Oh* and *Topp* models were synergistically used to correct SAR images in terms of roughness and vegetation. Artificial Neural Networks (ANNs) were employed to develop sophisticated algorithms for carrying out estimation of SMC with means of EO. The developed algorithms were evaluated for their performance through sensitivity analysis. Finally, the overall proposed methodology was applied to support hydrological simulation at the Keramianos watershed, Crete, Greece. Results highlight the contribution of both EO and ANNs in estimating SMC and supporting hydrological studies.

Keywords: Soil Moisture Content, Sentinel 1, Landsat 8, Earth Observation

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Trees shifting from competition to facilitation due to apparent climatic change

[1]Aristides Moustakas and [2]Tim G. Benton

[1]*Institute for Applied Data Analytics, Universiti Brunei Darussalam, Brunei*
[2]*School of Biology, University of Leeds, Leeds, UK*

Soil water is a key component of ecosystems, modulating ecohydrological cycles across scales. Coupled ecological-hydrological data can provide key insights in understanding long-term population dynamics as well as the role of water resources in tree survival strategies over time. While the role of soil water is elementary for vegetation growth and survival, its importance is often hard to quantify due to differing time scales of long-lived plants such as trees. Thus the role of soil water availability or reciprocally tree mortality and competition under water stress are hard to quantify. Recent technological advancements regarding digital imagery and remote sensing, as well as significant progress in data analytics and data mining, have provided large spatio-temporal datasets as well as computational power and novel techniques for their analysis. Here we generate a long-term dataset (spanning from 1984 to 2001) using remote sensing techniques to identify tree individuals through time and couple it with Normalized Difference Vegetation Index (NDVI), Soil Moisture Index (SMI), and monthly precipitation data. Using this dataset of trees following over 100,000 tree individuals over time in the Kalahari, Southern Africa, we quantify tree survival as a function of soil surface water and tree density. During the same period, rainfall decreased as well as the variance in precipitation values increased. This resulted in soil water availability becoming both lower and more unpredictable throughout the duration of the study. Our analysis indicates that trees were initially competing with their nearest neighbours, as indicated by decreasing probability of survival with decreasing distance to the nearest neighbouring trees, and this coincided with the period of high soil water availability. During the latest period when soil water availability decreased, tree survival increased with decreasing distance to the nearest neighbouring trees i.e. trees that were initially competing against each other were latter on facilitating each other's survival. The suggested mechanism for driving facilitation is increased soil water availability at locations where trees form patches. The implications of these results are discussed both in terms of tree mortality as well from an ecohydrological perspective under climatic changes.

Keywords: Trees, ecosystems, ecohydrological cycles, scaling

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Soil Moisture Variability as a Driver of Vegetation Dynamics in the Mediterranean Rangelands

Ioannis N. Daliakopoulos

School of Environmental Engineering, Technical University of Crete, Chania, Greece. and Department of Agricultural Technology, Technological Educational Institute of Crete, Heraklion, Greece.

The protection of Mediterranean rangelands against natural and human induced degradation is limited by our ability to understand and model the underlying dynamics in space and time. Since the advent of mutli-spectral satellite imagery, vegetation dynamics has been successfully monitored by radiometric measures of the green vegetation canopy chlorophyll and leaf area. The potential of meteorological variables and indices to explain current and future rangeland vegetation dynamics using remote sensing and empirical models has recently been investigated by Daliakopoulos et al. (2017) and Daliakopoulos and Tsanis (2017). Here we investigate the potential of driving Random Forest (RF) models with remote sensing soil moisture to approximate NDVI-based vegetation dynamics. To account for uncertainty, a bootstrapping approach is used to train a sufficient number of RF models using random subsets of the dataset. The Soil Moisture CCI dataset, one of the most integral and consistent global soil moisture datasets based on active and passive microwave sensors, along with observed monthly meteorological variables and indices from the E-OBS-v13.1 dataset, are used as predictors. Vegetation dynamics is depicted using the latest version (3g.v1) of the GIMMS NDVI dataset. Analysis is conducted for the period 1981-2015 at a spatial resolution of 25 km. Preliminary results show the potential of machine learning to capture the underlying relationship of soil moisture and vegetation dynamics to provide insight of rangeland health based on soil moisture variability.

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Keywords: NDVI; LAI; Soil Moisture; Random Forests; Mediterranean rangelands

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Discharge estimations of historical floods in the Almanzora basin, southeastern Iberian Peninsula

Carlos Sánchez-García and Lothar Schulte

University of Barcelona, Department of Geography. Spain

Despite the fact that flooding and flash-floods are the outstanding natural hazard in the semi-arid basins of southeastern Spain, instrumental hydraulic records are generally sporadic, short or even absent in ephemeral river systems. Therefore, the estimations of magnitude and frequency of extreme events include large uncertainties or are simply wrong when longer time series are not included in the models. However, flood frequency analysis (FFA) based on historical sources can be problematic when they do not include primary sources and flood-damage reports are not checked by different archives.

This study aims to reconstruct accurately flood history of the 2600 km2-large Almanzora basin since 1500 AD. Data compilation from primary sources was performed in all accessible municipal archives (6). To assess the magnitude and frequency of flood events, the following categories of flood intensities were established. Magnitude 1 (M1): ordinary floods that affected only agriculture plots; M2: extraordinary floods which produced damages of buildings and hydraulic infrastructure; M3: catastrophic floods which caused very severe damages, fatalities and partial or complete destruction of settlements. A damage intensity of +1 magnitude was added up when the event was recorded from more than one sub-basin or stretch, which were previously defined according to physiographic and topographic settings.

In a second phase of the research, peak discharges of 12 floods from 1960 to 1993 AD of the Sta. Bárbara station were associated to flood intensities of reported flood damages and interpolated to perform a FFA. The results are: 137 m3s-1, for intensity M1, 1300 m3s-1 for M2 and 3600 m3s-1 for M3. The highest peak discharge of 5600 m3s-1 were recorded on October 18th 1973. The associated discharge magnitudes of all flood events were processed using a Bayesian approach to calculate return periods of floods.

Environmental issues we would like to highlight and discuss: 3. Land Degradation and Restoration, ORAL Format.

Keywords: Flood Frequency Analysis, flood hazard, extreme events, climate change.

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Tall trees safeguard biodiversity under climatic changes: assessing the effect of tree size, soil moisture, and vegetation density on tree survival.

[1]Aristides Moustakas and [2]Tim G. Benton

[1]*Institute for Applied Data Analytics, Universiti Brunei Darussalam, Brunei*
[2]*School of Biology, University of Leeds, Leeds, UK*

Soil water availability is a major limiting factor to drylands' vegetation worldwide. Soil water is among other factors related to precipitation and both factors in turn drive both animal and plant diversity. In arid lands, trees in particular are keystone species for other plants as well as animals providing shelter. In addition, trees in arid locations protect the soil through their rooting system, deterring land degradation and maintain soil and soil moisture. Climatic changes are impacting arid areas and this effect is predicted to become more pronounced in the near future. Therefore, survival of trees in arid areas is crucial for ecosystem functioning as their death is likely to introduce cascade effects on other species as well as in soil surface water availability. Arid lands are poorly studied ecosystems as they often lay far from developed areas and the human population density is low; however, this makes them ideal study areas for climatic changes and eco-hydrological functioning. A large spatio-temporal dataset containing data on soil water availability, precipitation, and a very large number of tree individuals followed one-by-one over a period of 30 years was derived in the Kalahari, Africa, a place where water is scarce. Here we show with these data, that during the past 30 years rainfall has been both reduced in magnitude but increased in variability. Monitoring long-term tree survival indicated that while rainfall was uniformly distributed across the study areas, soil water was higher in the vicinity to tall tree individuals. This result became more pronounced as rainfall decreased. Tree survival was also higher closer to tall tree individuals and this result became more pronounced as both rainfall and soil water availability on bare ground (i.e. away from tree canopies) decreased. These result indicate that tall tree individuals are keystone species for plant survival safeguarding biodiversity in arid lands. Maintaining or establishing tall tree species in such areas facilitates other vegetation under water stress.

Keywords: Trees, soil water availability, water stress, biodiversity

LD2: Land Degradation and Remediation: The State of the Art

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Updating field techniques to assess soil erosion in vineyards: ISUM (Improved Stock Unearthing Method)

[1]Jesús Rodrigo-Comino, [2]Jorge García Jiménez, [2]Carlos Atienza de la Cruz, [2]Artal Cabo Pitarch, [2] Jose Vicente Vega Perona and [2]Artemi Cerdà

[1]*Instituto de Geomorfología y Suelos, Department of Geography, University of Málaga, 29071, Málaga, Spain.*
[2]*Soil erosion and Degradation Research Group, Department of Geography. University of Valencia, 46010 Valencia, Spain.*

Vineyard soils experience high erosion rates compared to other agricultural land uses. The extremity of soil losses in vineyards limits the sustainability of traditional production schemes and should lead to comprehensive research to thwart the main processes affecting vineyard systems. However, long-term measurements and spatial variability of soil erosion rates at the plot scale are unknown, as most of the measurements have taken place either at the hillslope or watershed scales. Against this background, the stock unearthing method (SUM) is considered a useful methodology (Brenot et al., 2006; Casalí et al., 2009; Rodrigo Comino et al., 2016). However, the current method falls short because it assumes that the topography between the vine lines (rows) remains planar. Therefore, we propose a new methodology (ISUM: improved stock unearthing method) that includes three measurements between the vine rows (Rodrigo-Comino and Cerdà, 2018). The ISUM costs approximately 20% more time to conduct than the SUM, but greatly improves the utility of the field survey. As a new method allows for: i) the creation of maps that identify linear soil erosion features and accumulation sites; ii) measures the amount of soil accumulated under the vines; iii) the estimation of soil erosion rates with higher accuracy at long-term periods. We pretended to test five different issues: i) comparison between SUM and ISUM; ii) the age of plantation as a driving factor of soil erosion; iii) differences among slope positions; iv) differences among parent materials; v) changes before and after tillage.

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Keywords: Soil erosion; land degradation; vineyards; ISUM; field measures; connectivity.

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The interplay between facilitation and habitat type drive spatial vegetation patterns in global drylands

[1]Miguel Berdugo, [2]Santiago Soliveres, [3]Sonia Kéfi and [1]Fernando T. Maestre

[1]*Departamento de Biología y Geología, Física y Química Inorgánica, Escuala Superior de Ciencias experimentales y Tecnología, Universidad Rey Juan Carlos, C/Tulipán, s/n, 28933, Móstoles, Spain*
[2]*Institute of Plant Sciences, University of Bern, Altenbergrain 21, 3013 Bern, Switzerland*
[3]*Institut des Sciences de l'Evolution, BioDICée team, Université de Montpellier, CNRS, IRD, EPHE, CC 065, Place Eugène Bataillon, 34095 Montpellier Cedex 05, France.*

Our study is conducted on an important indicator of soil degradation and is focused on understanding key gaps of knowledge which preclude its generalization and adaptation in real-world ecosystems.
Research questions:
The size distribution of discrete plant patches (PSDs), a common descriptor of the spatial patterns of vascular vegetation, has been linked to variations in land degradation and ecosystem functioning in drylands. However, most studies on PSDs conducted to date have focused on a single or a few study sites within a particular region. Therefore, little is know on the general typology and distribution of PSDs at the global scale, and on the relative importance of biotic and abiotic factors as drivers of their variation across geographical regions and habitat types.
We analyzed 115 dryland plant communities from all continents except Antarctica to investigate the general typology of PSDs, and to assess the relative importance of biotic (plant cover, frequency of facilitation, soil amelioration, height of the dominant species) and abiotic (aridity and sand content) factors as drivers of PSDs across contrasting habitat types (shrublands and grasslands). We found that both power-law and lognormal PSDs were generally distributed regardless of the region of the world considered. The percentage of facilitated species in the community drives the emergence of power-law like spatial patterns in both shrublands and grasslands, although mediated by different mechanisms (soil and climatic amelioration, respectively). Other drivers of PSDs were habitat-specific: height of the dominant species and total cover were particularly strong drivers in shrublands and grasslands, respectively. The importance of biotic attributes as drivers of PSDs declined under the most arid conditions in both habitats. We observed that PSDs deviated from power law functions not only due to the loss of large, but also of small patches. Our results expand our knowledge about patch formation in drylands and the habitat-dependency of their drivers. They also highlight different ways in which facilitation may act on ecosystem functioning through the formation of plant spatial patterns.

Keywords: Aridity, functional traits, grasslands, patch-size distributions, power laws, shrublands,

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spatial patterns.

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Respective and Shared Contributions of Land Preparation and Vegetation to Soil Ecosystem Services in Longtan Catchment, China

Feng Tianjiao, Chen Liding and Wei Wei

State Key Laboratory of Urban and Regional Ecology, Research Center for Eco-environmental Sciences, Chinese Academy of Sciences, Beijing 100085

In semiarid terrestrial ecosystems, soil moisture deficit, insufficient soil carbon stock and lacked soil nutrient are prominent issues hindering the ecological restoration and development. Vegetation recovery and proper land preparation as two important methods to alleviate eco-environmental problems, they both have respective and coupled effects on improving soil ecosystem services. Quantifying the independent and shared contribution of them are fundamental to find better measures of ecological rehabilitation. In this study, 18 experimental plots (6 kinds of combinations of land preparation and vegetation: leveled benches and C. korshinskii, fish-scale pits and P. orientalis, leveled ditches and M. sativa, zig terraces and P. orientalis, fish-scale pits and P. tabulaeformis and zig terraces and P. tabulaeformis) were designed in Longtan watershed of China, then the soil properties (0-100 cm) were analyzed to assess the respective and shared impacts of vegetation and land preparation on soil ecosystem services. The results showed that soil moisture storage (SMS), soil carbon and nutrient stocks (SCS, SNS, SPS and SKS) differ under different vegetation patterns. Leveled ditches-M.sativa had the most SMS (124.68 mm) while zig terraces-P. tabulaeformis had the least one (88.30 mm). Fish-scale pits-P. tabulaeformis had the most SCS (9803.71 g/m2) and leveled ditches-M. sativa had the least one (8162.74 g/m2). For soil nutrient stocks, leveled benches-C. microphylla and fish-scale pits-P. tabulaeformis had the higher ones while leveled ditches-M. sativa had the lower ones than other combinations. Moreover, as indicated partial redundancy analysis (pRDA) and variation partitioning (VP) analysis, SMS of 0-10 cm, 10-60 cm and 60-100 cm were more affected by precipitation (58.8%), the shared effects of vegetation and land preparation (61.3%), and vegetation (72.2%), respectively. At last, soil carbon stock was more affect by land preparation (30.5%) than vegetation (3.1%), however, vegetation had more contributions to soil nutrient stocks (36.5% to SNS, 31.1% to SPS and 77.1% to SKS, respectively) than land preparations (11.7% to SNS, 28.5% to SPS and 11.9% to SKS, respectively). Our findings can be considered helpful as a ecosystem restoration method for semiarid areas.

Keywords: Land Degradation, Land Preparation, Vegetation Type; Soil Quality, the Loess Plateau

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Effects of different soil managements in vineyards to slope stability

[1]Massimiliano Bordoni, [2]Alberto Verces, [2]Cristina Ganimede, [2]Maria Cristina Reguzzi, [2]Emanuele Mazzoni, [2]Enrica Capelli, [2]Sauro Simoni and [1]Claudia Meisina

[1]*Department of Earth and Environmental Sciences, University of Pavia, Pavia, Italy*
[2]*Department of Sustainable Crop Production, University Cattolica del Sacro Cuore, Piacenza, Italy*

Shallow landslides and soil erosion, induced by intense rainy events, are the most widespread slope instabilities that occur in vineyards cultivated along hillslopes. They could cause severe damages in the inter-row space and produce loss of soils characterized for high productivity levels. This fact provokes also land degradation and abandonment in cultivated areas. As a consequence of the higher diffusion of these extreme events in some European regions (e.g. Italy, France, Spain, Germany, Slovenia), it is necessary finding not invasive interventions, able to reduce the susceptibility of vineyards while preserving ecosystem sustainability. The inter-row soil managements at farm level could have effects on root distribution and, as consequence, on root reinforcement.
This study aimed to analyze different agronomic techniques and their effect on root reinforcement in soil, in order to increase slope stability of vineyards susceptible to shallow damaging events. This study is supported by Fondazione CARIPLO AttivAree programme - Oltrepò(Bio)diverso project. The research was conducted in Oltrepò Pavese (North-Western Italy), an hilly area where traditional viticulture is present on steep slopes soils affected by several shallow landslides and erosions which caused significant environmental and economic losses.
The parameters related on root density and reinforcement were evaluated under different soil management techniques (tillage, permanent grass mulching, alternation in the years of tillage and grass mulching in the inter-row spaces), also in relation to the presence of shallow landslides events. The techniques characterized to produce positive effects on soil stability were identified. This analysis, also, would furnish important guidelines in order to apply sustainable farm practices in vineyards while maintaining better levels of soil biodiversity and fertility and promoting a sustainable economic rising income of the territory.

Keywords: Slope instability, Vineyards, Soil management, Land degradation, Root reinforcement and Sustainable practices.

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Measuring the kinetic energy of rainfall and the soil particles splash

[1]David Zumr, [1]Martin Neumann, [1]Tomáš Laburda, [1]Jan Devátý, [1]Petr Kavka, [1]Josef Krása, [1] Martina Sobotková, [1]Tomáš Dostál, [2]Lisbeth L. Johannsen, [2]Nives Balenovic, [2]Andreas Klik, [3] Peter Strauss, [4]Ond?ej Fišer and [4]Zuzana Chládová

[1]*Faculty of Civil Engineering, Czech Technical University in Prague, Prague, Czech Republic*
[2]*BOKU, University of Natural Resources and Life Sciences, Vienna, Austria*
[3]*Institute for Land & Water Management Research, Federal Agency for Water Management, Petzenkirchen, Austria*
[4]*Institute of Atmospheric Physics, Academy of Sciences of the Czech Republic, Prague, Czech Republic*

The main goal of the presented work is to study the relation between rainfall characteristics (drop size distribution, drops shape, velocity, intensity, kinetic energy, amount) and corresponding soil particles detachment regime during various types of storms, that are typical for the Central European conditions. The splash erosion is studied on three different soils in Austria and the Czech Republic. The experimental sites are equipped with four types of distrometers and newly constructed splash cups. We monitor rainfall characteristics, soil loss due to the splash erosion and the topsoil micro-topography changes (surface roughness, soil compaction). The data are collected during the natural storms and also during the rainfall simulation experiments in the laboratory. Within this contribution we present the preliminary results of the measured rainfall kinetic energy – rainfall intensity relationship and corresponding splash erosion. The first tests clearly show different characteristics of the natural and simulated rain. Rainfall of the identical intensity have different kinetic energies and cause different splash erosion. The research has been funded within the frame of the project no. GA17-33751L.

Keywords: splash erosion, rainfall kinetic energy, distrometer, splash cup, soil loss, soil compaction

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Grey and green infrastructure used for flood retention in western Romania

Rares HALBAC-COTOARA-ZAMFIR

Politehnica University of Timisoara, Romania

Rivers have always played an important role in settlements development. A river is not just a water supplier but also, maybe more important, a dynamic ecosystem with frequent changes and specific characteristics influenced by many factors as local climate, geology etc. Human society, being in a continuous development and with high needs in new territories, finds in rivers a redoubtable adversary. The interference led, along centuries, to a radical alteration of rivers watercourses and major beds which had responded by flooding properties and livelihoods.
The result was an arms race, humanity with higher and stronger dikes, and other flood defenses, rivers with higher flow peaks with a strong destructive force. Regional and local authorities must develop integrated management plans for rivers in order to recreate their natural floodplains. However, traditional flood protection measures, mainly based on grey infrastructure are no longer sufficient to cope with dynamic flood risk being necessary to be implemented, as complement to grey infrastructure, nature-based solutions. An important challenge is to consider the reconciliation of flood risk management and land management, giving the multifunctional land uses which enable temporary flood retention and flood storage on private land without restricting the provision of other ecosystem services.
In addition, the origins and consequences of flooding have to be fully understood, particularly in developing countries, in order to propose and justify adequate institutional strengthening (regulatory agencies, conservation authorities) which should overcome existing institutional and political barriers.
This poster presentation will focus on grey and green presentation used for flood retention in western Romania, an area characterized by a high density of land drainage and irrigation system which provide several important regulating ecosystem services like flood retention, groundwater recharge etc. This area was recently affected by several floods requiring breaking down disciplinary boundaries between engineers, ecologists, agronomists, economists, hydrologists and climate scientist and the appliance of some reliable climate-energy-economic models as well as land-use models.
This paper is financially and scientifically supported by COST action CA16209 Natual Flood Retention of Private Land (http://www.cost.eu/COST_Actions/ca/CA16209) through and ITC Conference Grant.

Keywords: flood retention land use models climate energy models

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Analysis of the spatial variability of the relationships between rainfall, runoff, erosion and sediment yield and synoptic atmospheric patterns around the Mediterranean basin

Peña-Angulo, D

Departamento de Geografía, Instituto Universitario de Ciencias Ambientales (IUCA), Universidad de Zaragoza, Zaragoza, Spain

Peña-Angulo, D.1, Nadal-Romero, E.1, 2, González-Hidalgo, J.C.1, Albaladejo, J.3,Andreu, V.4, Bagarello, V.5, Barhi, H.6, Batalla, R.7, 8, 9, Bernal, S.10, Bienes, R.11, Campo, J.4, Campo-Bescós, M.A.12, Canatario, A.13, Cantón, Y.14, Casali, J.12, Castillo, V.3, Cerdà, A.15, Cheggourr, A.16, Cid, P.17, Cortesi, N.18, Desir, G.19, Díaz-Pereira, E.3, Espigares, T.20, Estrany, J.21, Fernández-Raga, M.22, Ferreira, C.S.S.23, Ferro, V. 24, Gallart, F.25, Giménez, R.12, Gimeno, E.4, Gómez, J.A.26, Gómez-Gutiérrez, A.27, Gómez-Macpherson, H.28, González-Pelayo, O.29, Hueso-González, P.30, Kairis, O.31, Karatzas, G.32, Keesstra, S.33, Klotz, S.34, Kosmas, C.31, Lana-Renault, N.35, Lasanta, T.2, Latron, J.25, Lázaro, R.36, Le Bissonnais, Y.37, Le Bouteiller, C.34, Licciardello, F.36, López-Tarazón, J.A.7, 21, 39, Lucía, A.40, Marín, C.1, Marqués, M.J.41, Martínez-Fernández, J.42, Martínez-Mena, M.3, Martínez-Murillo, J.F.30, Mateos, L.28, Mathys, N.34, Merino-Martín, L.43, Moreno-de las Heras, M.25, Moustakas, N.31, Nicolau, J.M.44, Novara, A.5, Pampalone, V.5, Raclot, D.45, Rodríguez-Blanco, M.L.46, Rodrigo-Comino, J.30, 47, Romero-Díaz, A.48, Roose, E.49, Rubio, J.L.4, Ruiz-Sinoga, J.D.30, Schnabel, S.27, Senciales-González, J.M.50, Simonneaux, V.51, Solé-Benet, A.36, Taguas, E.V.52, Taboada-Castro, M.M.46, Taboada-Casto, M.T.46, Todisco, F.53, Úbeda, X.54, Varouchakis, E.A.32, Wittenberg, L.55, Zabaleta, A.56, Zorn, M.57

1 Departamento de Geografía, Instituto Universitario de Ciencias Ambientales (IUCA), Universidad de Zaragoza, Zaragoza, Spain

2 Instituto Pirenaico de Ecología, IPE-CSIC, Zaragoza, Spain

3 Soil and water conservation research group, CEBAS-CSIC, Murcia, Spain

4 Department of Soil Degradation and Conservation. Centro de Investigaciones sobre Desertificación-CIDE (CSIC, UV. GV), Valencia, Spain

5 University of Palermo, Department of Agricultural, Food and Forest Sciences, Viale delle

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Scienze, 90128 Palermo, Italy

6 INRGREF, Ariana, Tunisia

7 Fluvial Dynamics Research Group – RIUS, University of Lleida, Lleida, Catalonia, Spain

8 Catalan Institute for Water Research, Girona, Catalonia, Spain

9 Faculty of Forest Sciences and Natural Resources, Austral University of Chile, Valdivia, Chile

10 Integrative Freshwater Ecology Group, Centre d\'Estudis Avançats de Blanes (CEAB-CSIC), Accés a la Cala St. Francesc 14, 17300, Girona, Spain.

11 Dto Investigación Aplicada y Extensión Agraria. Instituto Madrileño de Investigación y Desarrollo Rural, Agrario y Alimentario, Madrid, Spain

12 Department of Projects and Rural Engineering, ISFOOD Institute, Public University of Navarre, Pamplona, Spain

13 Polytechnic Institute of Castelo Branco, School of Agriculture, Center for GeoBioSciences, GeoTechnologies and GeoEngineering, Portugal

14 Department of Agronomy (Soil Science Area). University of Almeria. Engineering High School. La Cañada de San Urbano 04120. Almeria, Spain

15 Soil erosion and Degradation Research Group, Department of Geography. University of Valencia, 46010 Valencia, Spain

16 Universite Cadi Ayyad, Faculte des Sciences Semlalia, 40000 Marrakech, Morocco

17 Maize Genetics and Genomics Lab, Centro de Investigación y de Estudios Avanzados del IPN (LANGEBIO - CINVESTAV), Irapuato, Mexico

18 Centro Nacional de Supercomputación, Department of Earth Sciences, Barcelona, Spain

19 Departamento de Ciencias de la Tierra, Universidad de Zaragoza, Zaragoza, Spain

20 Departamento de Ciencias de la Vida, Unidad de Ecología, Universidad de Alcalá, 28805 Alcalá de Henares (Madrid), Spain

21 Mediterranean Ecogeomorphological and Hydrological Connectivity Research Team

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(MEDhyCON), Department of Geography, Palma, Spain

22 Department of Applied Physics University of León, Leon, Spain

23 Research Centre for Natural Resources, Environment and Society (CERNAS), College of Agriculture, Polytechnic Institute of Coimbra, Portugal

24 University of Palermo, Department of Earth and Marine Science, Via Archirafi 20, 90123 Palermo, Italy

25 Surface Hydrology and Erosion group, Institute of Environmental Assessment and Water Research (IDÆA-CSIC), Barcelona, Spain

26 Instituto de Agricultura Sostenible—CSIC, Córdoba, Spain

27 INTERRA Research Institute, University of Extremadura, Avda. de las Letras, 10071 Cáceres, Spain

28 Instituto de Agricultura Sostenible, Consejo Superior de Investigaciones Científicas, Córdoba, Spain

29 Department of Environment and Planning, Earth Surface Processes Team (ESP) Centre for Environmental and Marine Studies, Portugal

30 Instituto de Geomorfología y Suelos (IGSUMA), Departamento de Geografía, Universidad de Málaga, Málaga, Spain

31 Department of Natural Resources Management and Agricultural Engineering, Agricultural University of Athens, Athens, Greece

32 School of Environmental Engineering Technical University of Crete

33 Soil Physics and Land Management Group, Wageningen University, Droevendaalsesteeg 4, 6708PB, Wageningen, The Netherlands

34 Université Grenoble Alpes, Irstea, UR ETGR, F-38402 St-Martin-d\'Hères, France

35 Area of Physical Geography, Luis Vives Building, Luis de Ulloa Street, University of La Rioja, 26006 Logroño, Spain

36 Experimental Station of Arid Zones, EEZA-CSIC, Almería, Spain

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37 INRA - UMR LISAH (INRA, IRD, Montpellier SupAgro, University of Montpellier), 2 place Viala, Montpellier 34060, France

38 University of Catania, Department of Agriculture, Food and Environment, Catania, Italy

39 University of Potsdam, Institute of Earth and Environmental Science, Karl-Liebknecht-Str. 24-25, 14476 Potsdam, Germany

40 Center for Applied Geosciences, Faculty of Science, Eberhard Karls Universität Tübingen, Germany

41 Departamento de Geología y Geoquímica, Universidad Autónoma Madrid, Madrid, Spain

42 Instituto Hispano Luso de Investigaciones Agrarias, University of Salamanca, Duero 12, 37185, Villamayor, Spain

43 Botany and Modelling of Plant Architecture and Vegetation joint research unit (CIRAD, CNRS, INRA, IRD, University of Montpellier) France

44 Escuela Politécnica Superior, Instituto Universitario de Ciencias Ambientales, Universidad de Zaragoza, 22071 Huesca, Spain.

45 IRD - UMR LISAH (IRD, INRA, Montpellier SupAgro, University of Montpellier), 2 place Viala, Montpellier 34060, France

46 University of A Coruna, Faculty of Sciences, Centre for Advanced Scientific Research (CICA), 15071 A Coruña, Spain

47 Physical Geography, Trier University, 54286 Trier, Germany

48 Departamento de Geografía Universidad de Murcia Campus de La Merced 30.001, Murcia, Spain

49 UMR Eco&Sols, Institut de Recherche pour le Développement, Montpellier, France

50 Department of Geography, University of Málaga, 29079 Málaga, Spain

51 CESBIO (Centre d\'Etudes Spatiales de la Biosphere, UMR CNES-CNRS-IRD-UPS), 18 Av. Edouard Belin, 31401 Toulouse Cedex 9, France

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52 University of Cordoba –ETSIAM Campus Rabanales, Leonardo Da Vinci building, Córdoba, Spain

53 Agricultural and Biosystems Engineering Research Unit, Department of Agriculture-Food and Environmental Sciences, Italy

54 Grup de Recerca Ambiental Mediterrània, Departamento de Geografia Física i AGR, Universitat de Barcelona, Spain

55 Department of Geography and Environmental Studies University of Haifa, Haifa, Israel

56 Hydro-Environmental Processess Research Group, Science and Technology Faculty, University of the Basque Country, Basque Country, Spain

57 Geographical Institute, Research Centre of the Slovenian Academy of Sciences and Arts, Ljubljana, Slovenia

This contribution results from international collaborative efforts of different research groups around the Mediterranean basin focusing on soil conservation and water management. We will present the most complete database of runoff and soil erosion information and analyze the records from 68 locations, including more than 22458 detail events between 1985-2015. Soil conservation and water planning are two of the most challenging problems around the Mediterranean basin due to climate conditions and human activity. We believe that future advances on understanding soil degradation by water should be developed under global approaches. In this contribution, we will present an analysis of atmospheric conditions, expressed by weather types and the resulted rainfall, runoff, and erosion and sediment yield around the Mediterranean basin. The weather types compile daily information about the different air masses responsible for rainfall, runoff and eventually erosion and sediment yield, and their analyses let us know the synchrony of the response at different sites around the Mediterranean basin. The analyses of the global dataset display different spatial patterns for rainfall, runoff, and sediment yield, related to different atmospheric patterns. This research will be a valuable tool for understanding the evolution of these environmental variables, and therefore it will allow future planning to design regional water management and soil conservation measures.

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Keywords: Soil erosion, weather types, water management, Mediterranean basin, spatial variability, databases

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Effects of different amounts of olive pruning residues on soil quality indicators in superintensive olive orchards

[1]Encarnación V. Taguas, [1]Víctor Marín-Moreno, [1]M Castillo Amaro, [1]Diego Barranco, [2]Artemi Cerdá, [1]J Antonio Cobacho, [1]Alfonso García-Ferrer, [3]Luciano Mateos, [1]Concepción M Díez, [1]F Javier Mesas, [1]Rafael Pérez and [1]José L Quero

[1]*ETSIAM, University of Córdoba*
[2]*University of Valencia, Valencia (Spain)*
[3]*Sustainable Agriculture Institute, Córdoba (Spain)*

Pruning residues have been described as an effective measure for soil conservation. The high cost of managing and transporting pruning residues and the improvement of chopping machinery have led to leave them on the soil surface of numerous olive groves in Andalucía, Spain. Improvements in soil fertility is expected in super-intensive olive groves (>1500 olives.ha-1) due to the great incorporation of organic matter. The aim of this research is to study the characteristics and evolution of the residues one year after their application and their impact on soil properties related to olive production and soil quality. Four treatments (5 replicates of 6x2 m plot) were applied: residues application rate of 0.0 t ha-1 (control), 7.5 t ha-1, 15.0 t ha-1 and 30.0 t ha-1.
Soil cover percentage was well-correlated with the residues application rate. Moisture content of the residue showed high variability along the year with values between 4-40%. Temperature of the pruning residues was higher than the soil temperature, with the exception of the winter measurements. Soil moisture (0-10 cm) did not differ among treatments significantly in conditions of very low and very high moisture, whereas notable differences were found in spring. It is worth noting how the mulch increased soil organic matter and CO2 after only one year and its high correlation with the residues application rate. It is necessary to continue the study of the cumulative long-term effect to provide management guidelines.

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Keywords: pruning residues, soil cover, erosion, soil management

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Causes, controlling factors and rehabilitation challenges of valley bottom gullies: A review

[1]Selamawit Amare, [1]Saskia Keesstra, [2]Eddy Langendoen, [1]Martine van der Ploeg, [3]Tammo Steenhuis and [4]Seifu Admassu Tilahun

[1]*Wageningen University, The Netherlands*
[2]*USDA, USA*
[3]*Cornell University, USA*
[4]*Bahar Dar University, Ethiopia*

Gullies are found both on hillslopes and on valley bottoms across a wide range of environmental conditions. Valley bottom gullies, which form under different conditions than hillslope gullies, pose multiple onsite and offsite problems. Researchers, however, have not clearly distinguished between the controlling factors and reclamation measures of these two different gully types. Erosion of valley bottom gully is more severe than hillslope erosion. In addition, only a small percentage of the published gully erosion studies focuses on valley bottom gullies. Therefore, we conducted a review on causes, controlling factors and management challenges of valley bottom gullies in a wide range of climatic, soil and land use conditions and future research focuses were emphasised. The review indicates that onsite and offsite anthropogenic and/or natural factors that increase water delivery to the valley bottom, in the form of both surface and subsurface flow, are the major determinants of gullies. These factors include land use change from forest to grazing and cropland, increase in the drainage area, cumulative rainfall amount, drought accompanied by intense rainfall, increase in degraded lands, hydrological changes due to dam and reservoir construction, alluvium and colluvium soil deposition, soil stoniness, and terrain slope gradient surrounding the gully. The impact of these factors negatively affects the soil stability (e.g., lowering soil shear strength), which leads to combined fluvial and mass wasting gully erosion processes. Grazing land (31%), followed by crop and grazing land together (19%), and cropland (11%) were the most frequent land uses in which valley bottom gullies were reported. Hortonian, or infiltration excess, overland flow is the typical cause of valley bottom gullies for arid and semi-arid regions, whereas for humid and sub-humid regions saturation excess overland flow is the reason. Huge investments have been made to restore unstable and degraded channels worldwide, but their benefits are inconclusive. Valley bottom gully reclamation measures seem effective in areas where gullies are due to Hortonian overland runoff, whereas for subsurface saturation excess erosion remedial actions were not successful. In summary, no universal agreement exists on the causes and factors governing the development of gullies at the valley bottom. Based on this review we have developed a form that summarizes all the controlling factors and can assist scientists with planning new studies on valley bottom gully erosion and develop improved reclamation measures.

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Keywords: Erosion; runoff; soil saturation; sediment; Badlands; reclamation measure

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Is Cover Crops Contribution to Soil Organic Carbon Sequestration Per Se Overestimated?

[1]Novara A, [1]Santoro A., [2]Rodrigo- Comino J, [1]Mario Minacapilli, [3]Cerdà A. and [1]Gristina L

[1]*Dipartimento di Scienze Agrarie, Alimentari e Forestali. University of Palermo, Italy*
[2]*Department of Physical Geography, Trier University, D-54286 Trier, Germany and Department of Geography, Málaga University, Campus of Teatinos s/n, 29071 Málaga, Spain.*
[3]*Soil Erosion and Degradation Research Group, Department of Geography, University of Valencia, Valencia, Blasco Ibàñez 28, 46010- Valencia Spain.*

Cover crop soil management is considered a strategy for soil organic matter increase in Mediterranean orchards. This research focused on the evaluation of the effect of erosion on soil organic carbon (SOC) sequestration rate after 5 years of cover crop soil management in a Mediterranean vineyard. Two paired sites, one in a sloping area and the other one in a contiguous flat area, were chosen. The vineyard soils of the two plots of each paired site were managed with (CT) conventional soil tillage and with (CC) Vicia faba cover crop since 5 years. SOC content was measured in three points along the slope (top, middle and bottom part of the slope) and in the flat area. Results showed that in the slope area the highest SOC content was found in CC management, with an average value of 9.52±0.34 g kg-1, while the SOC content under CT was 8.74± 0.20 g kg-1. In the flat vineyard the SOC ranged from 9.88 g Kg-1 and 10.47g Kg-1 under CT and CC, respectively.

The SOC increase was of 6% in the flat area and of 9% in the slope vineyard after five years since CC management adoption. The higher C sequestration rates in the slope vineyard in comparison to flat area can be attributed to the role of CC to prevent sediment and nutrient erosion. These findings demonstrated that C sequestration rate per se can be overestimated and therefore, further studies on the effect of slope gradient in SOC sequestration are needed for an accurate C estimation.

Keywords: orchard, soil organic carbon, slope, C loss.

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Impact of tillage intensity on clay loam soil structure

[1]Omar Daraghmeh, [1]Carsten Petersen, [2]Lars Munkholm, [3]Liubava Znova, [2]Peter Bilson Obour, [3] Søren Kirkegaard Nielsen and [3]Ole Green

[1]*Department of plant and environmental sciences, Section for Environmental Chemistry and Physics, University of Copenhagen, Thorvaldsensvej 40, 6. Sal, T645, 1871 Frederiksberg C, Danmark.*
[2]*Dept. of Agroecology, Aarhus University, Blichers Allé 20, Postboks 50, DK-8830 Tjele*
[3]*AGROINTELLI, Agro Food Park 13, Skejby, 8200 Aarhus N, Denmark.*

Soil structure and structural stability are key parameters in sustainable soil management and optimum cropping practices. Locally and temporally adapted precision tillage may improve crop performance while at the same time reduce environmental impacts. The main objective of this study was to improve the knowledge of precision tillage practices through characterizing the effect of varied tillage intensities on structural properties of a clay loam soil. A field experiment was conducted using a randomized complete block design with two main factors, i.e. operational speed (OS, 2 levels) and rotovating speed (RS, 3 levels). The tillage was conducted using a PTO-driven rotovator equipped to measure angular velocity. The effect of traffic compaction, made directly after tillage, was measured on soil taken from wheel track (WT) compared with soil outside wheel track (NWT). Soil samples from 0-3 cm depth, were collected three times, before (T0), after tillage (T1) and later after 45 days. Results show that bulk density as a grand mean was 1.22 g/cm3 at T0; 0.95 and 1.42 g/cm3 (NWT and WT, respectively) at T1, and 1.05 and 1.44 g/cm3 (NWT and WT, respectively) at T2. Low OS (2.9 km/hr) combined with high RS (630 rpm) showed significantly higher air permeability than the other treatments. Log-transformed air permeability was 17% lower for the WT treatment than for the NWT treatments at T2. Treatments with the high OS (6.3 km/h) and thus lowest tillage intensity, generally showed lower clay and silt dispersibility (CSD) at T1 and T2. Dispersibility was larger for the WT treatment than for the NWT treatments at T2. Generally, specific energy input was higher (10.2 kJ/m2) under low OS than under high OS (4.8 kJ/m2). Wheel tracked soil resulted in significantly higher GMD (56 mm) compared to the non-wheel tracked soil at T1 (9 mm). We conclude that precise combination of operation and rotation speeds will result in optimum seedbed in terms of permeability and stability of soil structure.

Keywords: Tillage intensity, precision cropping, soil structure, air permeability

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Use of Phytoremediation and Biochar to Remediate the Rio Tinto Area (Spain)

[1]Eliana Cárdenas, [1]María Luisa Álvarez, [2]Gabriel Gascó, [3]César Plaza, [4]Jorge Paz-Ferreiro and [1] Ana Méndez

[1]*Departamento de Ingeniería de Ingeniería Geológica y Minera, ETSI Minas y Energía, Universidad Politécnica de Madrid, Ríos Rosas 21, 28003 Madrid, Spain.*
[2]*Departamento de Producción Agraria, ETSI Agronómica, Alimentaria y de Biosistemas. Universidad Politécnica de Madrid, 28040 Madrid, Spain.*
[3]*Instituto de Ciencias Agrarias, Consejo Superior de Investigaciones Científicas, Serrano 115 bis, 28006 Madrid, Spain.*
[4]*School of Engineering, RMIT University, GPO Box 2476, Melbourne 3001, VIC, Melbourne, Australia.*

Soil contamination is a global issue, constituting a threat to ecosystems, farming production and human wellbeing. When soil contamination is produced by heavy metals due to mining and metallurgical activities impacts are significant due to heavy metals are non-biodegradable compounds and therefore accumulate in the ecosystem. Recently, a great interest was performed in the treatment of metal polluted soils with organic amendments such as composts and biochars combined with phytoextraction. In this work, we study the possible combination of biochar and phytoremediation to the recovery of the soil functions of degraded soils of Rio Tinto Area (Huelva, Spain). Results shown a reduction on the mobile form of trace metals. This fact had a positive impact on soil quality increasing biological soil properties and the plant growth.

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Keywords: biochar, soil enzymes, CO2 emissions

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Patch Diversity and Spatial Pattern Modulate Sediment Yield in Restored Drylands

[1]Valeriia Nazarova, [1]David Fuentes, [1]Sonia Vega, [1]Andrés S. Cases, [1]Diana Turrión, [2]Manuel Ruiz, [2]Juan R. Sánchez, [3]Carme Bladé and [1]Susana Bautista

[1]*Department of Ecology, University of Alicante, Spain*
[2]*Department of Ecology, University of Alicante*
[3]*Department of Evolutionary Biology, Ecology and Environmental Sciences, University of Barcelona*

This research focuses on disentangling the role played by the spatial and biotic structure of dryland vegetation in resource conservation and ultimately in dryland vegetation dynamics. Increasing functional diversity is hypothesized to have a positive effect on soil and water conservation, and thereby on general ecosystem functioning, which may be modulated by the spatial pattern of the vegetation. To better inform dryland restoration and management, it is important to disentangle the independent role of these factors as well as their combined effects.

We used a manipulative experimental approach to address this question and evaluate the effects of plant diversity and patch pattern on soil conservation and dryland recovery (restoration potential). On 56 (8x5m) plots established on a bare dryland slope, we installed patchy plant communities (12 patches per plot) with different combinations of plant diversity (1, 2, 4, or 8 species per patch) and patch size. On these plots, we monitored patch productivity and sediment yield (captured by silt-fences). Using high resolution photographs taken from a UAV, we also monitored the plot dynamics of plant cover and bare-soil connectivity.

Results from the first year of monitoring show that plant communities with larger and more diverse patches result in higher resource conservation (lower sediment yield), yet this relationship appeared to tend to a plateau so that beyond certain values, further increasing patch size or diversity would not increase resource conservation. Longer-term results are expected to provide insights on the feedbacks between soil conservation and plant cover and pattern. Both short-term and expected longer-term results can provide useful information for dryland restoration optimization.

Keywords: Bare-soil connectivity, dryland restoration, patch size, plant diversity, soil conservation.

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Beech (Fagus Sylvatica L.) Versus Pine (Pinus Sylvestris L.). The Impact of Plants on Soil Water Repellency and Infiltration in Temperate Forest. The Wageningen Forest Study Site.

[1]Saskia Keesstra, [2]Simone di Prima, [3]Laurent Lassabatere, [4]Jesús Rodrigo-Comino and [5]Artemi Cerdà

[1]*Wageningen University, Droevendaalsesteeg 4, 6708PB, Wageningen, The Netherlands.*
[2]*Agricultural Department, University of Sassari, Viale Italia, 39, 07100 Sassari, Italy.*
[3]*Université de Lyon, Laboratoire d'Ecologie des Hydrosystèmes Naturels et Anthropisés, LEHNA, UMR 5023 CNRS, ENTPE, UCB-Lyon-1, Rue Maurice Audin, 69518 Vaulx-en-Velin, France*
[4]*Department of Physical Geography, Trier University, D-54286 Trier, Germany*
[5]*Soil Erosion and Degradation Research Group. Department of Geography, Valencia University, Blasco Ibàñez, 28, 46010 Valencia, Spain.*

In most hydrological models the infiltration capacity of soils under forests is assumed to be ideal. In these models also the tree species is not considered in the analysis. A recent study by Cerdà et al. (2017) demonstrated that in a Mediterranean climate the hydrology under pines is very different than under Oaks. Also other literature suggests the role of water repellancy under coniferous trees to be important (Buczko et al., 2005; Wahl, 2008). However, in temporal forest water repellancy is not taken into account in hydrological and sedimentological modelling. In this study in a temporal planted, mixed forest in the Netherlands the hydrological behaviour of the soil under different forest types was assessed. Two types of tree species were selected: Fagus sylvatica L.and Pinus Sylvestris L. Under both tree species infiltration was assessed using different methodologies. We measured the water repellency degree (Water Drop Penetration Time), the infiltration capacity and infiltration envelops by means of minidisk infiltrometer, ring infiltrometer (5 and 7 cm diameter) and the Beerkan experiments. The results show that under deciduous tree species like Fagus little water repellancy is found. However, under coniferous species like Pinus Sylvestris there is very hydrophopic soils which prohibits the infiltration is some place up to being completely unwettable. The soil hydrology is completely fingered and large dry pockets of soil exist in the forest soil. The use of the combined methodologies to assess the soil hydrology under Pinus and Fagus shows that plantations of Pinus Sylvestris decrease the infiltration capacity, which does not occur in plantations of Fagus Sylvatica. Our results have implications for the hydrological cycle, the recharge to the groundwater and growth potential of the trees.

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Keywords: Infiltration, water repellancy, temporate forest, Fagus Sylvatica, Pinus Sylvestris

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Hydrological Impact of Innovative Barriers Derived from Industrial Vegetal Residues for Control Hillslope Erosion: Commercial Erosion Control Barriers (CECBS)

[1]Albert-Belda, E., [2]Bermejo, A. and [3]Taguas E.V.

[1]*Grupo de Ecología del Fuego y Cambio Global (FIREC) de la Facultad de Ciencias Ambientales - Universidad de Castilla-La Mancha. Campus Fábrica de Armas, Toledo (España).*
[2]*Agroforestal Montevivo S.L. Calle Europa, Chilluévar, Jaén (España).*
[3]*Escuela Técnica Superior de Ingeniería Agronómica y de Montes - Universidad de Córdoba. Campus de Rabanales, Córdoba (España).*

In this work, the hydrological behavior and sediment control capacity of an innovative type of sediment barriers of low structural weight, easy transport and implementation in the field and suitable durability developed by Agroforestal Montevivo S.L., were described. This type of barriers were designed in order to improve restoration of burnt and/or degraded areas because they result more economical and they demand less machinerythan the conventional techniques. The experimental design was based on the analysis of the impact of flow equivalent to 0.6 l.s-1 circulated on plots with 2 treatments (trial and with barriers; of 3 repetitions and of 24 m2 each plot). The rills generated were measured and the rates of sediments cumulated in the barriers in six milestones along the plots were compared through of erosion pins. In addition, the total load and runoff in the outlet of the plots were also quantified through volume and sediment concentration measurements. Finally, an easy approach to pre-size and to implement them in the field was presented.

For the trial plots, the observed threshold length for the rill generation was approximately 15 m. The impact of barriers compared to the trial, meant the decrease in the peak flow and the rise in the runoff time in the outlet of at least two minutes. Moreover, the sediment trapped by the barriers presented after a week, twice more soil moisture than non-mobilized soil, which illustrates its suitability for establishing vegetation. Finally, the sediment trapping rate of the barriers was of 42.7%. The nomographs developed for different rates of erosion, slope and soil type might be useful to determine the quantity of required barriers (expressed in m.ha-1) following the new paradigm of forest restoration based on effective and quick measures of low impact on soils.

Keywords: soil erosion, sediment, degraded areas, barriers, runoff and restoration.

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Effects of Previous Soil Humidity on Sediment Production in a Semi-Arid Catchment - Brazil

[1]Helba Araújo de Queiroz Palácio, [2]Julio César Neves dos Santos, [3]Eunice Maia de Andrade, [4] Jacques Carvalho Ribeiro Filho and [1]Marcos Makêison Moreira de Sousa

[1]*Instituto Federal de Educação, Ciência e Tecnologia do Ceará, Campus Iguatu*
[2]*Instituto Fedral de Educação, Ciência e Tecnologia do Triângulo Mineiro, Campus Uberlândia*
[3]*Universidade Federal do Ceará*
[4]*Universidade Federal Rural do Semiárido*

The tropical semi-arid is characterized by rainfall events with low frequency, short duration and high intensity. High intensity rainfall result in a high erosive power, deaggregating particles that can be transported by surface runoff. However, the processes and main factors that control the generation of runoff and the production of sediments in this region have not yet been completely studied and fully comprehended. Within this context, the main objective of this work was to analyze the effects of previous soil humidity on sediment production in a catchment located in the Brazilian semi-arid region, which was submitted to change in it's soil use. The data was collected between 2009 and 2013 in a 2.8 ha catchment, for a total of 179 natural rainfall events. During the first year (2009), the catchment was preserved with it's natural vegetation. During the second year (2010), deforestation was carried out, followed by burning and the cultivation of grass (Andropogon gayanus Kunt), which was maintained for the remainder of the study. It was observed that the occurrence of consecutive dry days and the formation of cracks in the soil were the most important controlling factors of runoff generation and sediment delivery. The data indicates that sediment production is directly related to the transport capacity, in other words, the occurrence of surface runoff with enough energy to transport them. The change of vegetation coverage influenced sediment production mainly for the first two events, which corresponded to 73% of the total sediment production, during the year of 2010. After the new vegetation coverage appeared (2010), a sediment production similar to before the removal of the original vegetation was observed. The results indicate that, in expansive soil, the amount of initial humidity and the presence of cracks in the soil define the generation of runoff and, consequently, sediment transportation.

Keywords: Dry spells. Soil management. Land use. Sediment transportation. Runoff.

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Wadi Dynamics in the Souss Region, South Morocco

[1]Mario Kirchhoff, [2]K. Daniel Peter, [1]Jesús Rodrigo-Comino, [3]A. Ait Hssaine and [4]Johannes B. Ries

[1]*Physical Geography, Trier University, 54286 Trier, Germany.*
[2]*University of Luxembourg, Esch-sur-Alzette, Luxembourg*
[3]*Department of Geography, University Ibn Zohr Agadir, Morocco*
[4]*Physical Geography, Trier University, 54286 Trier, Germany*

The Souss region is strongly influenced by sheet wash, rill and gully erosion and intersected by ephemeral rivers varying in size, called wadis or Oueds. The due to dry farming oftentimes bare agricultural land is incised by gullies. Because of an ongoing land use change these agriculturally used areas are continually leveled and replaced by fruit plantations or greenhouses. The impact of this land use change on the sediment washed into the wadis was studied as well as the question if wadis act as sinks for the sediment or if the sediment is transported further through the network of wadis. Furthermore, other potential factors controlling the dynamics inside a wadi should be identified.

Scour chains were used to measure erosion or accumulation on the wadi bed. During the years 2011-2014, 37 measurements in total were conducted in seven different wadis. These study areas were situated from northeast to southwest on an alluvial fan between the High Atlas in the north and the city of Taroudant in the south. The measurements showed variable results ranging from +30 cm (accumulation) to -37 cm (erosion) per measurement interval ranging from two weeks to one year. While erosion was dominant in some wadis, others showed a tendency towards accumulation. From the measurement data, the phenomenon of \'Scour & Fill\' becomes apparent: sediment from the plains is eroded from the wadi with high water velocities and fills scour rills downstream with decreasing flow speed. Factors most likely controlling wadi dynamics were \"daily maximum precipitation\" for yearly surface changes and \"accumulated wadi length\", \"catchment area\" and \"mean slope per catchment\" for the change in bed elevation since the installation of the scour chain, while \"land use\" showed less correlation in both aspects. Since scour chains represent punctual measurements which do not allow for an interpolation to higher tempo-spatial scales, this study can only show trends inside a wadi. Erosion and accumulation in the cross-section as well as over the length of a wadi can vary greatly, and the presented empirical method seems promising for approaching the quantification of inherent dynamics.

Keywords: Wadi; gully; soil erosion; \'Scour & Fill\'; land degradation; land uses.

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Terraces and Rainwater Harvesting Design Criteria: a Review Focused on Application to Sloping Orchards

[1]V. Marín-Moreno, [2]L. Mateos and [1]E.V. Taguas

[1]*ETSIAM, University of Córdoba, (Spain)*
[2]*Sustainable Agriculture Institute, Córdoba (Spain)*

Terraces are used since immemorial time to cultivate in mountainous areas or land with gentle slope. These structures reduce the steepness and length of the slope, surface runoff and soil erosion, and retain water for crops. In this work, a review has been carried out in order to examine criteria of design and modeling tools which can be applied or adapted to the recent tendencies in agricultural woody crops in Andalusia (Spain), such as superintensive olive (>1500 kg.ha-1), almond and pistachio groves.

By searching though Web of Knowledge and other scientific databases, this work reviews: i) design aspects such as the determination of the horizontal and vertical distance between terraces, the ratio between the catchment basin and the reception basin in rain water harvesting, and adaptations to machinery and management; ii) available models with potential use for analysis and design.

Finally, a study and classification of terraces and rain water harvesting design models will be carried out in order to provide guidelines for the establishment of individual terraces or rain water harvesting structures in groves under physical and management constraint.

ACKNOWLEDGEMENT

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Keywords: Terraces, Rainwater Harvesting, superintensive olive orchards; design; models.

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Finding Soil Quality Indicators by Principal Component Analysis at the Pedon Scale. A Study Case in one Semiarid Catchment of Northeast Iran

[1]Jesús Rodrigo-Comino, [2]Ali Keshavarzi, [3]Ali Bagherzadeh and [4]Eric C. Brevik

[1]*Instituto de Geomorfologia y Suelos, Department of Geography, University of Malaga, 29071, Malaga, Spain.*
[2]*Laboratory of Remote Sensing and GIS, Department of Soil Science, University of Tehran, P.O. Box: 4111, Karaj 31587-77871, Iran*
[3]*Department of Agriculture, Islamic Azad University, Mashhad Branch, Emamyeh Boulevard, P.O. Box: 91735-413, Mashhad, Iran.*
[4]*Department of Natural Sciences, Dickinson State University, Dickinson, ND 58601, USA*

Natural biological and pedological cycles in soils have been highly degraded by human impacts. Land degradation due to soil contamination is one of the most important problems faced in semiarid areas such as in Northeast Iran. There is pedon scale and at different soil depths a lack of information about which soil quality indicator affect soil quality. Therefore, the main objective of this research was to evaluate differences in soil properties (soil texture, saturation point, bulk density, soil organic carbon, pH and electrical conductivity) at different soil depths (0-30 and 30-60 cm) and their statistical correlation with soil quality indicators (CEC, total N, Olsen-P, K, available Na, calcium carbonate, Fe, Mn, Zn and Cu). Forty-eight soil samples were tested by ANOVA, Spearman Rank coefficients and Principal Component Analyses. The statistical analysis was applied for different soil depths in a semiarid catchment of Northeast Iran (Khorasan-e-Razavi Province, Mashhad Plain between latitudes 35° 59? N to 37° 04? N and longitudes 58° 22? E to 60° 07? E) with irrigated farming and well-documented land degradation issues. We conclude that: i) organic carbon and bulk density were different at different depths; ii) the calcium carbonate and sand content influenced organic carbon content and bulk density; iii) organic carbon showed the highest correlations with soil quality indicators; iv) soil texture conditioned cation-exchange capacity; and v) heavy metals such as Mn and Cu were highly correlated with organic carbon due to non-suitable agricultural practices.

Keywords: Land degradation; soil quality indicators; principal component analysis; Northeast Iran; soil depths; soil contamination.

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Experimental Evaluation of the Effect of the Protective Technical Measures Against Rill Erosion

Petr Kavka, David Zumr, Tomáš Laburda and Martin Neumann

Faculty of Civil Engineering, Czech Technical University in Prague, Prague, Czech Republic

The embankments along the roads, railroads, watercourses and other linear structures are very often not protected against the soil erosion during the construction works and also operation phase. In the conditions of the Central Europe the earthworks stage usually overlaps with the period of sudden heavy rainstorms with very high erosivity factors. This causes mobilization of large amounts of soil from the construction sites to the surrounding environment. The sediment, often enriched with bounded pollutants, causes siltation and pollution of the nearby watercourses and reservoirs.

We present an ongoing research project that investigates the quick and easy technical measures that have a potential to protect the slopes against the splash erosion, rills development and the topsoil sliding. The specific goal is the experimental testing of various mechanical and technical surface protection measures and evaluation if it's effectivity.

In the first stage of the research we test covering of the slopes with different permeable materials. The experiments are done on the 6 m long inclined plots with different inclination. The plots, encapsulated in large steel containers, are equipped with a nozzle rainfall simulator, with sediment and runoff collection system and with soil water regime and temperature regime monitoring. We compare the runoff, soil loss and surface topography changes (sliding, soil compaction and rills development) on the protected and untreated plots. The research is funded by the Technological Agency of the Czech Republic (research project TH02030428) and an internal student CTU grant.

Keywords: soil erosion, rill erosion, geotextiles, rainfall simulator, photogrammetry

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Measuring Splash Erosion Initiated by Simulated Rainfall

[1]Martin Neumann, [1]David Zumr, [1]Tomáš Laburda, [1]Jan Devátý, [1]Petr Kavka, [1]Josef Krása, [2] Tomáš Dostál and Andreas Klik

[1]*Faculty of Civil Engineering, Czech Technical University in Prague, Prague, Czech Republic*
[2]*BOKU, University of Natural Resources and Life Sciences, Vienna, Austria*

Rainfall simulators are common tool used to study the impact of rainfall on soil surface. This study presents the effect of various rainfall intensities and kinetic energies to splash erosion under controlled experimental conditions. We utilized “Norton ladder” laboratory rainfall simulator to recurrently simulate several rainfall patterns with predefined kinetic energy and rainfall intensity. First, twelve positions under the simulator were fixed and the rainfall kinetic energy and intensity were measured for those positions. Range of the kinetic energy was 112 through 574 J m-2 h-1 and range of the rainfall intensity 23 through 71 mm h-1. Second, a soil sample contained in round plastic cup with a surface area of 88 cm2 was positioned in the centre of the splash cup with outer diameter of 45 cm. The splash cups were placed on the preselected positions. After every rainfall simulation, the splashed material was collected, filtered and dried in an air dryer to estimate total amount of soil loss. For each of the samples a photographs of the surface were taken before and after the experiments to create digital model of the surface and to calculate changes in roughness and rate of soil compaction. More repetitions were measured for a proper statistical evaluation. We present first results of the observed relationships between rainfall intensity, kinetic energy and splash erosion. This project was funded by projects SGS17/173/OHK1/3T/11 and GA17-33751L.

Keywords: Rainfall simulator, splash erosion, rainfall kinetic energy, drop size distribution

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Straw Hidric Properties and Use as Mulch to Control Soil and Water Losses. A Large Rainfall Simulation Approach

[1]Cerdà, A. and [2]Keesstra, S.D.

[1]*Soil Erosion and Degradation Research Group. Department of Geography, Valencia University, Blasco Ibàñez, 28, 46010 Valencia, Spain.*
[2]*Wageningen University, Droevendaalsesteeg 4, 6708PB, Wageningen, The Netherlands.*

Land degradation as a consequence of soil erosion is found mainly in agriculture land due to the lack of vegetation cover, soil compaction and lost of organic matter (Cook et al., 2009; Zhang et al., 2013: Rodrig-Comino and Cerdà, 2018; Rodrigo-Comino et al., 2018a; 2018b). Soil erosion control by means of mulches has been seeing very successful by many researchers (Brown, 1985; Brown and Kemper, 1987; Döring et al., 2005; Bhatt and Khera, 2006). Straw is applied to control soil erosion, but little is known about the dose necessary to reduce the soil and water losses. A 15 m2 rainfall simulator was used to produce thunderstorms of 45 mm h-1 during 30 minutes to determine the effect of different straw mulch cover on soil erosion and runoff discharge. Measurements of the water storage capacity and water interception under ponded conditions and rainfall were done. The rainfall simulation experiments where done after the saturation of the Clay loam 10 cm depth soil to isolate the effect of the straw mulch on runoff generation. Before each experiment the straw cover was measured. The results show that the water interception is in average 3 times the weight of the straw and that increase when the amount of straw increase. Under simulated rainfall the interception capacity after 30 minutes is 4 times the straw weight. The water retention capacity was 6 times the the runoff discharge was very high and that the straw mulch influence was very low due to the saturation of the soil. Average runoff discharge range from 89 % in bare soil till 84 % in 100 % covered soil. Soil losses ranged from the soil erosion was highly determined by the straw mulch cover.

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Keywords: straw, soil erosion, rainfall simulators, runoff, sediment yield, Wageningen.

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Testing Different Infiltration Devices in Vineyards

Javier León and ArtemI Cerdà

Soil Erosion and Degradation Research Group. Department of Geography, Valencia University, Blasco Ibàñez, 28, 46010 Valencia, Spain.

The state of the Art of land degradation research was rounded up for the USA with studies of infiltration rates in agricultural fields around 1940 (Horton, 1940; Holtan, 1961) and his application in Spain goes aroun 1990 (Cerdà, 1996). The variation of saturated hydraulic conductivity and infiltration rates associated with vegetation cover, land use changes were examined in previous research and linked to the influence of alterations in the physical properties of the soil, and its can be affected by the spatial and temporal variability of hydraulic properties. But this devices are so difficult to apply in some crops as the vineyards.
At this experiment we can show the comparison with different infiltration devices: double ring infiltrometer and mini disc infiltrometer by DECAGON, and two diferent pipe infiltrometers (height 5 and 10 cm and radius 2.5 and 5 cm respectively) the infiltration rates and the hydrophobicity. The main objective of this experiment is measured the differences in the hydrualic conductivity in two techinques of conservation and maintenance of the fields (disturb and remove the stones and grass and don\'t disturb) for a better irrigation and soil conservation.
The results shown a significant increase in the infiltration rate in the samples with disturbed jobs on the soil than the undisturbed, in all devices. We didn\'t show hydrophobicity processes in this sandy soils, in the first centimeters.
In conclusion the alteration in the rails of the vineyards with soil remotion and elimination of the grass affects to the infiltration rates increasing this parameter.

We acknowledge the project RECARE to offer the oporunity to develope this applications in agricultural lands in the Canyoles river basin.

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Keywords: Canyoles river (Spain), Double ring infiltrometer, hydrophobicity, infiltration rate, irrigation, RECARE project, vineyards.

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Testing Infiltration Measurements Under Different Devices

Javier León and Artemi Cerdà

oil Erosion and Degradation Research Group. Department of Geography, Valencia University, Blasco Ibàñez, 28, 46010 Valencia, Spain

The state of the Art of land degradation research was rounded up for the USA with studies of infiltration rates in agricultural fields around 1940 (Horton, 1940; Holtan, 1961) and his application in Spain goes around 1990 (Cerdà, 1996). The variation of saturated hydraulic conductivity and infiltration rates associated with vegetation cover, land use changes were examined in previous research and linked to the influence of alterations in the physical properties of the soil, and its can be affected by the spatial and temporal variability of hydraulic properties.
At this experiment we can show the comparison with different systems to performance faster system to collect date around the concept of the infiltration rate. We compared three systems, both commercial devices by DECAGON (double ring infiltrometer and mini disc infiltrometer-MDI-), with a two different pipe infiltrometers (height 5 and 10 cm and radius 2.5 and 5 cm respectively). The secondary objective is correlated with the spacial variability. We want performance other device to take measures more faster and cheapest and don´t disturbed a lot the surface the collection data. A third objective is to show operators simple systems for taking and controlling the rate infiltration in order to better use of the irrigation.
The results shown a good correlation using the double ring infiltrometer with the pipe infiltrometers (2.5 and 5 cm) while the MDI shown the less values in the infiltration rates.
In conclusion the pipe infiltrometers (2.5 and 5 cm) shown a good application to measure the infiltration rate and its was a very fast device to take more samples.

We acknowledge the project RECARE to offer the opportunity to develop this applications in agricultural lands in the Canyoles river basin.

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Keywords: Canyoles river (Spain), Double ring infiltrometer, Infiltrometer, infiltration rate, mini disk infiltrometer, pipe infiltrometer, RECARE project.

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Microbial biomass carbon of soils in sugarcane cultivation systems

Jadson Belém de Moura, Maurício Oliveira Barros, Rodrigo Fernandes de Souza, Maurício Oliveira Barros, Jean César de Oliveira and Amanda Cristina de Araújo

Evangelical Faculty of Goianésia, Brasil Avenue nº 2020, Covoá, Goianésia, GO, Brazil.

The objective of this work was to verify the microbial biomass carbon present in the soils managed with different cropping systems in Goianésia, Goiás, Brazil. The conventional and organic systems was evaluated, with the application of vinasse in three cutting ages (2nd, 4th and 6th cuts). The samples were taken to the laboratory where the carbon contents of the Microbial Biomass were evaluated by the irradiation-extraction method proposed by Islam & Weil (1998).
In general, it was observed that the organic system in the depths (0-10 and 10-20) presented better performance in the carbon contents of the microbial biomass in relation to the conventional system. This can be explained by the non-use of phytosanitary products and the accumulation of organic matter that promotes a good condition for the development of the soil microbiota. The use of vinasse showed a better effect on the microbial biomass regardless of the depths evaluated (0-10 and 10-20) in relation to the culture system without the use of vinasse. The result can be explained by the greater flow of waste and organic matter. The difference in carbon content at the different ages of depth cuts (0-10) was not verified. This fact can be explained with some papers that relate that a change in organic matter requires a medium and a long term. In the depth (10-20), the 6th cut differentiated from the other cuts presenting lower microbial biomass.

Keywords: organic carbon, stilage, availability.

LD3: Modelling erosion by water

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Revision of currently used of values of Cover and Management factor C (USLE) using experimental methods

[1]Dostál T., [1]Krása, J, [1]Zumr D., [1]Strouhal L., [2]Mistr M, [2]Novotný I. and [3]Brant, V.

[1]*Czech Technical University in Prague, Faculty of Civil Engineering, Department of Irrigation, Drainage and Landscape Engineering, Prague, Czech Republic*
[2]*Research Institute for Water and Soil Conservation, Prague, Czech Republic*
[3]*Czech University of Life Sciences Prague, Prague, Czech Republic*

Factor of Crop Cover and Management (C) in USLE represents the protective effect of the vegetation and its management at the field. The values of this factor has been determined in late 60-th by number of recorded erosion events at experimental plots in USA. The database has been enlarged during revision of USLE known as RUSLE in late 80-th of 20th century, mostly using field rainfall simulators again in USA.
However, all these measurements were done in USA, while in Europe, the rainfall simulators have been used by single teams mostly for determination of specific parameters for individual simulation models.
The presentation describes the application of field rainfall simulators, to revise the database of C factor values for recently produced field crops in the region of Central Europe and the most common agrotechniques. The goal is at first to better calibrate USLE as the most common method for soil erosion risk quantification and at second, to justify the demands of soil conservation paragraphs within Common European Agricultural policy (GAEC). Troubles, related to methodology of measurement, concerning of duration, intensity, homogeneity and kinetic energy are discussed within the presentation.
When revised C factor values are known, next question is, how the climate change perspective will affect recent soil erosion risk. Changing climate can be described within USLE by changed R and C factor. The determination of C factor changes due to climate fluctuation will also be described and presented.
The paper was prepared within the projects NAZV QJ1530181 and NAZV QJ1230056.

Keywords: Soil erosion, USLE, C factor, rainfall simulator, mathematical modeling

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Pinpointing areas of increased surface erosion following land cover changes using RUSLE modelling and sediment fingerprinting: a case study of the Lake Manyara basin, Tanzania

Maarten Wynants and William Blake

School of geography, earth and environmental sciences, Plymouth University.

Lack of long-term scientific land cover and sediment flux data impedes the development of sustainable land management plans to tackle the increasing land degradation and soil erosion problems in East-Africa. Using Landsat imagery this study managed to reconstruct almost three decades of land cover change (1988-2016) in the Lake Manyara catchment, Tanzania. The main observed trend was the conversion of natural or semi-natural land cover towards agricultural cover with 'permanent savanna', 'bushland' and 'seasonal grassland' as the biggest declining cover types. Subsequently, the effect of these land cover changes on the surface water erosion risk was modelled using the RUSLE approach. The results highlighted that a lot of the land conversion happens in high risk areas, seriously increasing the surface erosion risk in these areas. Complementary to the risk change mapping, information about the actual sediment movement was gained by tracing the transported riverine- and deposited lake sediment. By unmixing the fingerprints of the lake mixture and riverine sources, the proportional sediment contributions of the different subcatchments in Lake Manyara were obtained. The sediment contribution from different subcatchments closely matched with those subcatchments where the model predicted big increases in surface erosion risk. This study thus highlights the potential for combining risk change mapping and sediment fingerprinting, which is particularly useful for pinpointing exact areas of increased erosion and that way assist management authorities to target these areas for on-site action.

Keywords: Erosion modelling, sediment flux

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The Daily Erosion Project: Potential application in Europe

[1]Richard Cruse, [1]Brian Gelder, [2]Javier Casalí, [2]Miguel Ángel Campo Bescós and [2]Eduardo Luquin Oroz

[1]*Iowa State University*
[2]*Universidad Pública de Navarra*

Soil erosion and water runoff from agricultural fields are substantial global threats to water quality and sustained agricultural productivity. To protect soil and water resources, farmers, conservationists, and policy makers must understand trends and severity of soil degradation across large areas and then develop management systems prioritizing most risk prone areas. To that end a system, the Daily Erosion Project (DEP), was designed and recently implemented to inventory precipitation, runoff, and soil erosion across sections of the Midwestern United States. DEP utilizes the Water Erosion Prediction Project (WEPP) soil erosion model along with radar-derived precipitation data, national soil databases and remote sensing technologies to derive slope and field-level management inputs for WEPP. These remotely sensed parameters, along with detailed meteorological data (precipitation input with temporal resolution of 2 minutes and spatial resolution of 1 km2) drive daily WEPP hillslope soil erosion and water runoff estimates across sections of multiple Midwest states. Results are averaged and reported at the small watershed scale with an average area of approximately 90 km2. Statistical and comparative evaluations of soil erosion simulations indicate that the sampling framework is adequate and the results are rigorously defendable. Interest in this system has resulted in continuous expansion of covered area in the US with new efforts to implement DEP in Northeast China. Opportunities to implement DEP in other regions, including Europe, are dependent on availability of inputs required for this system. These include remotely sensed and geo-referenced rainfall estimates, LiDAR derived land surface configuration, field boundaries and crop rotations within each field, satellite derived soil surface cover, and georeferenced soils information. This presentation will explain basics of the DEP operation, verification of past soil erosion estimates, and potential application of DEP for selected regions of Europe.

Keywords: Soil Erosion, Water Runoff, LiDAR, Soil Degradation, Soil Erosion Modeling, WEPP

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The Pan-European Soil Erosion Risk Assessment, the PESERA model.

[1]Brian J. Irvine, [1]Mike Kirkby, [2]Luuk Fleskens and [3]Hedwig van Delden

[1]*The University of Leeds*
[2]*Wageningen University, The Netherlands*
[3]*Maastricht, the Netherlands*

The initial output from the PESERA project, the Map, was issued with a number of clear caveats. Amongst them was the awareness that the quality of available European climate data was a limiting factor and that erosion estimates from the PESERA model should be supported with local climate data. Although, the Map, was considered the primary product of the PESERA project, the PESERA model has endured and applied through time at hillslope, catchment and national level over many continents.

Since the initial project, the PESERA model has evolved through participation in a number of EU, UK and national projects with a focus on hillslope and catchment issues and applications to coarse scale climate assessments. A recent trend of the model has been towards learning from local field studies in sustainable land management and water harvesting across a series of global sites and considering barriers to upscaling through integration of socio-economic models and land use models. The hydrological water balance at the core of the model has also been used as a basis for estimating the intensity of other identified soil threats, in including wind erosion, loss of soil organic matter and salinization.

This paper considers the impact and focus of PESERA, through time, as a coarse scale model at the European scale and as a hillslope/catchment model through to a number of recent and continuing applications in the UK, Europe and Africa. The integration with socio-economic models (DESMICE) and land use models (Metronamica) in future applications is highlighted, in the context of looking towards the support of policy at the European scale within the RECARE framework.

Keywords: soil, landscapes, PESERA, modelling

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Soil and Water Conservation in a Rainfed Vineyard: Effectiveness Of Common Sainfoin Cover Crop

Manuel López-Vicente, Sara Álvarez and Nahed Ben-Salem

Dept. of Soil and Water, Experimental Station of Aula Dei, EEAD-CSIC. Avda. Montañana 1005, 50059, Zaragoza, Spain.

Cover crops (CC) in vineyards and other woody crops (olive, almond and other fruit trees) provide an environmental-friendly alternative to conventional tillage (CT) for land management. Indeed, CC reduce soil, nutrients and organic matter losses and pesticide delivery in comparison with CT and no-tillage systems. Water infiltration improves in the inter-row area with CC compared to CT, and thus runoff coefficients decrease, though these changes depend on soil permeability and structure (macro, meso, and micropores and the root system). In spite of these advantages, CT and bare soil after using herbicides still represent the most common techniques of soil management in the woody crops within the Mediterranean Basin.

In this study, we evaluate the effectiveness of a plantation of common sainfoin (Onobrychis viciifolia) in the inter-row areas of a rainfed vineyard as CC by means of (i) measuring the topsoil water content in the different vineyard compartments and in the surrounding land uses; and (ii) quantifying the runoff and sediment yields in two ephemeral gullies within the vineyard and using open sediment traps (ST). The commercial vineyard (Bodegas Fábregas, Certificate of Origin Somontano) is cultivated with the variety Grenache (Vitis vinifera L. cv. Grenache) and is located near Barbastro town (NE Spain). Soils are Luvic Calcisols, and climate is continental Mediterranean (annual rainfall of 420 mm / year; mean temperature of 14.1 °C, and ET0 of 1225 mm / year). The two ST have different upslope contributing areas (A: 3,286 and 6,214 m2), mean slope gradients (S: 17.0% and 9.2%), and areas with bare soil and very low surface cover (BS: 18.4% and 10.6%). The highest rates of runoff and sediment yield were recorded in September and October when the peaks of maximum rainfall intensity (I30max) were observed, and the percentage of surface cover by the CC was low.

Keywords: Vineyard; cover crop; soil erosion; runoff yield; soil water content; soil conservation.

LD5: Restoration and rehabilitation of degraded lands in arid and semi-arid ecosystems

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Water repellency and heavy metal mobility and speciation in coal ash reclaimed hydrophobic technogenic soils (Technosols)

[1]Irena D. Atanassova, [1]Maya G. Benkova, [1]Tsetska R. Simeonova, [1]Lyuba G. Nenova, [2]Nikolaya S.Velitchkova and [3]Stefan H. Doerr

[1]*Institute of Soil Science, Agrotechnologies and Plant Protection, 7 Shosse Bankya Str. 1331 Sofia, Bulgaria*
[2]*Geological Institute, 24 Acad. G. Bonchev Str., 1113 Sofia, Bulgaria*
[3]*College of Science, Department of Geography, Swansea University, Singleton Park, Swansea, SA2 8PP, UK*

Soil hydrophobicity is an important mechanism for sequestration of organic carbon, however it can induce preferential flow and affect contaminant mobilization and transport. Heavy metal mobility and speciation in solutions from acidic (pH 3-4) coal ash reclaimed hydrophobic technogenic soils from a major coal mine region in Eastern Europe were studied with the aim to reveal relationships with soil hydrophobicity and other soil characteristics. Non-vegetated and pine-afforested spoils-turned soils were studied. The “water drop penetration time” (WDPT) varied from 14-14440s. Mobility and solubility of metals (1M NH4NO3, 0.01 MCaCI2) were closely related with the cation exchange capacity (CEC) and WDPT. Lead mobility and solubility was less satisfactorily predicted from measured soil characteristics. Principal Component (PCA) and cluster analysis involving exchangeable and soluble forms of Co, Cu, Fe, Mn, Ni, Zn and Pb and other soil properties and characteristics (CEC, organic carbon (OC) content, % clay, % sand and WDPT) revealed that soil hydrophobicity and soluble and exchangeable forms of most heavy metals had a similar source. Especially strong was the link between WDPT, OC and soluble and exchangeable Fe. Iron solubility (water) was also significantly correlated with WDPT. All heavy metals (1M NH4NO3, 0.01 MCaCI2) except Pb were positively related with % sand content due to accumulation of coal and ash particulate organic matter in the sand fraction. Ion activity and species distribution based on water solution chemistry data were calculated using Visual Minteq. The majority of heavy metal species in the extremely acidic (pH~3) Technosols were represented by free ions (M2+) and sulfate complexes (MSO40). Results obtained in this study suggest that lignitic coal and ash particles are the main source of soluble and mobile metals. The high share of free and neutral dissolved species has further implications on heavy metal mobility and transport in the reclaimed hydrophobic Technosols.

Keywords: heavy metals, mobility, speciation, soil hydrophobicity, principal component analysis

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Local and global implications of ecosystem restoration in degraded arid farmland

[1]Stefan Leu, [2]Amir Mor-Mussery and [3]Michael Ben Eli

[1]*Ben Gurion University of the Negev, Israel and Leu-Sella Environmental Development, Ben Gurion College, Israel*
[2]*Ben Gurion University of the Negev, Israel*
[3]*The Sustainability Laboratory, New York*

Stopping and reversing desertification and land degradation can contribute significantly to global food security and sustainable development while mitigating global warming. We have tested rehabilitation technologies aiming at maximizing environmental and economic benefits in four research plots along the arid-semi-arid interface (200 mm mean annual precipitation). The resulting insights were applied in 2012 to 15 hectares of heavily degraded farmland at Project Wadi Attir, an initiative to establish a model sustainable agricultural operation in the Northern Negev, Israel. The technologies applied included strict protection from grazing, erosion control by terracing and soil conservation and planting of about 3000 native and agroforestry trees (over 30 species), carefully selected for requested ecosystem services (http://www.sustainabilitylabs.org/ecosystem-restoration/). All aspects of ecosystem rehabilitation including soil quality, biodiversity, biological productivity and carbon balance were monitored during five years. Soil organic matter increased by about 1 % compared to untreated control plots. Key nutrient pools (NPK) showed gradual but significant increases in the conserved plots compared to the degraded control plots. Better water conservation by terraces, higher water infiltration and lower evaporation due to shade and litter accumulation lead to significantly increased soil moisture in the conserved plots. All three factors together contributed to 3-5 fold higher rain-fed herbaceous biomass productivity in the restored areas compared to nearby control plots. Among the tree species planted, some showed annual rain-fed timber production of over 10 kg per year and tree, adding to carbon sequestration and economic viability. Biodiversity recovery was facilitated by the protection of biodiversity hotspots resulting in rapid five-fold increase in the numbers of plant species and bird species. On a global scale such approaches would contribute to mitigation of global warming, climate resilience and protection of biodiversity in degraded agro-ecosystems, combat desertification and provide food, fodder and income to the inhabitants of marginal dryland areas worldwide.

Keywords: Arid degraded farmland, soil conservation, biodiversity, carbon sequestration, biological productivity, desertification control

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Catchment hydrology and soil degradation following farmland abandonment A comparison between different land management scenarios

[1]Miriam Lana-Renault, [2]M. López-Vicente, [1]E. Nadal-Romero, [1]R. Ojanguren, [3]A. Llorente, [3]P. Errea, [1]D. Regüés, [3]P.Ruiz-Flaño, [1]M. Khorchani, [1]J.Arnaez and N. Pascual

[1]*Área de Geografía Física, Departamento de Ciencias Humanas, Universidad de La Rioja, Edificio Luis Vives, 26004 Logroño, Spain*
[2]*Departamento de Suelo y Agua, Estación Experimental de Aula Dei, EEAD-CSIC. Avda. Montañana 1005, 50059 Zaragoza, Spain*
[3]*Instituto Pirenaico de Ecología, CSIC, Campus de Aula Dei, Apdo. Correos 13034, 50080 Zaragoza, Spain*

Farmland abandonment has been one of the major changes in many Mediterranean mountainous areas throughout the 20th century. Abandoned areas are often considered of marginal interest from an economic perspective; however, they are essential from an environmental and societal point of view as they provide important ecosystem services, such as water supply, soil and biomass, carbon storage, or recreational services. Large areas of former agricultural land have undergone natural revegetation. In other cases, extensive afforestation programs have been conducted to reduce land degradation following farmland abandonment. On terraced landscapes, the lack of maintenance may cause failures in the terrace risers, resulting in new sediment sources on the hillslopes. The heterogeneity of landscapes present in mountainous regions of the Mediterranean increases the uncertainty in forecasting changes in water resources and soil conservation after farmland abandonment: is the hydrology of these revegetated areas comparable to that of a natural forest? What are the off-site effects of the increasing soil degradation in abandoned terraced landscapes?
This study presents several key hydrogeomorphological results obtained from research undertaken in three small headwater catchments in northern Spain, representing different farmland abandonment scenarios (natural revegetation, afforestation and terraced fields), and one small catchment, representing an undisturbed forested environment. The hydrological responses of these catchments differed significantly, showing the influence of not only vegetation cover but of the properties of soil remaining after previous agricultural activities. Land abandonment resulted in a general reduction in computed hydrological connectivity at the catchment scale, except in localized areas close to the main channel, new forest roads, and upstream of terrace wall collapses, all areas of increased hydrological connectivity.
Land and water management should pay attention to the large heterogeneity of post farmland abandonment scenarios when assessing the hydrological implication of farmland abandonment and establishing restoration measures to mitigate soil erosion.

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Keywords: farmland abandonment; storm-flow; hydrological connectivity; sediment sources; catchment; Mediterranean mountain

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Strengthening community resilience to soil erosion challenges in northern Tanzania: an interdisciplinary approach

[1]William H. Blake, [1]Maarten Wynants, [2]Anna Rabinovich, [1]Claire Kelly, [3]Mona Nasseri, [4]Aloyce Patrick, [1]David Gilvear, [4]Linus Munishi, [4]Kelvin Mtei, [1]Neil Roberts, [1]Geoff Wilson and [4]Patrick Ndakidemi

[1]*School of Geography, Earth and Environmental Sciences, Plymouth University, UK*
[2]*Department of Psychology, University of Exeter, UK*
[3]*Faculty of Ecological Design Thinking, Schumacher College, UK*
[4]*Nelson Mandela African Institute of Science and Technology, Arusha, Tanzania*

Soil erosion and associated land degradation is a widespread 'wicked problem' undermining the resilience of rural communities in the Global South. On and off-site consequences of soil erosion have severe impacts on food and water security as well as curtailing mobility between communities, resources and markets in fragmented landscapes. Co-design of sustainable land management practices and implementation of appropriate community-focussed legislation can enable rural communities to recover from these environmental impacts; rebuild resilience through restoration/enhancement of degraded landscapes;) withstand the shocks from future extreme events and develop longer-term plans for sustainable livelihoods which can bring wider socio-economic benefits.

'Jali Ardhi' (meaning 'Care for the Land' in Swahili) is the short name for the interdisciplinary project "Socio-ecological resilience to soil erosion driven by extreme events: past, present and future challenges in East Africa". This innovative and interdisciplinary programme draws on in-depth natural and social science evidence of soil erosion causes, processes and impacts, paying particular attention to feedback mechanisms between communities and their landscapes. The natural science evidence demonstrates increased landscape vulnerability to soil erosion through loss of vegetation cover following drought, increased grazing pressure and forest clearance. Damage to the soil surface leads to extensive sheet wash erosion, which initiates rill and gully formation. As flow lines develop, the network becomes ever more connected leading to rapid transfer of topsoil to downstream ecosystems through incised drainage networks where siltation threatens a wide range of aquatic ecosystem services. The social science evidence from interviews and stakeholder workshops underpins the environmental science base by underlining the co-development of human and landscape responses to erosion. From this participatory approach emerge pathways towards credible co-designed interventions which can contribute to strengthening community resilience and produce tangible outcomes in the short-term for end-user communities.

Keywords: Community resilience, Soil erosion, Interdisciplinary, Participatory design,

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Sustainable land management

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Evaluating past reforestations success in semi-arid Mediterranean areas now and under a climate change scenario

Alice Nunes, Melanie Köbel, Adriana Príncipe, André Vizinho, Helena Serrano, Cristina Soares, Pedro Pinho and Cristina Branquinho

Centre for Ecology, Evolution and Environmental Changes (cE3c), Faculdade de Ciências, Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal

Reforestations are a means to combat desertification and land degradation in drylands, increasing ecosystem services delivery. Forests contribute to carbon sequestration, soil formation, and water infiltration. They can be critical to climate change mitigation, e.g. through climatic regulation and attenuation of extreme events such as torrential rains. In the southeast of Portugal, many reforestations have been made over the past decades to promote soil quality, productivity and biodiversity. However, their outcome regarding ecosystem functioning and services delivery has been seldom evaluated, except for tree density. As climate change models predict an increase in aridity in these areas, it is vital to understand which reforestation practices lead to best results not only at present but also under a climate change scenario.

To assess this, we evaluated 44 pure and mixed reforestations with ca. 20 years old, of holm-oak, cork-oak and umbrella pine, located along an aridity gradient in southern Portugal. We evaluated tree productivity and natural regeneration, the diversity and cover/biomass of the understory vegetation, and soil organic matter, to test for differences between reforestation practices and climate. Oak trees grew less when in the presence of pines than in pure stands, and their natural regeneration showed no relation with reforestation type, but decreased with increasing aridity. This contradicts the alleged facilitative effect of pines on oak tree establishment and growth. The understory of pine-dominated reforestations was composed mainly of shrubs, while those dominated by oaks showed a higher biomass of the herbaceous layer. Soil organic matter showed no difference between reforestation types. Different reforestation practices promoted distinct ecosystem services, differing in their potential resilience to climate change, so they should be selected according to specific goals, considering also the climatic context. We suggest promoting a higher heterogeneity and diversification of activities in reforestations as an adaption to climate change.

Keywords: Cork-oak, ecosystem functioning, ecosystem services, Holm-oak, restoration success, umbrella-pine.

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Restoring dryland vegetation patches: the role of diversity and patch size

[1]Sonia Vega, [1]Andrés S. Cases, [2]Valeriia Nazarova, [3]Carme Bladé, [2]Diana Turrión, [2]Manuel Ruiz and [2]Susana Bautista

[1]*Department of Ecology, University of Alicante, Spain*
[2]*Department of Ecology, University of Alicante*
[3]*Department of Evolutionary Biology, Ecology and Environmental Sciences, University of Barcelona*

Dryland restoration could benefit from approaches that take into account the patchy structure of dryland vegetation and how the biotic structure and interactions of vegetation patches modulate the restoration potential of dryland ecosystems. This work aimed to investigate the effects of increasing patch size and/or diversity on plant performance and interactions, and thus to help identify biotic and spatial patch structures that can contribute to optimize dryland restoration efforts.

Using a community-scale manipulative experiment, we tested 6 patch treatments that combined different levels of within-patch plant diversity (1, 2, 4 and 8 species) and density (1, 2, 4 and 8 individuals). We applied the treatments by planting 1-year old seedlings of the respective plant species on 12 equal patches on (8 x 5 m) plots established on a bare-soil slope. We used eight replicated plots per treatment. The selected species represent four contrasting functional groups: Stipa tenacissima and Lygeum spartum (perennial grass); Anthyllis cytisoides and Dorycnium pentaphyllum (early-successional leguminous shrubs); Rosmarinus officinalis and Cistus clussi (early-successional non-leguminous shrubs); and Pistacia lentiscus and Phillyrea angustifolia (tall, late-successional shrubs).

Increasing patch size (density of individuals in the plant patches) decreased individual plant growth. However, this decreasing trend faded for the highest patch sizes. For a given plant density, species diversity increased plant growth, which suggests a complementarity effect between functional groups. Our results indicate that increasing plant diversity in plant patches could counterbalance or reduce the negative effect of increasing competition with plant density.

Keywords: Dryland restoration, community-scale experiments, plant diversity, plant functional groups, plant interactions.

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Using the litter in the revival of a degradated soil in seasonally tropical dry forest (SDTF)

[1]Eunice Maia de Andrade, [2]Eveline Viana Salgado and [3]Lindbergue Araujo Crisostomo

[1]*Universidade Federal do Ceará, Campus do Pici, Fortaleza, Ceará, Brazil*
[2]*Universidade de Fortaleza, Fortaleza, Ceará, Brazil*
[3]*EMBRAPA Agroindústria Tropical, Ceará, Brasil*

The seasonally dry tropical forest (SDTF) covers an area of approximately 1,048,700 km2, 54.2% of which are distributed over two large areas in South America. The most extensive area is situated in the northeast of Brazil, where more than 50% is degradated. We believe that litter from a conserved SDTF can be a good approach to regenerate the degradated area, since the natural biodiversity of the SDFT will be maintained. This research deals with the revitalization of a degradated area using different percentages of ground covering with litter, and its influence on the physical, chemical and biological soil attributes. The study was conducted in an SDFT area, located in the county of General Sampaio, Ceará, Brazil, which was degradated by intensive use of land through traditional agricultural practices.

This research was conducted for three consecutive years, 2009, 2010 and 2011. The experiment was organized in random block with split plots, with 6 different coverage treatments (0, 20, 40, 60, 80 and 100%), and 4 replications in each of three soil layers (0-5, 5-10 and 5-20 cm). We investigated some soil attributes and their spatial and temporal shape changes. These attributes were: Microbial Biomass Carbon (MBC), Organic Matter (OM), humidity, macropores and micropores. The highest averages of MBC and soil moisture were found in the treatments with highest percentages of ground covered. In the first year after treatment application, there was an increase in the average values of OM, macroporosity and microporosity. The 60, 80 and 100% coverages did not differ statistically ($p>0.05$). The litter obtained from a preserved SDFT was shown to be suitable means of recovering a degradated area.

Keywords: Recovering soil, tropical semi-arid disturbed area, cover vegetation, semi-arid ecosystems, soil restoration

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Goats eradication as a previous tool needed for biodiversity restoration of Mediterranean islets.

[1]Miquel Capó, [1]Joana Cursach, [1]Elena Baraza, [2]Jordi Bartolomé and [1]Juan Rita

[1]*Research Group on Plant Biology under Mediterranean Conditions. Department of Biology. Universitat de les Illes Balears.*
[2]*Departamento de Ciencia Animal y de los Alimentos. Facultad de Veterinaria. Universidad Autónoma de Barcelona.*

The small islands of the Mediterranean Basin are places with a high biodiversity value because they usually have very high rates of endemicity (Cruz et al. 2009). Although many of them have had intense human pressure in the past, they still maintain their role as a refuge for narrow endemic species (Médail, 2017). Es Vedrà, located in the south-west of Eivissa Island, is an islet of an area of 71 ha and an altitude of 388 m asl. Its vegetation is formed by seven different communities rich in endemic plant species. From a total of 166 species, 12 are endemic, such as the case of Santolina vedranensis, which is exclusive to this islet. The owners of the islet introduced goats at the end of the last century after many years without being used for this purpose. After being the islet declared as part of a Natural Reserve, the eradication of these goats was considered and executed by the environmental authority, not without a strong citizen protest. Nine permanent plots were installed around the islet to determine changes after goat presence. Our results obtained during eradication context show an important recovery of the vegetation. The total vegetal coverage has increased a 25%. Some threatened and endemic species have sprouted and flowered in places where goats depredated them before. This is the case of Diplotaxis ibicensis and Biscutella ebusitana, which are indicators of recovery from direct herbivory effects. On the other hand, nitrification indicators species decreased, as the case of Parietaria judaica. Our conclusion is that despite grazing can be used for cultural and traditional uses, it could be a huge problem for the conservation of micro-insular habitats. In this scenario, the eradication of introduced mammalians is suggested to be a priority in Mediterranean Islets with similar condition to Es Vedrà.

Cruz, F., Carrion, V., Campbell, K. J., Lavoie, C., Donlan, C. J. (2009). Bio-Economics of large scale eradication of feral goats from Santiago Island, Galápagos. Journal of Wildlife Management. 73 (2), 191-200.
Médail, F. (2017). The specific vulnerability of plant biodiversity and vegetation on Mediterranean Islands in the face of global change. Regional Environmental Change. DOI 10.1007/s10113-017-1123-7.

Keywords: Conservation biology, endemisms, islet, goats, eradication, invasive species

NBS1: Nature-based solutions for environmental social and economic challenges

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Nature-based solutions to control soil erosion need farmer's incentives and education to be applied

[1]Cerdà, A., [2]Rodrigo-Comino, J., [3]Giménez-Morera, A., [4]Novara, A., [5]Pulido, M., [6] Kapovi?-Solomun, M. and [7]Keesstra, S.D.

[1]*Soil Erosion and Degradation Research Group. Department of Geography, Valencia University, Blasco Ibàñez, 28, 46010 Valencia, Spain.*
[2]*Department of Physical Geography, Trier University, D-54286 Trier, Germany*
[3]*nstituto de Geomorfología y Suelos, Department of Geography, Málaga University, Campus of Teatinos s/n, 29071 Málaga, Spain.*
[4]*Dipartimento di Scienze Agrarie e Forestali, University of Palermo Italy,*
[5]*GeoEnvironmental Research Group, University of Extremadura, Faculty of Philosophy and Letters, Avda. de la Universidad s/n, 10071 Cáceres, Spain.*
[6]*Faculty of Forestry, University of Banja Luka. Stepe Stepanovica 75A, 78000 Banjaluka*
[7]*Wageningen University, Droevendaalsesteeg 4, 6708PB, Wageningen, The Netherlands.*

There is a need to devise management strategies that control soil and water losses in agriculture land to allow the design of proper policies to achieve sustainability (Cerdà et al., 2017; Keesstra et al., 2018). It is the responsibility of scientists to work with other actors to co-construct strategies that will lead to sustainable land-use policies (Novara et al., 2018; Rodrigo-Comino et al., 2018a). Using chipped pruned branches, straw, geotextiles, rock fragments and litter as mulch can be a viable option because they represent local (in situ) organic material that can restore soil nutrients and organic matter (Walmsley and Cerdà, 2017; Fernández-Raga et al., 2017; Rodrigo et al., 2018b). This research assesses: i) the perception of farmers towards different types nature-based management strategies; ii) their efficiency to control the soil and water losses; iii) their cost; and, iv) a discussion about how to favour the use of CPB thought successful policies, throughout education and incentives.

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Keywords: land degradation, soil erosion, nature-based solutions, farmers, agriculture land.

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Modelling and upscaling sustainable land management and water harvesting practices in arid and semi-arid environments

[1]Brian Irvine, [1]Mike Kirkby and [2]Luuk Fleskens

[1]*University of Leeds, UK*
[2]*Wageningen University, The Netherlands*

Management practices or technologies identified and trialled in both the DESIRE and WAHARA projects aimed to increase soil quality and water availability in arid and semi-arid environments tackling future land degradation. Although the main focus of the projects highlighted the selection and monitoring of indigenous and adopted technologies across a number of study sites, the PESERA-DESMICE modelling approach supported the upscaling and transferability of selected practices.

Each study site identified a number of technologies and had the autonomy, along with local stakeholders, to consider which current and innovative practices to adopt and monitor in the project. Across the study sites both field based and catchment based technologies were adopted.

The field trials demonstrated the potential of the technologies but also demonstrated the spatial and temporal variability. The PESERA model was adapted based on field observations. Through a series of daily rainfall realisations derived from long-term rainfall statistics the PESERA structure enables the impact of rainfall variability and yield probability to be assessed enhancing the understanding of transferability and associated risk.

The model output reflects improved soil conditions whilst reducing runoff and erosion. The paper will highlight the model adaptations and the potential pathways to impact and upscaling for the technologies and the PESERA-DESMICE approach. The Capo Verde study highlights the potential of the PESERA-DESMICE approach combining biophysical and social economic benefits of the conservation technologies against a local baseline condition.

Keywords: PESERA, Erosion Modelling, sustainable management

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Plant cover management can fully protect soil from erosion in avocado orchards

[1]Mayra E. Gavito, [1]Jean Arnaud García Brulé, [1]Yair Merlin-Uribe, [1]Laura Villamil-Echeverri, [2] Marta Astier, [1]Eloy Pat López and [1]Juan Tenopala Carmona

[1]*Instituto de Investigaciones en Ecosistemas and 2Centro de Investigaciones en Geografía*
[2]*Ambiental, Universidad Nacional Autónoma de México-campus Morelia, Mexico.*

Avocado production is increasing all over the world. Mexico contributes to nearly 40% of the world´s production and has over 250,000 ha of avocado plantations, usually established on slopes. Avocado tree cover is assumed to protect the soil and herbs are usually controlled as undesirable competitors for soil nutrients. We conducted a study to measure soil erosion in areas testing different tree and herb cover management within avocado plantations to find the best treatment to prevent erosion. We placed soil traps and wooden poles in 8 x 10 m plots located in six mature orchards (>11 years under avocado cultivation), with close canopy, and three forest sites, in the Tarasca Highland in Michoacán, Mexico. There were three treatments within each orchard: Normal management without tree pruning and herb trimming, Tree Pruning and Herb Trimming, and Tree pruning and no herb trimming. We measured soil mass loss during two rainy seasons and compared it against estimated soil loss using the Universal Soil Loss Equation (USLE). We measured also surface level changes, the extent of aerial vs. directly rooted plant cover and the proportion of non-graminoid and graminoid herb cover. There were significant differences in the extent of herb and canopy cover between treatments mainly due to the darkness generated by large canopies. Soil erosion was low in general but tree pruning reduced soil erosion to almost zero via an increase in herb cover. Erosion was minimal in both treatments with high herb cover of any kind. Herb trimming or graminoid vs. non-graminoid cover had no additional effect on soil erosion. USLE highly overestimated soil erosion mainly because of the lack of appropriate plant cover factors. Plant cover management in the orchards seems crucial to reduce soil erosion Herb cover reduced soil loss to levels as low as those measured in forests.

Keywords: herb, soil loss, plantation, USLE

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ECOMED Project, Ecoengineering and Soil and water Bioengineering in the Mediterranean area

[1]Guillermo Tardío, [2]Paola Sangalli and [3]Albert Sorolla

[1]*Asociación Española de Ingeniería del Paisaje UPM Madrid-Spain*
[2]*Asociación Española de Ingeniería del Paisaje Sangalli Coronel y Asociados S.L .Spain*
[3]*Asociación Española de Ingeniería del Paisaje.Naturalea .Spain*

The ECOMED project aims at supporting and promoting the specialization level of the bioengineering sector in the Mediterranean ecoregion. The Mediterranean particularities are related to the aridity of the climate and the selection of both plant material and planting techniques.
The ECOMED project is co-funded by the Erasmus+ project of the European Union and the project consortium includes academic entities and enterprises from 8 different countries (Italy, France, FYROM, Greece, Portugal, Spain, Turkey and United Kingdom). The use of the accumulated experience within the sector is a featured element into the sector specialisation process strategy. This strategy can be articulated from different perspectives:
- By analysing the sector current needs, strengths, weaknesses and opportunities
- By analysing existing soil and water bioengineering works
- By improving the existing design routines and protocols
- By reinforcing the sector by a know-how transfer strategy (generation of new interactional schemes and dynamics within the sector)
- By generating an improved syllabus and sector specific training modules
- By generating a plant database adapted to the bioengineering Mediterranean sector and needs.
The knowledge triangle is well represented within the preceding scheme and all the developed tools have a clear long term nature and development. Hence, the Ecomed project will be the basis for a long term continuous improvement dynamic that will allow the Mediterranean ecoengineering sector to achieve a higher specialization level.
After one year of work, some results and outcomes have already been generated. Results from the bioengineering works analyses and proposals for the overall improvement of the sector will be presented in the conference.

Keywords: Ecoengineering, Soil and Water Bioengineering, Natural based solutions, Land restoration ,

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City deal on valuing green and water in cities: integration of the multiple benefits of nature-based solutions in urban planning

Sandra Boekhold and Roy Remme

RIVM National Institute for Public Health and Environment, the Netherlands

In the context of the urban agenda to strengthen growth, innovation and livability of cities and supported by the national government, seven Dutch cities agreed upon collaboration with knowledge institutions, consultancies, a gardeners association and citizen groups. In 2016, they signed an agreement to dedicate themselves to accelerating the further development and use of the so-called TEEB-city tool (www.teebstad.nl). This tool enables integration of health and well-being, climate change adaptation, water management, biodiversity and other potential benefits of nature based solutions into the urban planning process. Planners, city authorities, developers, companies and citizen groups have free access to this tool which enables them to calculate and understand the value of green and blue infrastructures in their neigbourhoods.
An ambitious Community of Practice (CoP) has developed around this tool. By using the experience of the participating cities and the growing evidence on the impact of nature based solutions, they want to further develop the TEEB-city tool.
Stakeholder participation and co-creation of urban plans will increase the sustainability and effectiveness of nature-based interventions. In the context of the Dutch Atlas of Natural Capital, the TEEB-city tool is now progressing towards the Green Benefit Planner, a spatially explicit planning tool that facilitates the incorporation of nature-based solutions in urban planning. The tools bridge gaps between stakeholders in urban planning and the scientific state-of-the-art, creating a level playing field to inform all stakeholders on the (societal) value of green and blue infrastructure in cities.
We will illustrate the current performance of the TEEB-city tool as an instrument in participatory urban planning processes. We will present the first results of the Green Benefit Planner for Amsterdam's green infrastructure plan. We will demonstrate how we work on bridging the gap between science, policy and practice in the CoP.

Keywords: Nature-based solutions, co-creation, valuation , benefits and co-benefits, urban planning tool.

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Challenges and Advances in Urban Green Infrastructure and Nature Based Solutions: potentials of soil bioengineering techniques

Rosemarie Stangl and Pia Minixhofer

Institute of Soil Bioengineering and Landscape Construction, University of Natural Resources and Life Sciences, Vienna, Austria

Re-naturing cities and innovating with nature are key to ensure sustainability and resilience of our cities and societies. Soil bioengineering and vegetation technologies pave the way to more resilient cities by applying natural and biodegradable materials to urban environments and settlement infrastructures, while ensuring the conservation of resources, cost-effectiveness, diversity, environmental and protection functions, as well as social and long-term economic benefits.
The Institute of Soil Bioengineering and Landscape Construction aims to evaluate the challenges and to advance novel solutions in urban green infrastructure and nature based solutions in various on-going research projects. Specific fields of urban application can be associated with slope protection of industrial infrastructures, rain water management, urban river basin restoration, restructuring of brown fields and de-sealing of sealed surfaces. In light of climate change mitigation strategies and temperature regulations, a range of technical systems has evolved for advancing roof and façade greening of multi-storey buildings. Once again, the substrate development highly benefits from nature-based materials.
The greatest added value of soil bioengineering and vegetation technologies is to be seen in providing profound basic tools and instruments for advancing nature based solutions to counteract unsustainable urbanization trends, land degradation, risks of flooding and slope failure, loss of natural capital and biodiversity, and related human health restrictions.
However, research in the sector of urban land restoration has only started. The potential of soil bioengineering techniques to introduce very basic nature based solutions to urban environments is great and first assessments suggest benefits in biodiversity protection and habitat restoration resilience increase, and many more, providing most beneficial impacts to our society. We intend to introduce traditional and up-to-date approaches serving to establish diverse and wide ranging urban ecosystem services.

Keywords: soil bioengineering, vegetation technologies, nature based solutions, sustainability, green infrastructure

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Soil management under grapevines for reducing plague impact and soil erosion while enhancing sustainability

[1]Manuel Seeger, [2]Cord Treseler, [3]Sören Thiele-Bruhn and [1]Jesús Rodrigo-Comino

[1]*Physical Geography, Trier University, 54286 Trier, Germany.*
[2]*Weingut Dr. Frey, D54441 Kanzem*
[3]*Soil Science, Trier University, D-54286 Trier*

One of the major challenges on Central European steep sloping vineyards is the weed control underneath the grapevines. Their management affects directly the development of fungal diseases, the soil water availability and the impact on soil sustainability. Conventional wine growers usually apply at certain stages herbicides for weed control, whilst mechanical weed control is applied in low-input farming several times per growing season. Besides the withdrawals of excessive herbicide application or the labour intensive management, both management types share the development of bare soil underneath the grapevines, which then is prone to soil erosion, as slopes are usually steeper than 30 %.

Within the project DIVERFARMING (funded by the EU-Programme H2020), we are testing the planting of suitable herbs beneath the plants, which should help to:

- supress the growth of weeds affecting negatively the grapevines,
- cover the soil to avoid erosion,
- generate suitable products for commercial use.

Therefore, a case study has been implemented recently, in which the different species of local varieties of aromatic plants will be planted (e. g. Thymus vulgaris, Origanum vulgare). We will apply in an ecologically managed vineyard in the Mosel Region (Saar Valley, Germany) the mentioned plants to cover within the next years the ground beneath the grapevines, to study their effectiveness, and to compare it with the labour intensive mechanical weed control. In addition, the effect on biodiversity, on soil and vine quality, as well as the economical impact will be studied.

Keywords: Biodiversity; organic farming; nature based-solutions; vineyards; cover crops; DIVERFARMING.

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The superior effect of nature based solutions in land management for enhancing ecosystem services

[1]Saskia Keesstra, [2]Joao Pedro Nunes, [3]Agata Novara, [4]David Finger, [2]David Avelar, [5]Zahra Kalanthari and [6]Artemi Cerdà

[1]*Wageningen University, Droevendaalsesteeg 4, 6708PB Wageningen, The Netherlands*
[2]*CE3C – Centre for Ecology, Evolution and Environmental Changes, Faculdade de Ciências, Universidade de Lisboa, 1749-016 Lisboa, Portugal*
[3]*Dipartimento dei Sistemi Agro-ambientali, University of Palermo, viale delle scienze -Italy*
[4]*School of Science and Engineering. Reykjavik University, Iceand*
[5]*Stockholm University, Department of Physical Geography and Bolin Centre for Climate Research, SE-106 91 Stockholm, Sweden*
[6]*Soil Erosion and Degradation Research Group, Department of Geography, University of Valencia, Valencia, Spain.*

The Planet has been affected by milennia old abuses by humans. The rehabilitation and restoration of land is a key strategy to recover services -goods and resources- ecosystems offer to the humankind. This paper reviews key examples to understand the superior effect of nature based solutions to enhance the sustainability of catchment systems by promoting desirable soil and landscape functions. The use of concepts such as connectivity and the theory of system thinking framework allowed to review coastal and river management as a guide to evaluate other strategies to achieve sustainability(Smith et al., 2015; Galati et al., 2016). In land management NBSs are not mainstream management. Through a set of case studies: Organic farming in the Mediterranean; rewilding in Slovenia; land restoration in Iceland, sediment trapping in Ethiopia and wetland construction in Sweden we show the potential of Nature based solutions (NBSs) as a cost-effective long term solution for hydrological risks and land degradation (Laughlin, 2014; Nel et al., 2014, Berendse et al., 2015). NBSs can be divided into two main groups: soil solutions and landscape solutions. Soil solutions aim to enhance the soil health and soil functions through which local eco-system services will be maintained or restored. Landscape solutions mainly focus on the concept of connectivity. Making the landscape less connected, facilitating less rainfall to be transformed into runoff and therefore reducing flood risk, droughts and soil erosion problems. The enhanced eco-system services directly feed into the realization of the Sustainable Development Goals.

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Keywords: Nature based solutions, SDGs, ecosystem services, system dynamics

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Poll-Ole-GI SUDOE project: the creation of floral islands to promote pollination in sunflower fields

[1]Evan A.N. Marks, [2]José A. González, [3]José P. Sousa, [4]Silvia Castro, [2]Violeta Hevia, [4]Joana Alves, [4]Antonio Silva, [4]Henrique A. Pereira, [4]Lucie Mota, [4]Nuno Capela and [5]Carlos Rad

[1]*Composting Research Group UBUCOMP, E.P.S. La Milanera, Universidad de Burgos. 09001 Burgos*
[2]*Social-ecological Systems Laboratory, Department of Ecology, Universidad Autónoma de Madrid, Campus de Cantoblanco 28049 Madrid*
[3]*entre for Functional Ecology, Department of Life Sciences, Universidade de Coimbra, Calçada Martim de Freitas, 3000-456 Coimbra*
[4]*Centre for Functional Ecology, Department of Life Sciences, Universidade de Coimbra, Calçada Martim de Freitas, 3000-456 Coimbra*
[5]*Composting Research Group UBUCOMP, E.P.S. La Milanera, Universidad de Burgos. 09001 Burgos,*

The populations of pollinators in southwestern Europe have been reduced over the previous decades, mainly due to the destruction of habitat through agricultural intensification, in addition to vectors associated with pesticides and global change. This process of biodiversity and population loss has an impact on oilseed crops, which are dependent on pollination to some degree. The Poll-Ole-GI project, funded in the 5th INTERREG SUDOE call, aims to design and promote floral islands providing resources and refuge for wild pollinators over the complete growing season, and quantify the direct contribution of pollinators in the provision of this ecosystem service.

In Spain the project includes two pilot zones, in Cuenca and Burgos provinces. In each of these regions 11 floral islands have been established, and additional plots have been established to contrast this “enhanced” green infrastructure with natural landscape features providing floral resources and refuge, as well as zones with a lack of natural landscape features (no green infrastructure). With this design, the project aims to understand the utility of establishing floral islands – a practice which could be properly incentivized through “greening” in the European Common Agricultural Policy or similar. Specifically, over two years pollinator abundance and diversity is monitored as well as entomophilous pollination of the oilseed crop.

Keywords: Green infrastructure, pollination, biodiversity, floral resources, ecosystem services, oilseed crops

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Evaluation of subsurface drip irrigation mats manufactured with recyclable cellulose from meat industry

Alaitz Aldaz, Rafael Giménez and Miguel Angel Campo

Universidad Pública de Navarra, Spain

Agrifood Industries can generate large amount of different types of residues whose correct management arises nowadays as a real challenge. Cellulose used as a cooking mold for sausages in meat industry is a clear example of that. We observed that this cellulose is to some extent similar to the textile used in the manufacture of mats for subsurface drip irrigation.

The objective of this work is to evaluate the possibility to recycle strips of cellulose from sausage factory to make mats for subsurface drip irrigation for gardening (lawn).

Three different mats were made ad hoc by assembling cellulose strips in different patterns and density. Moreover, water absorption and suction of each mat were measured in the lab. Experiments were carried out in microplots cover with lawn, under a greenhouse. Six treatments were defined. Three of them corresponded to subsurface drip irrigation using each of the aforementioned mats. While the remaining 3 were control ones, as follows; conventional subsurface drip irrigation, subsurface drip irrigation using a commercial-like mat (polypropylene), no irrigation. There were 3 replicates for treatments. The development of the vegetation along several months was monitored using a RGB camera and a multispectral one.

Preliminary results show that the performance of subsurface drip irrigation using cellulose mats were not significantly better than that obtained with a conventional subsurface irrigation. It seems that the cellulose mats behavior is mainly dependent on their density rather than their assembling pattern.

Keywords: irrigation, drip, cellulose mats

NBS2: Connectivity in hydrology and sediment dynamics: concepts measuring modelling indices and societal implications

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The interrelation between ecological and eco-hydrological connectivity indexes demonstrates the relevance of different processes and feedbacks across scales and disciplines.

Nadia Ursino

University of Padova, Italy

A minimal model for two coexisting species and the soil moisture balance was formulated to understand of the effects of species differentiation on the dynamics of plants and resources on single pattern and landscape scales. In ecosystems where the field scale structure is the result of local facilitation and adaptation of vegetation species, the new ecological model for the dynamics of two plant species and soil water content was used to investigate whether the hypothesis that ecological connectivity of adaptation niches could upscale to hydrological connectivity of vegetation patterns.

New ecological connectivity indexes are defined, several niche differentiation scenarios are investigated, resulting connectivity indexes of landscape vegetation patterns are evaluated and relevant interrelations between ecological and eco-hydrological connectivity indexes are discussed.

Connectivity and connectivity indexes of different environmental variables, as well as the correlation between indexes defined at different scales seem to be valuable instruments to quantify the state, efficiency and resilience of fragile ecosystems.

Keywords: Connectivity indexes, eco-hydrology, facilitation, differentiation, modelling, ecosystem dynamics.

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SedInConnect: a free tool for a usable sediment connectivity index

Stefano Crema, Lorenzo Marchi and Marco Cavalli

Research Institute for Geo-Hydrological Protection, National Research Council, Padova, Italy

Sediment connectivity characterizes the degree of linkage that controls sediment fluxes, in particular between sediment sources and downstream target areas. The assessment of sediment connectivity turns into a key issue when dealing with risk mitigation and landscape intervention priorities.
Characterizing the prevailing ongoing process at catchment scale is also of great importance in relation to risk assessment, with the aim of optimization of operational and non-structural intervention procedures.
In the present work, the authors present the freely available SedInConnect application, an open-source tool for the assessment of sediment connectivity.
The tool is intended to have a wide variety of users, both from the scientific community and from the actors involved in the environmental planning. Due to its open source nature, the tool can be adapted and/or combined according to the users' requirements. Being also a stand-alone, easy-to-use, application, the tool can help management authorities in the quantitative estimation of sediment connectivity in the framework of hazard and risk assessment. A review of recent and ongoing application of the approach has given encouraging results since the modeled connectivity appears appropriate to detect the potential for the sediment to reach specific areas of interest, thus enabling for a rapid ranking of intervention priorities.
In particular, the index of connectivity has proved to be a valuable indicator of the dominant processes characterizing the basin dynamic. Furthermore, the comparison with other morphometric indexes commonly used to characterize catchment activity confirmed this hypothesis.
The application of the connectivity index has therefore permitted not only to characterize the catchment dominant process, but also to depict the connectivity variability inside each basin. While spatial variability is part of the outcomes of the analysis, temporal variability might represent a key improvement of the analysis and could be included for instance modeling different scenarios, thus devising a precious tool for research and land management purposes.

Reference: Crema S. , Cavalli M., SedInConnect: a stand-alone, free and open source tool for the assessment of sediment connectivity, In Computers & Geosciences, Volume 111, 2018, Pages 39-45, ISSN 0098-3004, https://doi.org/10.1016/j.cageo.2017.10.009.

Keywords: sediment connectivity, hazard/risk assessment, geomorphometry, GIS, open source

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Integrating sediment connectivity into the assessment of landslides susceptibility for road network

[1]Massimiliano Bordoni, [1]Maria Giuseppina Persichillo, [2]Marco Cavalli, [2]Stefano Crema, [1]Claudia Meisina, [3]Carlotta Bartelletti, [3]Yuri Galanti, [4]Michele Barsanti, [3]Roberto Giannecchini and [3] Giacomo D\\\'Amato Avanzi

[1]*Department of Earth and Environmental Sciences, University of Pavia, Pavia, Italy*
[2]*Research Institute for Geo-Hydrological Protection, National Research Council, Padova, Italy*
[3]*Department of Earth Sciences, University of Pisa, Pisa, Italy*
[4]*Department of Civil and Industrial Engineering, University of Pisa, Pisa, Italy*

Landslides provoke significant direct and indirect economic losses to infrastructures, in particular along road networks. Thus, it is fundamental identifying the route sectors that could be affected by landslides, in order to reduce the risk level for the population and the economic cost of road damaging. Moreover, several researches conducted in different contexts stressed that the exposure of road networks to slope instabilities could increase because of ongoing climate change and as a consequence of growing economy in several countries.
For these reasons, the present work aims to develop and test a data-driven model, based on Genetic Algorithm Method (GAM), for the identification of the sectors road network sectors that are susceptible to be affected by landslides triggered upstream the infrastructure. This work quantifies, also, the impact of sediment connectivity on the susceptibility evaluation in the case studies. The study area corresponds to the north-eastern area of Oltrepò Pavese (northern Italy), a zone very prone to shallow landslides causing severe damages to the road networks.
This work shows that the effectiveness of the model in the identification of the most susceptible routes increases including sediment connectivity in the predisposing factors. This parameter, indeed, characterizes runout and the travel distance of a slope instability, improving the ability in identifying the road sectors hit by landslides. The modeled susceptible roads are, then, mapped correctly by the methodology, furnishing an important tool for land use planning and for implementing tools able to reduce the risk for the infrastructures.

Keywords: Roads, Shallow landslides, Sediment connectivity, Susceptibility, Data-driven models and Land use.

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A null model for assessing the independent effects of plant cover and bare-soil connectivity on dryland functioning

[1]Francisco Rodríguez, [2]Angeles G. Mayor and [3]Susana Bautista

[1]*Department of Applied Mathematics, University of Alicante, Spain*
[2]*ISEM, Université de Montpellier, CNRS, IRD, EPHE, Montpellier, France*
[3]*Department of Ecology, University of Alicante, Spain*

Both plant cover and the connectivity of the bare-soil interpatch areas are key pattern attributes that control resource conservation and ecosystem functioning in drylands. These two attributes are closely interlinked. However their relative importance and the respective role played as control factors are hypothesized to vary in response to changing environmental conditions. We aimed to characterize the dependence of bare-soil connectivity on plant cover and provide a null model that differentiates the independent effects of plant pattern and cover on the hydrological and overall functioning of drylands.

Using a bare-soil connectivity index, Flowlength, we developed explicit theoretical expressions for its expected value and variance under a null model of random vegetation cover distribution and constant slope. Bare-soil connectivity exhibits a non-linear inverse dependence on vegetation cover, which explains sharp increases in runoff and sediment yield for low cover values. The expressions for the mean values and standard errors for the random model allow the construction of confidence intervals and testing for deviations from the null random model in experimental data, and thus disentangling vegetation cover and pattern functional roles. We found that positive deviations of Flowlength from the expected values, either under random or aggregated-pattern null models, sharply increase before transitions to a degraded state in a spatially-explicit dryland vegetation model, suggesting that an extraordinary increase in bare-soil connectivity may lead to unavoidable degradation. Our results show that increased deviation from the expected cover-dependent bare-soil connectivity may serve as early warning of dryland degradation.

Keywords: Connectivity, drylands, Flowlength, functional indicators, spatial pattern, vegetation cover

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Reducing peri-urban flood hazard using a holistic catchment approach to reduce hydrological connectivity

[1]Carla S. S. Ferreira, [2]Rory P. D. Walsh, [3]Lenka Slavikova, [4]Paulo Pereira and [1]António A. J. D. Ferreira

[1]*Research Centre for Natural Resources, Environment and Society (CERNAS), College of Agriculture, Polytechnic Institute of Coimbra, Coimbra, Portugal*
[2]*Department of Geography, College of Science, Swansea University, Swansea, UK*
[3]*Institute for Economic and Environmental Policy, Faculty of Social and Economic Studies, University of J. E. Purkyne, Ústí nad Labem, Czech Republic*
[4]*Environmental Management Centre, Mykolas Romeris University, Vilnius, Lithuania*

Continuing rise in urban population is resulting in expansion of urban land into peri-urban areas. Impacts of urbanization in increasing overland flow, streamflow and the magnitude- frequency of floods are well documented. From 2000 to 2012, annual estimated costs of losses due to floods in European Union averaged €4.9 billion, but these costs may increase to €23.5 billion by 2050 due to climate change (Jongman et al., 2014).
Traditional flood protection measures based on grey infrastructures (e.g. dikes and dams) have proven to be not sufficient and effective. Nature-based green solutions, however, have recently been proposed as a promising complement to mitigate flood risk. This paper stresses the relevance of a holistic overview to mitigate flood hazard based on a catchment-based approach, in which hydrological connectivity between mosaics of distinct land-uses should be clearly articulated. This approach is based on the findings of a study developed in Ribeira dos Covões peri-urban catchment, in central Portugal. Hydrological field measurements include temporal variations on soil properties in different land-uses (i.e. soil moisture, hydrophobicity and infiltration), runoff measurements in distinct woodland types (plot scale) and rainfall-runoff responses in sub-catchments with distinct urban patterns and land-uses. This work also presents and incorporates provisional outcomes of the COST Action "Natural Flood Retention on Private Land" (LAND4FLOOD), addressing topics related to (i) potential synergies between different land-uses and the provision of flood storage; (ii) the adaptation of land-uses to increase water retention capacity; and (iii) engagement of public and private stakeholders in urban and rural areas to reduce flood damage through the implementation of retention and resilience measures throughout the catchment.

Reference

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Keywords: Land-use mosaics, floods, nature-based solutions, hydrological connectivity, catchment-based approach, LAND4FLOOD.

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Woody debris jams to prevent stream bed erosion in a semi-natural brook system

[1]Roel Dijksma, [1]Gonzalo Campuzano Izquierdo and [2]Monique Korsten

[1]*Hydrology and Quantitative Water Management group, Wageningen University, the Netherlands*
[2]*Waterboard Limburg, the Netherlands*

The Noor brook, a small headwater at the Dutch-Belgian border, is incising deep into its own sediments. This erosion can reduce the vertical resistance of the cannel bed dramatically, causing more seepage water to flow directly to the stream instead of seepage to the adjacent 'Natura 2000' nature area, called the Noorbeemden. The frequency and size of peak flows has been reduced considerably by the construction of a sewage system retention reservoir upstream. To prevent deeper erosion, dead woody debris jams were installed in the stream bed. To study the impact of the jams on erosion, sedimentation, groundwater and water quality, a series of piezometers and erosion/sedimentation pins were installed. Data were gathered from October 2016 to July 2017. The HEC-RAS model was used to compute vertical channel bed changes in response to dynamic mass balance and bed processes, including lateral bank erosion by using the coupled Bank Stability and Toe Erosion Model (BSTEM).
In the first stage after installing the woody debris jams, they act as a horizontal resistance and as such promote a higher water level in the brook system. This higher water level saturates the steep banks and causes bank erosion. The pins showed that the woody debris jams influence the sediment transport considerably. They promote preferential flow inside the jams, increasing local erosion by a rate of even 5 cm per year. The channel bed sediment transport model provided a rather good approximation to the field measurements, but detailed flow inside the woody debris jams could not be simulated accurately, because of the complex accumulations of coarse and fine woody debris.

Keywords: Stream bed erosion, sediment transport, woody debris, bank erosion, HEC-RAS-model, BSTEM-model

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A framework for using connectivity to measure and model water and sediment fluxes

[1]Saskia Keesstra, [2]Joao Nunes, [3]Patricia Saco, [4]Tony Parsons, [5]Ronald Poeppl, [6]Paulo Pereira, [7] Agata Novara, [8]Jesús Rodrigo Comino and [9]Artemi Cerdà

[1]*Wageningen University, Droevendaalsesteeg 4, 6708PB Wageningen, The Netherlands.*
[2]*University of Lisbon, Portugal*
[3]*Civil, Surveying and Environmental Engineering, The University of Newcastle, Callaghan 2308, Australia.*
[4]*Department of Geography, University of Sheffield, Sheffield S10 2TN, United Kingdom*
[5]*Department of Geography and Regional Research, Universitätsstraße 7, University of Vienna*
[6]*Environment Management Laboratory, Mykolas Romeris University, Ateities g. 20, LT-08303 Vilnius, Lithuania*
[7]*Dipartimento di Scienze Agrarie e Forestali, University of Palermo, ed.4 Viale delle Scienze, 90128 Palermo, Italy.*
[8]*Instituto de Geomorfología y Suelos, University of Málaga, Edificio Ada Byron, Ampliación del Campus de Teatinos, 29071, Málaga, Spain*
[9]*Soil Erosion and Degradation Research Group, Department of Geography, University of Valencia, Valencia, Spain.*

For many years, scientists have tried to understand, describe and quantify water and sediment fluxes at multiple scales (Cerdà et al., 2013; Rodrigo Comino et al., 2016). In the past two decades, a new concept called connectivity has been used by Earth Scientists as a means to describe and quantify the influences on the fluxes of water and sediment on different scales: aggregate, pedon, location on the slope, slope, watershed, and basin (Baartman et al., 2013; Parsons et al., 2015; Masselink 2016a,b; Mekonnen et al., 2016). A better understanding of connectivity can enhance our comprehension of landscape processes and provide a basis for the development of better measurement and modelling approaches, further leading to a better potential for implementing this concept as a management tool. This paper provides a short review of the State-of-the-Art of the connectivity concept, from which we conclude that scientists have been struggling to find a way to quantify connectivity so far. We adapt the knowledge of connectivity to better understand and quantify water and sediment transfers in catchment systems. First, we introduce a new approach to the concept of connectivity to study water and sediment transfers. In this approach water and sediment dynamics are divided in two parts: the system consists of phases and fluxes, each being separately measurable. This approach enables us to: i) better conceptualize our understanding of system dynamics at different timescales, including long timescales; ii)

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identify the main parameters driving system dynamics, and devise monitoring strategies which capture them; and, iii) build models with a holistic approach to simulate system dynamics without excessive complexity. Secondly, we discuss the role of system boundaries in designing measurement schemes and models. Natural systems have boundaries within which sediment connectivity varies between phases; in (semi-) arid regions these boundaries can be far apart in time due to extreme events. External disturbances (eg. climate change, changed land management) can change these boundaries. It is therefore important to consider the system state as a whole, including its boundaries and internal dynamics, when designing and implementing comprehensive monitoring and modelling approaches.

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Keywords: Connectivity, catchment systems, measuring and modelling approaches, co-evolution, management, boundary conditions, fire effects.

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Combining the Improved Stock Unearthing Method and Structure-from-Motion for connectivity assessment and soil erosion in sloping vineyards

[1]Jesús Rodrigo-Comino, [1]Alexander Remke, [2]Artemi Cerdà and [1]Johannes B. Ries

[1]*Physical Geography, Trier University, 54286 Trier, Germany.*
[2]*Soil erosion and Degradation Research Group, Department of Geography. University of Valencia, 46010 Valencia, Spain.*

Soil erosion in vineyards is a well-known environmental problem in Germany, especially on the steep slopes of the Mosel Valley (Rodrigo-Comino et al., 2017; Richter, 1980; Rodrigo-Comino et al., 2017). Unfortunately, soil erosion mitigation measures are either very costly or tedious (Galati et al., 2015; Marques et al., 2015). In order to achieve connectivity assessments and soil erosion measurements in sloping vineyards for long-term periods and with non-invasive methods, the improved stock unearthing method (ISUM) can be used (Rodrigo-Comino and Cerdà, 2018a). Recently, Rodrigo-Comino (2018b) included an improvement for this method by doing three extra measurements in the inter-row-areas, thus monitoring the surface between the vines (Rodrigo-Comino et al., 2018b). However, a shortcoming of both SUM and ISUM remains clear: the area between the cross sections is not scanned at all. Therefore, an exact accuracy for soil erosion estimations has not been reached.

In order to fill this vast data gap, we can recognize Structure-from-Motion-Technique (SfM) as a suitable supplement. In this way, we want to present a combination of ISUM and SfM, which my enable an estimation of soil erosion with higher accuracy. Therefore, applying the erosion-deposition equation described by Paroissien et al., (2010), soil loss rates could be estimated. Thus, the main aim of this research is to combine both methods (ISUM and SfM) to map the actual top soil level and assess the connectivity of the processes and estimate soil erosion rates. This methodological research presents an improved easy, quick and low-cost method to assess connectivity soil erosion rates in vineyards with higher accuracy.

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Keywords: Soil erosion; ISUM; SfM; vineyards; connectivity; pedon scale.

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Sediment connectivity and fan formation processes in glacial and periglacial regions: the Ala Archa Valley in Tian Shan (Kyrgyzstan)

[1]Virginia Ruiz-Villanueva, [2]Andrea Omlin, [3]Stefano Crema, [3]Marco Cavalli, [4]Sergey Aleksandrovich Erokhin, [4]Vitalii Viktorovich Zaginaev and [5]Markus Stoffel

[1]*Institute for Environmental Sciences, University of Geneva, Geneva, Switzerland*
[2]*Institute of Geography, University of Bern, Bern, Switzerland*
[3]*Research Institute for Geo-Hydrological Protection, National Research Council, Padova, Italy*
[4]*Institute of Water Problems and Hydropower, National Academy of Science, Bishkek, Kyrgyzstan*
[5]*Dendrolab.ch, Department of Earth Sciences, University of Geneva, Geneva, Switzerland*

Periglacial areas are shaped by very active geomorphic processes resulting in a highly dynamic landscape. In this context, the hillslope-channel coupling plays a fundamental role in controlling catchment sediment dynamics. The sediment produced on hillslopes may reach the channel network and downstream propagation may have important effects on the environment, and create potential hazards.

This is the case of the Ala Archa river basin (mean elevation 3160 m a.s.l.), located in the Tian Shan Mountains of Kyrgyzstan. Glaciers cover the upper part of the basin and, along the main valley, numerous fans are formed as a result of glacial lake outburst floods, debris flows, and colluvial processes. The Ala Archa river flows through the Kyrgyz capital city of Bishkek in the lower part, and, in the recent past, floods and debris flows triggered in the upper part of the catchment caused important damage to infrastructures and people. Therefore, the aim of this work is to improve the understanding of the hillslope-channel coupling in the Ala Archa basin, to support hazard and risk assessment, and to shed light into sediment connectivity in high mountain glacial and periglacial regions. A field survey was carried out in summer 2015 to analyse sediment sources and deposition sites (rock slopes, debris flow tracks, fans etc.), in addition, remote sensing and connectivity analyses have also been applied to map and characterize the main morphological characteristics of the basin. Connectivity results permitted to enlighten the role of the fans in coupling/decoupling the hillslpoes to main valley. Furthermore, a focus on periglacial areas allowed for a characterization of connectivity patterns and magnitude in such dynamic environments that will feature the most important changes in sediment dynamics and availability in the near future.

This work has been supported by the Swiss National Science Foundation, through the joint SCOPES research project “Debris flow and outburst flood hazard in Tian Shan under impact of changing climate” (DEFENCC; grant no. IZ73Z0_152301).

Keywords: connectivity, proglacial, high mountains, debris flows, alluvial fan, Tian Shan.

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Dynamics of nutrients input output in a reservoir of the tropical semi-arid

[1]Eunice Maia de Andrade, [2]Kássia Crislayne Duarte Ferreira and [2]Fernando Bezerra Lopoes

[1]*Universidade Federal do Ceará, Campus do Pici, Fortaleza, Ceará, Brasil*
[2]*Universidade de Fortaleza, Fortaleza, Ceará, Brasil*

The tropical semi-arid regions are characterized by rivers that are ephemeral or intermittent, where supply of the water is obtained from groundwaters or reservoirs. In the Brazilian semi-arid, the water supply to its multiple uses is stored in reservoirs, since the geological base is crystalline with low storage capacity. The surface waters are easily enriched by nutrients (total nitrogen - TN and total phosphorus - TP) coming from the urban and agricultural-livestock area; therefore the knowledge of the nutrient dynamics in reservoirs is essential. The main objective of this study was to quantify the amount of input and output of TN and TP in a reservoir of the tropical semi-arid, which stores 2 x 109 m3 and is responsible for supplying water to 50% of the population of the State of Ceará, Brazil. 12 water collection campaigns were carried out on 7 of the main tributaries of the reservoir from 2011 to 2012.

The highest input values were registered during the rainfall season, period in which the highest inflows are registered in the reservoir and, consequently, the highest nutrients rates. The peaks in daily input of TN (8 Mg) and of TP (2.5 Mg) occurred during the rainfall season of 2011. The highest phosphorus contribution comes from the Jaguaribe river, main tributary, as for nitrogen, it presents similar input from all tributaries. The smallest input was registered during the dry season of Nov/11 and Nov/12, period during which there is no contribution from surface runoff to the inflow. The high amount of nutrient deposition during the wet season, period in which there is a predominance of surface runoff, and the sharp decline during the dry season, expresses the origin of the deposited nutrients is associated the agro-livestock business that function in the region of the reservoirs watershed.

Keywords: Water quality, eutrophication, land use, semi-arid ecosystems, dam

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Suspended sediment and dissolved solids concentrations and loads in small agricultural watersheds in Navarre (Spain)

[1]Merchán, D., [1]Luquin, E., [1]Hernández-García, I., [1]Campo-Bescós, M.A., [1]Giménez, R., [1]Casalí, J. and [2]Del Valle de Lersundi, J.

[1]*Department of Projects and Rural Engineering, IS-FOOD Institute (Innovation & Sustainable Development in Food Chain). Public University of Navarre, Campus de Arrosadía, 31006 Pamplona, Navarra, Spain*
[2]*Department of Rural Development, Environment and Local Administration, Government of Navarre, C/ González Tablas 9, 31003 Pamplona, Navarra, Spain*

The suspended sediment (SS) and dissolved solids (DS) concentrations and loads were analysed for four small agricultural watersheds in Navarre during the hydrological years (Oct-Sep) 2007-2016 through daily discharge and concentration data.
The studied watersheds include: La Tejería (159 ha) and Latxaga (207 ha), in which the main land use is rainfed agriculture (cereals such as barley and wheat); Oskotz Principal (1674 ha), with forests (60%) and grazed pastureland (39%), and its subwatershed Oskotz Forested (500 ha); and Landazuria (480 ha), in which around half of its surface is pressurized irrigated agriculture and the remaining is rainfed agriculture.
DS concentration followed a seasonal pattern imposed by the availability of water, with higher concentrations recorded in low flow periods (summers, with the exception of the irrigated watershed, where the low-flow period coincided with the non-irrigated season) and lower concentration in the high-flow period or for specific high-flow events. SS concentration was extremely variable, with a range of 2 – 4 orders of magnitude in concentration for any specific order of magnitude in discharge. The daily loads of DS were highly correlated with the water yield whereas those of SS were not, being the SS load associated mainly with high flow events. In fact, 85 – 94% of SS load was exported in only 5% of the time whereas the DS load mirrored the pattern observed for water yield.
Yield estimations for the whole study period of SS were considerably more variable than those of DS, not only within watersheds but also among different watersheds. DS yield was the highest (>2 Mg ha-1 year-1) in two rather different watersheds: the one with the highest water yield but with the lowest DS concentration (Oskotz Principal) and the one with the highest DS concentration and the lowest water yield (Landazuria). SS was higher in watersheds with rainfed cereal land use, but it was highly variable even within this homogeneous land use as a consequence of site specific characteristics. The percentage of SS yield out of total yield ranged from 12 to 80% and was mainly associated to the variability in SS yield.
The observed patterns and findings in this study were then compared and contextualized with the available literature for small watersheds to improve the understanding of the effects of agricultural

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land use in the SS and DS dynamics.

Keywords: Connectivity, suspended sediment, catchment dynamics

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Contribution of Soil Tillage Translocation to Soil Erosion in Vineyard

Luciano Gristina, Antonino Santoro and Agata Novara

Dipartimento di Scienze Agrarie Alimentari e Forestali, University of Palermo, Italy

Soil erosion has been described as the ma¬jor cause of physical soil degradation, but little attention to the erosivity of full sequence in various tillage systems was paid except in few papers considering this issue. Tillage translocation is defined as a transport and a resultant displacement of soil by tillage (Govers et al. 1999).

In fact, the long-term effects of soil redistribution by tillage increase the variabil¬ity of soil properties (Kosmas et al. 2001), trans¬form soil profile morphology and landscapes (De Alba et al. 2004) and lead to a significant decline in soil productivity as well as processes due to water erosion.

The rates of tillage erosion have been reported all over the world ranging from 14 to 150 Mg ha-1 yr-1 depending on tillage operation, slope, track speed, slope concavity and/or convexity.

Tillage erosion can be measured with a tracer method, i.e. a volume of soil is labelled and tilled, and then changes in tracer concentrations before and after tillage are used to calculate soil translocation. The tracer method for measuring soil translocation includes physical (metal cubes (Van Muysen et al. 1999), flat steel washers (Mont¬gomery et al. 1999), magnetic tracers (Zhang et al. 2009), rock fragments (Nyssen et al. 2000) and gravels (Zhang et al. 2004)) and chemi¬cal methods (radionuclides (Zg?obicki 2002) and chlo¬rides (Lobb et al. 1999)).

The aim of this study is to estimate the rate of tillage erosion on vineyard floor since very few information is available and to develop a new soil tracer methods using ?13C natural abundance.

Keywords: Tillage, erosion, tracers, vineyards

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Catchment model approach for the assessment of the fate of pesticides in sediments and surface waters fluxes

Ana-Patricia FERNÁNDEZ-GETINO and Jose-Luis ALONSO-PRADOS

DTEVPF - Plant Protection Products Unit - Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria (INIA) - Madrid, Spain

In agricultural systems, the main aim is to achieve high crop yields under sustainable management systems, so the control of pests, weeds and diseases becomes fundamental. This requires the use of plant protection products, which must be used in a proper, safe and effective way (Regulation 1107/2009 EC and Directive 2009/128/EC). The purpose of Regulation 1107/2009 is to ensure a high level of protection of human and animal health, and the environment, while the competitiveness of EU agriculture is guaranteed. This Regulation establishes the need to perform the environmental risk assessment of pesticides, to demonstrate that the use of the pesticide complies with the criteria set in the Regulation and that the substances are not persistent, bioaccumulative, or meet the criteria of potential long-range transport in the environment. In the risk assessment process, the FOCUS (FOrum for the Co-ordination of pesticide fate models and their USe) models are used. These models consider different scenarios at European level to calculate exposure concentrations. In order to deepen into the study of potential long-range transport of pesticides in the environment, the assessment of the degree of linkage between various parts of the catchment which controls sediment and water fluxes through landscape, could provide useful insights. The spatial characterization of connectivity patterns in the catchment allows estimation of the contribution of a given part of the catchment as sediment source, and it defines transfer paths (Crema & Cavalli, 2018). Various studies have pointed out the high concentrations of some pesticides in sediments and waters detected at certain times in hydrographic basins in the East of Spain, where pesticides are commonly applied in irrigated agriculture. In this sense, it would be interesting to develop a catchment model approach for the assessment of the fate and behaviour of pesticides through the sediments and water fluxes. In this context, the implementation of the index of connectivity for pesticides transfer paths identification could be very useful.

Keywords: pesticides, catchment, sediments, surface water, connectivity index, transfer paths

NBS3: Drones Internet of Things and Remote Sensing for Environmental Monitoring

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Can drone footage be of help in hydrological analyses? A case from the Mara River Wetland in Tanzania.

Paolo Paron and Francesco Bregoli

River Basin Development Chair Group, Department of Water Science and Engineering, IHE Delft Institute for Water Education, Westvest 7, 2611 AX Delft, The Netherlands

Hydro-meteorological observations are traditionally punctual: they are either fixed at bridges or at other river structures (gauge stations), or collecting meteorological data at fixed locations. Satellite remote sensing has already offered the opportunity to extend these observations over large areas.

In the last few years the appearance of drone technology and software has allowed for the proliferation of their applications. Some of the major advantages of drones as compared to satellites are: the higher resolution of resulting data; the operator has control on the temporal and spatial scale of the surveys; and, flying below the clouds, the gathered images are less subject to atmospheric alteration.
We applied drone footage in the Mara River Wetland, Tanzania, combined with more traditional methods of hydrological data collection to understand the hydrology of a remote and neglected area of an important freshwater ecosystem. We used a DJI Phantom 4 Pro and open source mapping and photogrammetry software. We did fly in three occasions over two specific points in the Mara River Wetland: one where the river loose its meandering course and spreads into the wetland and the other about 50 km downstream where a granitic inselberg forms a convenient reference for water stage analyses. We calculated the areal water extent of these two locations for the three times finding some very interesting results about water travel time, possible inputs from unknown sources, water abstraction and diversion for irrigation and domestic uses.
Without the availability of prompt detailed orthophotography obtained by drone we would not be able to map the spatial extent of the water surface and thus we would not be able to make quantitative correlations between these two points.

Keywords: Drone footage, Hydrology, Wetlands, Mara River

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The UARSF of Wageningen UR: applications and projects

[1]Keesstra, S.D., [2]Kooistra, L., [3]Muecher, S., [2]Bartholomeus, H., [3]Franke, J. and [3]Janssen, H.

[1]*Soil Physics and Land Management Group, Wageningen University, Droevendaalsesteeg 4, 6708PB, Wageningen, The Netherlands; Civil, Surveying and Environmental Engineering, The University of Newcastle, Callaghan 2308, Australia.*
[2]*Wageningen Environmental Research, Droevendaalsesteeg 2, 6708PB, Wageningen, The Netherlands.*
[3]*Laboratory for Geoinformatics and Remote Sensing, Wageningen University, Droevendaalsesteeg 2, 6708PB, Wageningen, The Netherlands.*

To support environmental management there is an increasing need for timely, accurate and detailed information on our land. Unmanned Aerial Systems (UAS) are increasingly used to monitor agricultural crop development, habitat quality or urban heat efficiency. An important reason is that UAS technology is maturing quickly while the flexible capabilities of UAS fill a gap between satellite based and ground based geo-sensing systems.
In 2012, different groups within Wageningen University and Research Centre have established an Unmanned Airborne Remote Sensing Facility. The objective of this facility is threefold: a) To develop innovation in the field of remote sensing science by providing a platform for dedicated and high-quality experiments; b) To support high quality UAS services by providing calibration facilities and disseminating processing procedures to the UAS user community; and c) To promote and test the use of UAS in a broad range of application fields like habitat monitoring, precision agriculture and land degradation assessment.
The facility is hosted by the Laboratory of Geo-Information Science and Remote Sensing (GRS) and the Department of Soil Physics and Land Management (SLM) of Wageningen University together with the team Earth Informatics (EI) of Alterra.
The added value of the Unmanned Aerial Remote Sensing Facility is that compared to for example satellite based remote sensing more dedicated science experiments can be prepared. This includes for example higher frequent observations in time (e.g., diurnal observations), observations of an object under different observation angles for characterization of BRDF and flexibility in use of camera's and sensors types. In this way, laboratory type of set ups can be tested in a field situation and effects of up-scaling can be tested.
In the last years we developed and implemented different camera systems (e.g. a hyperspectral pushbroom system, and multispectral frame cameras) which we operated in projects all around the world, while new camera systems are being planned such as LiDAR and a full frame hyperspectral camera. In the presentation we will give an overview of our activities, ranging from erosion studies, decision support for precision agriculture, determining leaf biochemistry and canopy structure in tropical forests to the mapping of coastal zones.

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Keywords: Unmanned Aerial Systems

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Influence of DEM source LiDAR and photogrammetry and resolution on computing topographic parameters in contrasted croplands

[1]Manuel López-Vicente and [2]Sara Álvarez

[1]*Dept. of Soil and Water, Experimental Station of Aula Dei, EEAD-CSIC. Avda. Montañana 1005, 50059, Zaragoza, Spain.*
[2]*Unit of Woody and Horticultural Crops, Technological Agriculture Institute of Castilla y León, ITACyL. Ctra. Burgos Km. 118, 47071, Valladolid, Spain*

Digital elevation models (DEMs) can be derived from several sources, for example, using contour line maps, remote sensing, Light Detection And Ranging (LiDAR) technology, photogrammetric restitution, and most recently Structure-from-Motion (SfM). These DEMs are characterized by different degrees of precision and accuracy, as well as varying ranges of spatial resolution, time and economic cost. Some studies have found large disagreements between the field-scale contributing areas mapped from the LiDAR DEM and photogrammetric DEM. In areas with low vegetation cover and/or before sprouting in woody crops, the SfM technique provides landform models and point cloud data of similar quality to those generated by airborne LiDAR but more quickly and at a lower cost. On the other hand, raster DEM resolution is known to have an effect on simulations of hydrological features such as stream networks, watershed boundaries and sizes, flow accumulation threshold values, network morphology and slope. In agricultural catchments, DEM resolutions must be optimised in order to identify critical source areas of diffuse pollution and to capture any microtopographic features acting as topographic barriers or channels which divert runoff away from the hillslope scale flow direction. In this study, we evaluated four independent topographic parameters, such as slope gradient (S), soil roughness (SR), the upslope contributing area (A), and the convergence index (CI), in two contrasted agricultural systems – the 'Barbastro' and 'Peñaflor' sites – located in the Ebro River Basin (NE Spain), by using seven DEMs at each study site. One LiDAR- and six photogrammetry-derived DEMs with 0.03, 0.05, 0.1, 0.2, 0.5, 1 and 5 m cell sizes. The two study sites have contrasted topographic (hillslope and flat terraces), land use (woody and cereal crops) and climatic (subhumid and semiarid) conditions, and thus they offer an ideal frame to assess the influence of DEM source and resolution on derived topographic parameters.

Keywords: LiDAR; photogrammetry, DEM, spatial resolution, soil roughness, tillage practices

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A method for monitoring and measuring soil loss with a UAV (Unmanned aerial vehicle)

[1]Antonio Minervino Amodio, [2]Pietro P.C. Aucelli and [1]Carmen M. Rosskopf

[1]*University of Molise, Italy*
[2]*University of Naples Parthenope, Italy*

Soil erosion is one of the main factor for land degradation in nature. Its quantification in field conditions is very difficult. Here we present the development of a simple, sensitive and inexpensive field method for the quantification of soil loss. The goal is to produce high precision digital elevation models (DEMs) of the soil surface that is repeatedly investigated (after days, months, years, events). The volumetric quantification of soil erosion will be the result of DEM overlapping over time.
According to the developed methodological procedure, high-resolution aerial images will be acquired by a small unmanned aerial vehicle (UAV) flying at low altitude (10-20 meters) on test areas smaller than 2 hectares in order to assure a very high image resolution. For each test area, at least four, homogenously distributed GCPs (Ground Control Points) will be measured with GPS for geo-referencing the soil surface.
The images will be processed with methods from photogrammetry and computer vision; the Structure from Motion (SfM) software will be applied for this purpose.
To build 3D DEMs, the software procedure will be the following: 1) homologous image points between images will be matched; 2) the orientation of the camera for all images will be rebuild from the previous information; 3) a dense point cloud will be constructed from the orientation of the images and homologous points; 4) the model will be build and exported as DEM from the point cloud. This procedure will be applied to build other DEMs of the same area after days, months, years or events. At this point, volumetric erosion quantification will be obtained using raster calculator tools.

Keywords: Soil erosion, UAV (Unmanned Aerial Vehicle), DEM (Digital Elevation Model), SfM (Structure from Motion)

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Multispectral UAV Imagery Automatic Registration

Jordi Salvador Bernadí, Felipe Lumbreras and Angel Sappa

BCN Drone Center - Computer Vision Center (CVC)

The UAV technology usage for Earth Observation environmental applications have been continuously increasing during past few years. This has been possible thanks to two facts: UAV systems are becoming safer and cheaper and, at the same time, most of the countries have stablished legislation frameworks that allows to legally operate UAVs for commercial apps. This exponential grow of the UAV civil market will continue during incoming years, forecasted 2 billion worth in 2020.

Unlike images obtained with traditional airborne systems, UAV imagery is usually acquired at varying altitude, without precise orientation data and without proper optics calibration. This has led to the appearance of specific commercial software capable of processing this type of images to generate orthophotomaps and digital elevation models (DEM). This kind of processing relies on two major points: having big overlap between the images and having high resolution imagery. However, it is not possible to always have big overlaps, because this may limit the flight productivity and the flight plan may have errors because of the wind effect. Furthermore, multi/hyper-spectral and thermal sensors usually have low resolution and cannot easily be processed.

In order to face these limitations, we are proposing a new approach consisting of directly geo-registering the images with a reference orthomosaic instead of creating a new map from scratch for each flight. This simplifies the full processing step without requiring any overlap at all and allowing to work with any type of imagery. The method is based in the automatic detection and description of Control Points using Computer Vision techniques and an iteratively improvement of the result using Mutual Information. The current work is based on improving the base algorithm to make it robust to register imagery from different bands taken at different moments of the year.

Keywords: Computer Vision, UAV, Multispectral, Image Registration, Remote Sensing, Earth Observation.

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Irrigation optimization under limited water supply by integration modern approaches in traditional water management on the cotton fields

Anna Brook, Maria Polinova, Keren Salinas and Antonello Bonfante

University of Haifa, Haifa, Israel

The ability to effectively develop agriculture with limited water resources is an important strategic objective to face future climate change and to achieve the Sustainable Development Goal. The aim of modern irrigation management is to ensure the maximum productivity yet, new irrigation conditions increasingly addressed to the limited water supply. On the above reasons, this study aims to explore the advantages of the introduction of a crop simulation model supported by field feedback obtained by spectroscopy and low-cost optical imagery collected by DJI Phantom4 system, to irrigation water management. In this study, spectral vegetation indices and trained models were used for estimating the crop-related physical parameters and health. Both indices and models show stress in conditions of over- or under-irrigation. The agro-hydrological model was applied to predict water consumption and long-term planning. The simulation models have a number of advantages for agricultural management in general and for irrigation planning in particular (simulation of crop development under real field conditions, long-term planning, and prediction of crop-water needs by short-term and mid-term weather forecast). However, such models cannot be considered decision support systems for irrigation management, until they are able to compete with traditional methods based on deep knowledge and experience about each crop and specificity of the field. Thus, the irrigation schedule provided by the model was far from realistic and focused on maximum yield. The proposed optimization in real field conditions carried out by minimizing water amount for optimal growth rate. The results show that field spectroscopy and low-cost drone imagery provide reliable plant-state data. It indicates that irrigation scheduling and optimization is more effective with the use of combined methods: the principles of growth, allowable stresses, crop coefficients provided by agri-guides, the estimation of water consumption (simulation model in common with the weather forecast) and field crop feedback.

Keywords: agro-hydrological models, irrigation

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Evaluation of Mine Restorations Using UAV Imagery

[1]PADRÓ, Joan-Cristian, [2]CARABASSA, Vicenç, [3]BALAGUÉ, Jaume, [4]ALCAÑIZ, Josep Maria and [1]PONS, Xavier

[1]*Grumets Research Group; Dep. Geografia, Edifici B, Universitat Autònoma de Barcelona, 08193 Bellaterra, Catalonia, Spain*
[2]*CREAF, Cerdanyola del Vallès 08193, Spain*
[3]*Unitat Mixta InForest (CTFC-CFREAF)*
[4]*Univ Autònoma Barcelona, Cerdanyola del Vallès 08193, Spain*

Monitoring the restoration of extractive activities is a requirement for mine companies and public administrations. The objective of this contribution is to present our first results of a protocol to support this need using drone imagery to map and quantify land cover dynamics in these areas. In the case of Catalonia, the size of most open-pit mines is not extensive enough to be monitored using only medium-high spatial resolution satellite imagery (e.g., 30 m in Landsat-8, 10/20 m in Sentinel-2) because although the temporal and spectral resolutions are good (e.g., 5 days, 13 bands in Sentinel-2) the pixel size is not detailed enough. On the other hand, airborne imagery with very high spatial may be used to map land cover of restoration areas, but the cost is not worthwhile for such exploitations' dimensions. Consequently, monitoring task are currently supported by in situ technicians. In this work we tested the use of drones for monitoring the restoration of open-pit mines using a multispectral sensor (MicaSense Sequoia). The goal was to map and quantify the area of grasslands, shrubs, forest, and soil with organic matter presence and bare soil using remote sensing and GIS techniques. We tested different flight heights (30 m, 60 m, 90 m), experimenting with spectral indices (NDVI,NDWI, SAVI, MSAVI-1), classification methods (Maximum likelihood, kNN, hybrid (clustering + supervised)) and assessing the contribution of several digital models (Digital Cast Shadow Model, Digital Illumination Model, Digital Slope Model) derived from the photogrammetric Digital Surface Model obtained from the flight. The results here presented constitute a first protocol to optimize mapping and quantification of mine monitoring restoration using drone imagery.

Keywords: Monitoring, restoration, mining, drone, UAV, remote sensing, multispectral imagery, cartography, protocol.

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Coupling residue and water spectral indices to improve crop residue cover estimation from satellite images

[1]M. Quemada, [2]W. D. Hively, [3]C.S.T., Daughtry, [4]B.T. Lamb and [2]J. Shermeyer

[1]*Universidad Politécnica de Madrid, Spain.*
[2]*U.S. Geological Survey, Eastern Geographic Science Center, VA, USA*
[3]*Agricultural Research Service-USDA, Hydrology and Remote Sensing Laboratory, MD, USA.*
[4]*Department of Earth and Atmospheric Sciences, City University of New York, NY, USA.*

Crop residues on the soil surface protect against erosion, increase water infiltration and reduce agrochemicals in runoff water. Remote sensing assessment of tillage intensity and crop residue cover (fR) can improve predictions of the environmental impact of agricultural practices and promote sustainable management. The reflectance spectra of crop residues have absorption features in the 2100–2350 nm wavelength region associated with cellulose and lignin that are absent in the spectra of soils and green vegetation. Various spectral indices based on detecting these absorption features have been proposed for estimating fR but are sensitive to soil and crop residue water contents, therefore the uncertainty of fR estimates increases under variable moisture conditions. Our goals were to evaluate the robustness of spectral residue indices based on the shortwave infrared region (SWIR) for estimating fR and to mitigate the uncertainty caused by variable moisture conditions on fR estimates. Ten fields with uneven and with uniform water distribution were identified in satellite images (WorldView-3) acquired for a study site in Maryland (USA). Fields were subdivided into wedges within the dry and wet portions of each field, and SWIR bands were extracted for each pixel. Two crop residue indices (Normalized Difference Tillage Index (NDTI); Shortwave Infrared Normalized Difference Residue Index (SINDRI) and a water index (WI) were calculated. Estimation of fR from the residue indices were calculated for each field before and after moisture correction. The results showed that moisture correction of spectral bands based on a water improved fR estimation of both residue indices, but SINDRI was more robust to moisture than NDTI. If bands are available, crop residue estimation should be based on SINDRI. If only Landsat or Sentinel-2 satellites are available, crop residues could be estimated combining NDTI with a water index to alleviate the adverse effect of variable moisture conditions.

Keywords: Conservation agriculture; normalized difference tillage index; shortwave infrared normalized difference residue index; tillage intensity; water content index; Worldview-3.

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Future Biomass Supply for Low Carbon European Energy Provision in a Changing World

[1] Hastings Astley, [1]Smith Pete, [2]Taylor Gail and [3]Clifton-Brown John

[1]*Institute of Biological and Environmental Science, University of Aberdeen, UK;*
[2]*University of Southampton, Southampton, UK;*
[3]*Institute of Biological, Environmental and Rural Sciences, Aberystwyth University, UK;*

European nations have committed to reduce greenhouse gas (GHG) emissions to 20% of the 1990 emissions by 2050. Most have foresworn nuclear energy in favour of energy generated by renewable sources such as tidal, wave, wind, solar, hydro and bioenergy to achieve this goal. Most renewable energy sources are intermittent or cyclic and have to be balanced by dispatchable power sources to balance the intermittency of supply to the base load and to supply peak demand. Historically this dispatchable power has been provided by fossil or nuclear power which can, by varying degrees, be increased and decreased to match demand. Pumped hydro storage is also used in this way. Of the renewable technologies bioenergy and to a lesser extend natural flow hydro have the potential provide dispatchable energy as the energy source can be stored and used as required. Bioenergy in all its forms requires biomass feedstock, whose provision requires land and suitable soil and climatic conditions for it to grow. This biomass feedstock is also required to supply other bio-economy chains which will also assist in reducing GHG emissions. The quantity of biomass feedstock is limited by land area and the net primary productivity of this land due to the environmental conditions, which will favour the growth of different types of feedstock species, each of which have their optimum bioclimatic envelope for maximum growth and hence biomass yield. As the climate changes the geographic range of each bioenergy feedstock species will move due to changes in temperature and rainfall. Productive land is the factor limiting the amount of biomass that can be provided as land is also required to provide food for an increasing global population and their dietary aspirations as well as providing forestry for wood products, habitats for wildlife and terrestrial carbon storage. Food crops are used to provide first generation feedstocks for biodiesel, bioethanol and biogas but their use competes with human food provision and causes indirect land use change. This combined with intensive crop management results in little impact on reducing GHG emissions. Bioenergy feedstock can also be provided from woody plants from forest management in the form of thinnings and residues to produce a low GHG feedstock as long as the total quantity of harvested biomass is less than the annual growth so that the carbon stock in the forest remains constant. Second generation lignocellulosic bioenergy crops such short rotation forestry, coppiced woodland and perennial grasses such as miscanthus can be specifically grown for bioenergy using low inputs and land that does not compete with food production to produce a low GHG feedstock. Bioenergy is also one pathway to negative emissions through carbon capture and storage. In this presentation the technical, policy and social limitations

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to the rate of uptake of bioenergy are discussed.

Keywords: Modelling, land use change, bioenergy, land availability, feedstock resource, spatial modelling

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LIFE LASER FENCE: Laser systems for the prevention of food chain poisoning and minimization of chemical exposure to the environment

[1]Katherine Franco, [1]Sven Kallen, [2]Priya Devasirvatham and [3]Santiago Martínez

[1]*TRANSFER CONSULTANCY S.L*
[2]*VOLTERRA ECOSYSTEMS S.L.*
[3]*IRIS UAV services S.L.*

In a world with increasing demands for food and energy, effective and long lasting animal control is crucial. Animals are naturally drawn to food supplies in agricultural areas but this leads to consequences for both animals and farmers. Chemical poisons are often used to control rodent populations on farms, where these animals destroy crops, eat livestock feed and can transmit disease. However, rodenticides may also put other species at risk. Studies in Europe show that anticoagulant rodenticides contribute to the deaths of a variety of mammals and birds. The poisons accumulate in the food chain, so for animals that prey on or scavenge rodents this repeated exposure may be fatal.

Furthermore, farmers lose billions of euros each year through damages in crop production. A virtual fence is then an interesting solution to contain animals in an area or keep them out of a defined range. This project presents an innovative technology, Agrilaser, to keep animals away from productive fields while maintaining animal welfare. Its application ensures a safer working environment without chemicals, thereby preventing accidental poisoning for both animals and humans.

The project's main objectives are to demonstrate:

1. Reduction of the impact of chemicals on fauna by the minimization of exposure to toxic chemicals through the application of innovative laser systems. Hereby we avoid animals intruding into agricultural fields, preventing poison entering the trophic chain, which in the long term also enhances local biodiversity

2. Calibration and improvement of the functionality of the laser systems towards animals other than birds (rodents i.e. rabbits and mice or bigger mammals i.e. deer, wild boars, bears, etc.) in ecologically sensitive areas where nature conservation increasingly conflicts with agriculture and daily economic activities

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3. Cost-efficient and more sustainable agricultural management practices thanks to the incorporation of non-harmful technologies such as laser fences and drones, which are accurate and cheap to monitor farmlands, protected or difficult to reach areas, and over long distances. At the same time demonstrate to farmers and land owners the positive economics of this sustainable practice due to lower operating costs and decrease in yield loss in order to promote scale-up and replicability

Acknowledgement. This project is co-financed by the European Union through the LIFE Programme. Duration 01/09/2016-31/12/2019.

Keywords: Wildlife poisoning, animal intrusion, food chain, virtual fence, laser systems, animal welfare.

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Monitoring soil surface by close-range photogrammetry in multiple scales

Josef Krasa, Petr Kavka, David Zumr and Tomas Dostal

Department of Irrigation, Drainage and Landscape Engineering, Faculty of Civil Engineering, Czech Technical University in Prague, Thakurova 7, Prague, 16629, Czech Republic, phone: +420 605 700 908

UAV and close-range photogrammetry can be used for complex monitoring of soil surface and related degradation processes. We can accurately assess the rill volumes by creating DEMs with millimeter resolutions. The system of automatic volumetric analyses in larger scales needs accurate rill boundary definitions to be able to create pre-erosion surface estimation. For the purpose different morphometry analyses were tested but skilled visual interpretation proved to be the best. Here multiple flying altitudes can serve to get from handheld imagery in testing zones (sub millimeter GSD) to accurate total field estimates. We could estimate actual sediment fluxes over ca 10 ha watersheds.

Secondly, handheld imagery serves as a basis for estimating actual soil surface roughness under different tillage types and a soil roughness decay in time related to rain impact. Here ca 1 mm GSD surface models provide necessary information.

Finally, close range photogrammetry in micrometer resolution is used to define changes in soil surface morphometry induced directly by raindrop impacts. Experiments with splash cups aim to define relation between rain kinetic energy and splash erosion. Here photogrammetry is used to interpret differences in surface change of different soils, in soil aggregates' destruction by raindrops of different sizes and velocities. The research is supported by project of Ministry of Agriculture of the Czech Republic No. QK1720289 and by project No. GA17-33751L.

Keywords: close range photogrammetry, volumetric analyses, surface roughness, rills

SP2: Sustainable Development Goals and Soil policy and practical implementation

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Land Degradation Neutrality and Restoration, how can we achieve that?

[1]Keesstra, S.D., [2]Mol., G., [3]Okx, J., [3]Molenaar, C., [4]de Cleen, M., [4]Moolenaar, S. and Visser, S.M.

[1]*Soil Physics and Land Management Group, Wageningen University, Droevendaalsesteeg 4, 6708PB, Wageningen, The Netherlands; Civil, Surveying and Environmental Engineering, The University of Newcastle, Callaghan 2308, Australia.*
[2]*Wageningen Environmental Research, Droevendaalsesteeg 2, 6708PB, Wageningen, The Netherlands.*
[3]*Rijkswaterstaat, Ministry of Infrastructure and the Environment, Rijkswaterstaat, WVL/Soil plus, Utrecht, The Netherlands*
[4]*Commonland, Department of Science & Education, www.commonland.com, Amsterdam, The Netherlands*

There is an increasing pressure on land, this calls for using the land for different functions at the same time and restore degraded land. A sense of urgency is needed, because the deadline (2030) is like tomorrow for environmental issues. Healthy soils and healthy land is essential to realize many of the societal goals as have been described in the framework of the SDGs.

- To measure and monitor the state of the land (or land degradation) methodology development is needed, specifically for parameters like soil infiltration capacity, erosion processes on different scales ... In addition, the monitoring needs to be done in a smart way, pure grid based sampling is not needed and not economically feasible. Monitoring schemes need to be based in system knowledge.

- Academic disciplines and national and international governmental agencies are focussed on working on well defined, single discipline, narrow goals, that makes solutions based in systems thinking and collaborating beyond their own scientific field or governmental department a difficult issue. To come to integrated approaches to come to sustainable systems from an environmental, economic and social point of view, it is needed to have knowledge of the system dynamics.

- A paradigm shift is needed: to go from environmental protection to sustainable environmental use. To accomplish this, robust economic systems are needed that are based in environmental system thinking; an approach integrating environmental, social and economic interests. Only by making the transition towards integrated solutions based in systems analysis using concepts such as nature based solutions can we have a chance to

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realize the Land Degradation Neutrality by 2030.

- Transitions are needed to be made on multiple goals such as energy, climate adaptation, urbanisation, economic growth and mobility. This could be accomplished by giving value to land through the multiple use gives urgency to protect and restore.

- Awareness and stakeholder perceptions and collaboration ..

For the successful implementation and realization of the SDGs this systems approach is needed. The SGDs are not 16 separate goals, that need to be dealt with one by one. But should be seen as interlinked issues that by smart planning using the power of the system. SDG17 is specifically oriented towards this, but is mainly focused on developing countries.

Keywords: Sustainable development goals, land degradation neutrality, transitions

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Natural Capital Accounting of Soils for the U.N. System of Environmental Economic Accounts

[1]David A. Robinson, [1]Bridget Emmett, [2]Panos Panagos, [3]Pasquale Borrelli, [2]Arwyn Jones, [2]Luca Montanarella and [4]Carl G. Obst

[1]*NERC–Centre for Ecology and Hydrology, United Kingdom*
[2]*European Commission, Joint Research Centre, Italy*
[3]*University of Basel, Switzerland*
[4]*Institute for the Development of Environmental-Economic Accounting (IDEEA) & Melbourne Sustainable Society Institute, Australia*

Soils provide, and support, a range of functions that are vital to society and the performance of the earth system. A major challenge is to identify, and account for, 'soil change' and the contribution or impact this has on ecosystem service delivery. One way to attempt this is by better accounting for resource use and how it changes, then how this change affects other resources. Major international initiatives are seeking ways to quantify and account for change. For example, the United Nations System of Environmental Economic Accounts (SEEA). SEEA creates satellite accounts to run alongside the U.N. system of national accounts (SNA) from which indicators like Gross Domestic Product (GDP) are derived. GDP is deficient as the costs of environmental degradation, natural resource depletion and non-market values are not included because the SNA only considers goods and services transacted in markets or accounted for as a benefit. Worse still, the degradation and loss of environmental resources often involves additional economic activity and thus increases GDP. Thus, the current macro-economic measures of performance that inform policy and debate can provide misleading information with respect to sustainable use of resources.

Keywords: GDP, macro-economy, soil

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Can a glass of wine transpose in practice SDGs ?

[1]Ettore CAPRI, [2]Valentino Fiamma and [1]Lucrezia Lamastra

[1]*Università Cattolica del Sacro Cuore, Piacenza (Italy)*
[2]*Ministero dell'Ambiente, del Territorio e del Mare (Italy)*

Sustainable agriculture could be defined as a set of agronomic practices that are economically viable, environmentally safe, and socially acceptable with the aim to create a system that is capable of persisting preserving the same characteristics. In 2004, OIV (Organization Internationale de la Vigne et du Vin), defined sustainability as a "global strategy on the scale of the grape production and processing systems, incorporating at the same time the economic sustainability of structures and territories, producing quality products, considering requirements of precision in sustainable viticulture, risks to the environment, products safety and consumer health and valuing of heritage, historical, cultural, ecological and aesthetic aspects". This definition emphasizes the relationship between the sustainability and the area in which collective knowledge of the interactions between the identifiable physical and biological environment and applied agricultural practices have been developed, providing distinctive characteristics for the products originating from this area. In addition an holistic approach of this definition provides the strategy for achieving SDGs operative in practice.

Since 2011 in Italy we are working to achieve the above objectives developing voluntaree programs on certified sustainable food growing and organization. These labels signal to the stakeholders the sustainability attributes of the products and provides easily interpretable information about selected indicators. The wine label shows the V.I.V.A. logo and through a QR code it is possible to consult the results obtained in selected I and ad hoc developed ndicators. Multistakeholders platform bridging science to policies, bottom up approach by farmers, citizen science on resident-bystanders and consumer, traceability and LCA is feeding a productive a sustainable system which is transparent in communication, consistent in science, measurable in each step of the process.

Footprint data and SDGs achieved in the network of 50 farmers and hundred wines certified on sustainability in compliance with VIVA protocol are reported in this presentation and they could cover a reference model for the entire agricultural sector and society.

Keywords: SDGs, farmers, wine, vineyards

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Soil Information in the Indicator Framework for Sustainable Development Goal 15.3.1

Jan de Leeuw, Van den Bosch, Rik, Batjes, Niels and Kempen, Bas

ISRIC World Soil Information, Wageningen, The Netherlands

The target of Sustainable Development Goal 15.3 is by 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world. The UNCCD has taken up responsibility for developing the guiding principles for monitoring this target. Good practice guidance on the indicator for this target was published in September 2017. This presentation will introduce the indicator framework and highlight and discuss the role of soil information in there.

Keywords: LDN, UNCCD, SDG15.3, land degradation

SP3: Stakeholder demands and perspectives in sustainable development

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No till durum wheat yield success probability in Mediterranean climate: a methodological framework

[1]Luciano Gristina, [2]Saskia Keesstra and [1]Agata Novara

[1]*Dipartimento di Scienze Agrarie, Alimentari e Forestali, University of Palermo Italy*
[2]*Soil Physics and Land Management Group, Wageningen University, Droevendaalsesteeg 4, 6708PB, Wageningen, The Netherlands*

Enter description here.

The aim of this study is developing a framework to evaluate no till (NT) yield success probability, as decision tool for farmers or decision makers. The effect of soil management on durum wheat yield has been tested on many long term field experiments. Results of these researches were collected in a unique dataset to evaluate the success of no till (NT) management in comparison to conventional tillage (CT) as influenced by the aridity index, crop residue management and cropping system. A total of 635 observations of long term experiments (>3years) regarding durum wheat in several areas with Mediterranean climate were included in the present study. The relative ratio of yield under NT and CT was correlated to the aridity index (Ai) for different cropping systems and residue management strategies. No till performed better with lower values of the Ai. The value of Ai when the yields of NT and CT were the same was defined as the Ai threshold and this value strongly resulted as depended on the crop management.

The developed general framework provided the conditional probability of NT yield success in a specific environments. The inputs of this tool are the Ai probability and the probability of NT yield success which was estimated through a logit equation of the whole dataset.

Results of conditional probability of five long term experiments estimated with the general framework were compared to NT yield success probability of calculated data, showing a high significativity. The developed framework permits, in a specific site, to (i) know the threshold for different managements tecniques, (ii) estimate the probability of success of adopting NT and CT soil management techniques; (iii) predict the best management with reference to Ai variation.

Keywords: no till, aridity index, durum wheat

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Oat Straw Mulch to Control Soil Erosion in Agriculture Mediterranean Rainfed Agriculture Land. An Economic, Perception and Biophysical Approach

[1]Giménez-Morera, A., [2]Cerdà, A., [3]Rodrigo-Comino, J., [4]Novara, A., [5]Pulido, M., [6]Brevik, E. and [7]Keesstra, S.D.

[1]*Departamento de Economi?a y Ciencias Sociales, Escuela Polite?cnica superior de Alcoy, Universidad Polite?cnica de Valencia. , Paseo del Viaducto, 1 03801 Alcoy, Alicante, Spain.*
[2]*Soil Erosion and Degradation Research Group. Department of Geography, Valencia University, Blasco Ibàñez, 28, 46010 Valencia, Spain.*
[3]*Department of Physical Geography, Trier University, D-54286 Trier, Germany; 4Instituto de Geomorfología y Suelos, Department of Geography, Málaga University, Campus of Teatinos s/n, 29071 Málaga, Spain.*
[4]*Dipartimento di Scienze Agrarie e Forestali, University of Palermo Italy*
[5]*GeoEnvironmental Research Group, University of Extremadura, Faculty of Philosophy and Letters, Avda. de la Universidad s/n, 10071 Cáceres, Spain*
[6]*Department of Natural Sciences, Dickinson State University, EEUU.*
[7]*8Soil Physics and Land Management Group, Wageningen University, Droevendaalsesteeg 4, 6708PB, Wageningen, The Netherlands.;Civil, Surveying and Environmental Engineering, The University of Newcastle, Callaghan 2308, Australia.*

Soil erosion is a key cause of land degradation in agriculture lands (Zhao et al., 2013; Rodrigo-Comino et al., 2018); and it is a worldwide threat that must be solved by means of nature-based strategies to be able to achieve sustainability (Keesstra et al., 2018). The use of mulches can be a solution, but there is a lack of information on long-term effects of the use of straw (Mannering and Meyer, 1963; Kramer and Meyer, 1969; Meyer et al., 1970; Edwards et al., 2000; Brown, 1985; Bhatt and Khera, 2006). Furthermore, little is known about the perception of farmers and the economic cost on the implantation of straw as a conservation measure. Eight paired plots were selected in Sierra de Enguera on an agriculture field to determine the effect of straw cover on soil erosion. Four plots were tilled three times per year (Control) and four plots were not ploughed and 0.125 Kg m^{-2} y^{-1} of oat straw cover was applied yearly (Straw). The plots were established in 2002, and runoff and sediment was continuously collected after each rainfall event from 2004 till 2014 when the two managements were applied. The results show an immediate effect of the straw mulches as in these plots the runoff (from 7.7 till 5.9 %) and soil erosion (from 47 till 26 Mg ha^{-1} y^{-1}) was reduced already in the first year. The combined effect of the use of straw yearly and the no-tillage strategy resulted in a reduction of the sediment yield, and 11 years later soil erosion rates were two orders of magnitude lower than in the control plot. However, the perception of the farmers on the use of straw is very negative and they claim that subsidies need to be implemented, as the cost of straw mulch is 1.9 times more expensive than traditional tillage.

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Keywords: Soil erosion

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Knowledge Impulse for Dutch Delta Approach for Water Quality and Fresh Water

Hilde F. Passier

Deltares, The Netherlands

The quality of groundwater and surface water in the Netherlands needs to be improved. Therefore, former Minister Schultz van Haegen (Infrastructure and the Environment), together with the authorities involved and NGOs, signed an ambitious declaration on improving water qualiy. With this plan of attack, the 'Delta Approach for Water Quality and Fresh Water', all parties involved in the areas of drinking water, agriculture and horticulture, nature, industry, recreation, healthcare, and knowledge join forces to resolve persistent problems on fertilisers and pesticides, and emerging issues like pharmaceutical residues and microplastics (News item Dutch government, 17-11-2016).

Knowledge on water quality is present at several institutes in the Netherlands. Therefore, the Dutch institutes Deltares, KWR, WUR-WER, RIVM (aligned with PBL, STOWA, WVL) decided to strengthen their collaboration for the Delta approach, for chemically clean and ecologically healthy water. The institutes work closely with regional and national partners, companies, authorities and citizens. Goals are to effectively unlock knowledge; to build a common knowledge base; to make knowledge transparent, coherent and quickly applicable; to make unambiguous assessments; to increase environmental awareness; to learn across different sectors; to find efficient solutions; to design scenarios that ensure sustainable use of water.

Within this collaboration, projects are developed with authorities and stakeholders. Current projects mainly focus on relatively urgent short-term issues related to the Water Framework Directive. Meanwhile, the partners of the Delta Approach create a knowledge agenda. This agenda aims to address long-term issues also, and to strengthen the knowledge base. Co-creation and finding the right balance between partners are important in the process to design an efficient knowledge impulse for improvement of the water quality.

Keywords: water quality, knowledge agenda, knowledge collaboration

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Informal urban agriculture as a permanent and transitory land use for a landscape planning strategy

Maria Inês Adagói and Selma Beatriz Pena

ISA/ULisbon, Portugal

The informal urban agriculture is very common in vacant lots of the cities. It is also called “illegal urban agriculture” or “spontaneous urban agriculture.” However, this is a strong manifestation of the population\'s participation in the transformation of the city, recovering relationships between man and nature and bringing to the city rural traditions. People adapt and transform these spaces as their own, in order to respond to their needs.
The informal urban agriculture is a reality in many places in the city of Lisbon. It gives a significant and positive contribution to ecology, culture, society, health and well-being, for all community and to the urban landscape. This positive contribution values the landscape and can be measured in ecosystem services.
The main goal of this work is to define a landscape strategy plan based on informal urban agriculture for Marvila. Marvila has 640 hectares, 38 thousand inhabitants and is the parish in Lisbon with more urban agricultural areas (almost 40 hectares) with a very recent rural past.
The methodology used integrates three dimensions: the ecological dimension, by considering the municipal ecological network (EEM) from the Lisbon Municipal Plan, the study of land use suitability assessment of the existent permeable vacant lot and the awareness of ecosystem services provision; the historic dimension, by considering the rural past; and the social dimension by studying Marvila’s informal horticulturists, through personal interviews.
The results showed that 28 % of Marvila’s area is permeable vacant lots and 5 % is area urban agriculture. The main systems of EEM are wet systems, structural corridor systems and green spaces that aims to connect the green areas of the city. From the total area of the former farms, 20 % are nowadays urban agriculture or horticultural parks. From the 29 horticulturists interviewed, it was possible to understand that most of them live closer to the vacant lots (130 to 200 m away) and do it to feed themselves and their families and also for leisure, as a hobby.
The results showed that is possible to have a landscape planning strategy based on two levels of intervention. The first level corresponds to the urban voids related to the EEM, which should have a permanent agriculture and the second level, outside the areas classified as EEM, which can have a transitory land use of informal urban agriculture.
The informal urban agriculture gives an opportunity to plan for sustainable development, a healthier society, reinforcing the relationship between man and nature.

Keywords: illegal urban agriculture, ecosystem services, urbanism, landscape planning, society, Marvila

ECO1: Mapping for soil sustainable management

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Lithuanian National Ecosystem Services Assessment and Mapping (LINESAM)

Paulo Pereira, Ieva Misiune and Katarzyna Miksa

Environmental Management Laboratory, Mykolas Romeris University, Lithuania.

The project LINESAM (Lithuanian National Ecosystem Services Assessment and Mapping) aims to create a scalable Ecosystem Services (ES) mapping and assessment framework in order to understand the interaction between ecosystems- human wellbeing and how environmental and socio-economic drivers of change affect ES provisioning capacity. The project builds on terrestrial and marine case studies including urban areas (Vilnius Municipality), forests (Alytus Region), agricultural areas (Siauliai Region) and coastal environments. The specific objectives of the projects are: 1) Construct a scalable conceptual model for ES assessment in Lithuania, that can be applied in different areas (marine, urban an terrestrial) and scales (local, regional and national); 2) create a geodatabase different datasets at local, regional and national levels; 3) Identify the stakeholders and the different levels of interest towards ES; 4) development of a stakeholder engagement strategy; 5) mapping and assessment of ES at national level; 6) mapping and assessment of the effects of drivers of change on ES supply, 7) Evaluate ES supply according the importance of the ES in Lithuania, their socio-ecological dimension, heterogeneity of the ecosystem and finally, 8) the creation of a geoportal.

Acknowledgments

This study was supported by the project A09.3.3-LMT-K-712-01-0104 Lithuanian National Ecosystem Services Assessment and Mapping (LINESAM) (Program: improvement of researchers' qualification by implementing world-class R&D projects), Lithuanian Research Council.

Keywords: Ecosystem Services, mapping, socio-ecological dimension, stakeholders, geoportal

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Digital soil mapping and uncertainty propagation of available water capacity for metropolitan France

[1]Mercedes Roman Dobarco, [1]Nicolas P.A. Saby, [2]Hocine Bourennane, [2]Isabelle Cousin, [1] Dominique Arrouays and [1]Manuel P. Martin

[1]*INRA US1106 Infosol, National Institute of Agricultural Research, Orléans, France*
[2]*INRA UR Sols, National Institute of Agricultural Research, Orléans, France*

Plant available water capacity (AWC) refers to the maximum amount of water that a soil can store and provide to plant roots. Spatial predictions of AWC at high resolution and national extent provide relevant information for crop management, land use planning, and modelling ecological and hydrological processes. The objectives of this study were: 1) to produce a digital soil map of AWC for metropolitan France following GlobalSoilMap (GSM) specifications, and 2) identify the main sources of uncertainty of AWC predictions.
The digital soil mapping approach consisted in predicting sand and clay for the six GSM depth intervals (0-5, 5-15, 15-30, 30-60, 60-100, 100-200 cm) combining regression and geostatistical models, and then applying pedotransfer functions (PTF) for estimating AWC (cm3 cm-3) by layer. We applied continuous-PTF developed with data of soil hydraulic properties from French soils (SOLHYDRO database) for estimating soil moisture at field capacity (pF = 2.0) and permanent wilting point (pF = 4.2). The volume of coarse elements by GSM layer (Mulder et al., 2016) was subtracted before aggregating AWC to the predicted soil depth (Lacoste et al., 2016) for a maximum of 2 m. The variance associated to the AWC predictions by GSM layer was calculated by first-order Taylor analysis. We considered the uncertainty of the soil input variables (sand, clay, and coarse elements) and their spatial correlation, and the uncertainty of PTF coefficients.
The results indicated that for reducing the uncertainty of AWC we should invest our efforts on improving the predictions of soil input variables rather than on the PTF. A main advantage of the produced AWC map is that its uncertainty can be incorporated in uncertainty analysis for crop and ecological modeling.

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Keywords: Available water capacity, pedotransfer functions, digital soil mapping,

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GlobalSoilMap, error propagation, first-order Taylor analysis.

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Contributing to healthy landscapes by sustainable land use planning. A vision for restoring the degraded landscape of the Centre Region of Portugal

Selma Beatriz Pena, Manuela Raposo Magalhães and Maria Manuela Abreu

Universidade de Lisboa, Instituto Superior de Agronomia, LEAF - Linking Landscape, Environment, Agriculture and Food Research Centre

The National Ecological Reserve (REN) is a legal planning framework in Portugal, established in 1983, with the purpose of protecting the biophysical structure of the territory, ensuring the protection of ecosystems essential to the ecological balance of the landscape. The REN emerged in a context where urban growth was occurring without following any landscape plan. Its delimitation and regulation were made at the municipal level, losing the consistency of its criteria at regional and national scales.
In 2016, the authors research led to a proposal of mapping criteria, GIS methodologies and a set of potential land uses at the national level, to be used as a base map for regional and municipal delimitation of REN. The confrontation between the potential land uses of REN with the existent land uses allowed to determine the location of the areas that should be targeted for landscape conservation or restoration plans. This analysis had shown that about 33 % of the Portuguese mapped REN area should be the subject of landscape restoration plans. The work also showed that from the five NUTII regions of Portugal (Centre, North, Lisbon Metropolitan Area, Alentejo, and Algarve), the Centre Region represented the one with more needs in developing landscape restoration plans.
In addition, the Centre Region was the most affected by the recent rural fires from 2017, representing 15 % of total region area (416 thousand hectares). These events reflect the high importance of rethinking the territory with more suitable land uses, considering the concepts of sustainability, resilience, and ecological integrity. This work aims to demonstrate the relation between the degraded areas from the recent rural fires and the landscape restoration target areas considered by the team at 2016. This will contribute to the development of a landscape restoration vision for those degraded areas or target restoration areas using the main REN components (wet system, headwater system areas, high potential soil erosion areas, maximum infiltration areas), leading to a future healthy landscape.

Keywords: Landscape restoration, Ecological Integrity, Landscape Planning, Soil and Water Conservation, GIS, Rural Fires

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Hyper-spectral mapping of soil and vegetation conditions along semi-arid to arid climatic gradient

Maxim Shoshany

Mapping and Geo-Information Engineering Division, Faculty of Civil & Environmental Engineering, Technion, Israel Institute of Technology, Haifa 32000, ISRAEL

Climatic Gradients are the areas where climate change may cause ecosystems transition, desert boundary shift and irreversible degradation. Climate change predictions for this century for the South – Eastern Mediterranean suggest reduction of water resources by more than 20%. Such change is expected to have a significant impact on ecosystems along the climatic gradients between semi-arid and arid zones. Monitoring these zones of transition may allow better understanding of the expected changes. Hyperspectral remote sensing offers a unique tool for monitoring vegetation and soil conditions with high sensitivity to chemical-biophysical and biological properties of plants and soils. During April 2017 there was acquired a high spatial resolution (1 meter) hyper-spectral strip (1,500 meters width) between a desert fringe zone (230 mm/year Mean Annual Precipitation) and a semi arid shrubland (500 mm/year MAP) , passing through numerous spatial compositions and patterns of soils, rocks, herbaceous plants, dwarf shrubs, shrubs and planted trees . Using well established spectral indices we mapped vegetation (e.g., pigments) and soil conditions (e.g., organic versus inorganic carbon) along this strip. During the conference we will present analysis of mutual relationships between soil and vegetation conditions and between them and MAP. Such analysis sheds light on ecosystems transition along the climatic gradient and their sensitivity to the expected reduction in water resources.

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Keywords: mapping, vegetation, climate gradients, remote sensing

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Remote Sensing Techniques to Assess Post-Fire Effects at the Hillslope and Sub-Basin Scales via Multi-Scale Model

Anna Brook, Maria Polinova, Daniella Kopel, Lea Wittenberg, Dar Roberts and Nurit Shtober-Zisud

University of Haifa, Israel

Post-fire environmental footprint is expected at varying scales in space and in time and demands a multi-scale monitoring approach. A spatially and temporally explicit multi-scale model that reveals the physical and morphological indicators affecting hillslope susceptibility at varying scales, is explained and demonstrated. The qualitative and quantitative suitability classification procedures are adapted to translate the large-scale space-borne data supplied by satellite systems (Landsat OLS8 and Sentinel 2 and 3) to local scale produced by a regional airborne survey performed and by local-scale optical imagery collected by UAV. At the smallest spatial and temporal resolution, a daily airborne imagery collection by DJI Phantom4 system is linked to micro-topography model, using statistical and mathematical approaches. The spatial analysis of fire patterns allows us to identify the factors driving trends and interactions in the spatial/temporal distribution and determine the observation scales of possible spatial relationships. The methods for modelling local processes, specifically on slopes, have been used in the context of wildfires, but the spatial and temporal data were studied separately. The spatio-temporal structure of the distribution of wildfires is very complex as it dependence cannot be separated in space and time. However, for logistical reasons, only few studies have been able to examine the responses of burnt terrain immediately after burning. Moreover, the relation between erosion and surface runoff generation and the susceptibility of hillslopes is well established in the literature, these effects has been studies on topographic level without considering possible micro-topographic effects. In this study the morphological and textural variations of burned area associated with soil erosion at micro-topographical scale right after the fire and during 1 year of monitoring were investigated. For this purpose we developed a multi-scale/multi-source approach integrating satellite-, airborne-, UAV and field- remote sensing data with terrestrial survey and micro-topography data in the fire-affected area.

Keywords: UAVs, Mapping, remote sensing, soil, wildfires

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Mapping environmental variables for a sustainable management of soil using intercrops; an interdisciplinary student project as study case

Vandoorne Bertrand, Lejoyeux Charlotte, Baumann Geneviève, Vernier Louise and Rolloy Marie

Yncréa Hauts-de-France / ISA Lille, France

In the framework of their Master 1 project in agronomical sciences, one team of ISA Lille students took part in the European contest 'Farming by Satellite'. This contest, especially financed by Bayer, Claas and the European Spatial Agency, ask student to give ideas about the use of teledetection in agriculture.

The 4 students from ISA proposed to use satellite data coming from the Sentinel constellation (European Copernicus program) to map some plant and soil parameters in order to modulate the sowing of intercrops. This modulated sowing aims to correct observed soil deficiencies.

Students won the contest and this gave a lot of credit to their idea in the school and regionally thanks to the communication made around their victory. Yncrea – ISA Lille decides to support the team in their wish to continue this project. Together with students from the two other engineering schools of Yncrea (ISEN and HEI), they started in September 2017 an interdisciplinary project called co-elab. This Master 2 project showed that the concept was technically feasible. ISA Lille students do not have the competencies to work all aspects of the project alone, but students from HEI and ISEN showed that it was possible to map the needed environmental parameters using Sentinel data and propose modulated sowing advices for intercrops.

The Master 2 project concluded that the idea was interesting and feasible but showed also that it need some more research before to come on the agricultural market. Starting from a student project, the work will now lead to a new aspect; the development of an applied research program for the Smart Farming team of ISA Lille.

This presentation will give some environmental mapping aspects of the idea, but will mostly put forward the evolution of this interdisciplinary project, from an idea coming from student to applied research.

Keywords: Agriculture, teledetection, mapping, soil deficiencies, intercrops, modulation

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Mapping Green and Blue Infrastructures Using Digital Globe Images in Vilnius City

[1]Paloma Hueso-González, [2]Ricardo Remond, [1]Juan F. Martínez-Murillo and [3]Paulo Pereira

[1]*Instituto de Geomorfología y Suelos, Departamento de Geografía, Universidad de Málaga, Málaga, España.*
[2]*Departamento de Geografía, Universidad de La Habana.*
[3]*Environmental Management Laboratory, Mykolas Romeris University, Lithuania.*

Global population is concentrated in cities posing a great pressure on these of environments. Increasing population needs resilient and healthy ecosystems. Urbanisation reduces ecological connectivity and ecosystems are importantly affected. This decreases ecological resilience, ecosystem functioning and biodiversity, in turn affecting the supply of ecosystem services quality and quantity. Cities are complex socio-ecological systems and the needs to improve well-being are highly variable. The demand for ecosystem services is therefore equally diverse and context-dependent. Green-Blue Infrastructures (GBI) are hypothesised to increase ecological connectivity and quality, improve biodiversity and functioning, deliver multiple ecosystem services and direct improvements to human wellbeing. GBIs have an indirect well-being effect by mitigating the negative urbanisation cascade. They are defined as sets of ecosystems, linked into a spatially coherent system through flows of organisms, and interacting with the landscape matrix. This work aims to contribute to the socio-ecological knowledge based on critical features of GBIs assessed in Vilnius citiy (Lithuania), and provides tools for guiding their establishment, management and evaluation through an innovative two-way approach: citizen science including spatial data mobilisation, and the transdisciplinary valuation and co-creation of GBIs by a range of stakeholders.

To do this, one previous procedure to map green and blue infrastructure is applied to high resolution images Digital Globe (0.5x0.5 metres). Using ENVI, IDRISI and ArcGIS software, the images were treated and classified obtaining the map of land uses. Once this was obtained, the focus was put into the GBI: woodland in urban and periurban areas, parks, gardens, and fluvial channels. In the end, a tailored and detailed map of these infrastructure was obtained in order to assess the ecosystem services provided to local users and stakeholders.

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and the project A09.3.3-LMT-K-712-01-0104 Lithuanian National Ecosystem Services Assessment and Mapping (LINESAM) (Program: improvement of researchers' qualification by implementing world-class R&D projects), Lithuanian Research Council.

Keywords: Urbanisation, Green and Blue Infrastructures, Ecosystem Services, Biodiversity, Vilnius

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Sampling Density and Soil Phosphorus Mapping on Various Field Scales. What This Means for Farmers?

[1]Igor Bogunovic, [2]Paulo Pereira and [3]Sebastiano Trevisani

[1]*Faculty of Agriculture, University of Zagreb, Svetosimunska 25, Zagreb, Croatia*
[2]*Environmental Management Center, Mykolas Romeris University, Ateities g. 20, LT-08303 Vilnius, Lithuania*
[3]*University IUAV of Venice, Department of Architecture, Construction and Conservation, Dorsoduro 2206, 30123 Venezia, Italy*

The objective of this work is to study the spatial variability of soil available phosphorus (AP) on agricultural field scales in Croatia using geostatistical tools. The application of this technique is important to understand the spatial pattern of soil AP and identify areas where the deficit of this nutrient is high. Several datasets were used from different areas, with different sampling density: (100) 100 x 100 m (183 samples, Anthrosols), (50) 50 x 50 m (84 m, Stagnosols), (225) 225 x 225 m (404 samples, Gleysols), (12.5) 12.5 x 15.5 m (200 samples, Stagnosols). The results showed a highest concentration of AP in the following order: 12.5 (208 mg/kg) > 225 (208 mg/kg) > 50 (198 mg/kg) > 100 (30 mg/kg). Spherical models were the best fitted for 12.5, 225 and 100 datasets) and the exponential models for 50 dataset). Interpolation accuracy was evaluated using the Root Mean Square (RMSE) index. The highest accuracy (lowest RMSE) were noted at the 100 sampling density dataset (RMSE 4.49), followed by 50 (RMSE 25.97), 12.5 (RMSE 32.66) and 225 dataset (46.08). Nevertheless, the RMSE/mean AP concentration ratio in a given field represent 13.1%, 14.9%, 15.4% and 22.1% of AP for 50, 100, 12.5 and 225 dataset, respectively. Laboratory costs for sample preparation and AP determination were 3.5 euro/ha, 8 euro/ha, 32 euro/ha and 128 euro/ha for 225, 100, 50 and 12.5 datasets. According the precision and laboratory costs, the farmer's best choice for adoption of precision agriculture seems to be a sampling in regular grid 100 x 100 m.

Keywords: kriging, sampling density, mapping, farmer cost.

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A Review of Soil Geography Origins

[1]Jesús Rodrigo-Comino, J., [2]José María Senciale, [3]Artemi Cerdà and [4]Eric C. Brevik

[1]*Instituto de Geomorfología y Suelos, Department of Geography, University of Málaga, 29071, Málaga, Spain.*
[2]*Department of Geography, University of Málaga, 29079 Málaga, Spain.*
[3]*Soil erosion and Degradation Research Group, Department of Geography. University of Valencia, 46010 Valencia, Spain.*
[4]*Department of Natural Sciences, Dickinson State University, Dickinson, ND, USA.*

Soil geography is not clearly recognized as a sub-discipline soil science and geography, being various times over the last century accepted as a complementary and descriptive sub-discipline of botany, agronomy or geology. Definitely, there was not a clear consensus about its identification and origins over the world (Rodrigo Comino et al., 2016; Rodrigo Comino and Senciales González, 2013). Therefore, the main objective of this review is to perform a historical review from the development of soil sciences and geography to the s. XX-XXI, where soil geography can be considered as a discipline. We pretend to clarify its origin, early methods, first authors and the importance of its interdisciplinary perspective within the scientific community. K.D. Glinka (1867-1927), one of Dokuchaev´s students, who could be considered as the father of soil geography. We found that soil geography was considerably advanced by the work of C.F. Marbut (1863-1935), who could be considered one of the first world-reknown soil geographers. After that, since the s. XX, soil geography continued to develop with research conducted by scientists including Kellogg, Simonson, Kubiëna, Huguet del Villar, Fitzpatrick, Duchaufour, Stremme, Zinck and entities such as USDA, FAO-UNESCO and CSIRO.

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Keywords: Soil geography; K.D. Glinka; C.F.Marbut; soil mapping; multidisciplinary origin; interdisciplinary origin.

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Soil erosion in vineyards over the world. A review

Jesús Rodrigo-Comino

Physical Geography, Trier University, 54286 Trier, Germany.

Soil erosion is a major threat to achieving sustainability in agroecosystems. High erosion rates disturb natural cycles and crop production (Alewell et al., 2015; Muluneh et al., 2017a), making soil erosion one of the most important issues to be solved by humankind to achieve sustainability (García-Ruiz et al., 2015; Panagos et al., 2017). Soil erosion is a problem that affects vineyards worldwide. This is well assessed in the scientific literature, but there is not a review that shows the state-of-the-art. In general, it is accepted that soil erosion is high in vineyard fields and catchments (e.g. Bhatt and Khera, 2006; Feng et al., 2016; Mohammadkhan et al., 2011) and historically this has mainly been a Mediterranean issue (Prosdocimi et al., 2016a). But now we know that there is an expansion of vineyards in other regions and it is necessary to assess what we know so we can better plan future research. In addition, information about soil erosion in vineyards has often failed to reach an international audience, and we can affirm that soil erosion in vineyards has been more a scientific issue than an agronomic or environmental concern. Thus, the main goals are to assess: i) where and how soil erosion studies have been conducted; ii) which methods have been applied to measure soil erosion rates; iv) survey soil erosion rates in vineyards around the world; iii) list factors that enhance soil and water losses; iv) inform about the authors who developed current and past research; and, v) evaluate which management strategies can reduce soil losses and achieve sustainable crop management. There is a need to find management practices that will achieve sustainability through reduction of soil losses via nature-based solutions.

Keywords: Soil erosion; vineyards; review; human factors; natural factors; solutions.

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Mapping Physical and Chemical Parameters in a Complex Agricultural System: Implications for Soil Budgets at Field and Catchment Scales

Manuel López-Vicente and Sara Álvarez

Dept. of Soil and Water, Experimental Station of Aula Dei, EEAD-CSIC. Avda. Montañana 1005, 50059, Zaragoza, Spain.

Maps provide spatially distributed information of physical, chemical, topographic, climatic, geomorphic and land use and management parameters and processes. This data allow estimating soil budgets at field and catchment scales. Besides, maps make up the main input of rainfall-runoff and soil erosion models. Thus, accurate mapping becomes necessary to obtain representative values and rates in agricultural and environmental studies.

In this study, we generated different maps of eleven soil physical and chemical properties in a Mediterranean rainfed agricultural sub-catchment (27.3 ha) located in the Ebro River Basin (NE Spain; 42° 02´ 00´´ N; 0° 04´ 12´´ E). Topography is hilly with a mean slope gradient of 13%. Soils are Haplic Regosols (calcaric; RGca) in the upper part of the hillslope and surrounding the divides, and Luvic Calcisols (CLl) near the bottom. Land is mainly devoted to agriculture: four vineyards (15,039 grapevines arranged in 147 straight lines), five cereal fields, one abandoned and one commercial (314 trees) olive grove. Small patches of natural vegetation appear throughout the landscape (12% of the total area). A total of 222 soil samples (250 cm3 per sample) were collected in 74 points (3 replicates per point). Then, the bulk density (gr / cm3), the content of coarse fragments (> 2 mm, % weight), clay (0.04 - 2 µm), silt (2 - 63 µm) and sand (63 - 2000 µm) was measured, and the effective volume of the soil (%) and the texture classification were determined. The content of total nitrogen (TN; %), phosphorous (TP; mg /Kg), potassium (TK; mg /Kg) and soil organic carbon (SOC; %) was determined. Different kriging interpolation options were used obtaining clear differences in the soil budgets at the different compartments: rows, inter-row areas, corridors, at each field and land use, and at sub-catchment scale.

Keywords: Mapping; kriging interpolation; bulk density; soil texture; soil organic carbon; soil nutrient.

ECO2: Grazing as a management tool to build cultural landscapes

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Evaluating the impacts of grazing and climate change on the structure and functioning of global drylands: the BIODESERT global survey

Fernando T. Maestre

Departamento de Biología y Geología, Escuela Superior de Ciencias Experimentales y Tecnología, Universidad Rey Juan Carlos, c/ Tulipán s/n, 28933 Móstoles, Spain

Changes in climate and land use (e.g., increased grazing pressure), are two main global change components that also act as major desertification drivers. Understanding how drylands will respond to these drivers is crucial because they occupy 45% of the terrestrial surface and are home to over 38% of the world's human population. Land degradation already affects ~250 million people in the developing world, which rely upon the provision of many ecosystem processes (multifunctionality). To better understand the joint effects of climate change on drylands, I am currently coordinating a global field survey (the BIODESERT survey), involving more than 60 scientists working in over 30 countries from all continents except Antarctica, aiming to assess how simultaneous changes in climate and grazing pressure affect both biotic attributes and multifunctionality in drylands worldwide. In this communication, I will present the main characteristics of the BIODESERT survey, and some preliminary data regarding the location and environmental characteristics of the sites surveyed so far. By studying multiple grazing levels at each site and conducting a global study encompassing all aridity conditions found in drylands, the data gathered with this survey will provide key information to characterize the likely impacts of land degradation due to grazing on ecosystem structure and multifunctionality under climate change in drylands worldwide.

Keywords: drylands, biological soil crusts, spatial pattern, species richness, soil functioning, climate change.

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Feral goat in Balearic Islands: an ecological or social problem?

[1]Oriol Domenech, [2]Jordi Bartolome, [2]Joan Rita and [1]Elena Baraza

[1]*Departamento de Biología. Universidad Autónoma de las Islas Baleares (España)*
[2]*Departamento de Ciencia Animal y de los Alimentos. Facultad de Veterinaria. Universidad Autónoma de Barcelona. 08193 Bellaterra (España).*

The mountain systems of the islands of Mallorca, Menorca and some islets present a population of feral goats (Capra hircus L.), insufficiently known. There are not complete data about their distribution, density and abundance, or their population parameters. However is known that they are being able to have significant impacts on natural ecosystems. In some islands, especially oceanic ones, feral goats have been eradicated because of their high impact on native vegetation. However feral goat eradication on very populated islands, of large size and with a secular exploitation of the species is not possible. Moreover, on Mediterranean Island, with a long history of plant evolution with herbivores, ecosystem equilibrium could be established in some plant communities. This is the case of Mallorca and Menorca where, the habitat of the feral goats presents a complex orography, very fragmented property structure, and great landscape heterogeneity and typologies of agroforestry management of the territory, which limits the establishment of an effective management of their populations. Furthermore, from the social and emotional point of view, there are notable divergences at the level of perception of feral goats. Different social groups appreciate the species as a hunting resource and economic engine. Other groups demand for their eradication considering it as invasive species. Different sectors of society are concerned with the methods used during population control. This paper analyze the data coming from the intervention and control mechanisms of the territorial administrations, and evaluate to what extent they can reflect the evolution of the goat population and its impacts on the ecosystem. Likewise, information is collected from the media in order to relate the social perception with the possible variations in the density or behavior of the animals, as well as the influence of the management systems on their population dynamics.

Keywords: feral goat, ungulate pressure, social perception, population control, media.

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LIFE REGENERATE: Revitalizing multifunctional Mediterranean agrosilvopastoral systems using dynamic and profitable operational practices

[1]Katherine Franco, [1]Sven Kallen and [2]Priya Devasirvatham

[1]*TRANSFER CONSULTANCY S.L*
[2]*VOLTERRA ECOSYSTEMS S.L.*

The Quercus-based silvopastoral systems of the Mediterranean basin biome (for example dehesas, montados and meriagos that cover up to 6 mln ha in the EU) are in rapid decline [1]. Estimates show that dehesas currently produce a deficit of 200€/ha. Prices for their products are similar to those 30 years ago, and land owners face losses of up to 500€/ha due to phytophtora-related diseases. It is estimated that these agro silvopastoral lands have lost up to 20% of their value and currently lose millions of euros in productivity each year [2].

Simultaneously, agro-subsidies are steadily decreasing. In 2015, farmers in Andalucía reported up to 60% of cutbacks in CAP subsidies [2]. Regional subsidies in this area now only cover about 8% of landowners [3]. In Sardinia, rural abandonment has caused an increasing of the number of rented and leased farms and the loss of local typical micro-economies.

Many anthropogenic and environmental factors challenge the survival and sustainability of these valuable ecosystems. The younger generation inheriting these broken systems needs to transform current production models into cost-efficient operations that work with nature, not against it. They will have to lower input costs, find alternative sources of income, recycle resources, stimulate natural regeneration, improve soil and increase farm productivity so that their land can become economically and environmentally sustainable.

LIFE Regenerate\'s main objective is to demonstrate that these SMEs can become self-sufficient and profitable based on resource efficiency principles and incorporating added value products, both at a demonstration and a larger scale.

The project has the following specific objectives:

1. Combat the loss of natural regeneration and soil degradation in 100 ha of degraded silvopastoral areas by providing effective, mosaic landscape management procedures and improving soil quality;

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2. Recover the practice of multi-species rotational grazing, adapted to improve natural capital and optimize commercial advantages;

3. Recycle biomass waste within the farm, reducing external input of fodder and creating alternative sources of income;

4. Replicate the project's best practices to 5,000 ha in Spain, Italy & Portugal, proving it is a representative, effective model;

5. Integrate new technologies and monitoring of project advances;

6. Influence policy-making and involve external stakeholders to promote replication and long term Sustainability.

Acknowledgement. This project is co-financed by the European Union through the LIFE Programme. Duration 01/09/2017-29/10/2021.

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Keywords: silvopastoral systems, mosaic landscape management, rotational grazing, improving soil quality.

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Grazing Systems in The World: Differences and Similarities

Manuel Pulido and Jesús Barrena-González

GeoEnvironmental Research Group, University of Extremadura, Cáceres, Spain

Since the times of the Bible grazing has been one of the most important activities of humanity. This human activity has been modeling landscapes until nowadays reaching figures of more than 3 billion ha of pastures and 470 million ha of arable land dedicated to animal feed production. The current growing demand in animal products is being one of the main causes of many environmental alterations and the increasing of landless production as well. In parallel with this, different land management is being implemented in traditional grazing systems.

This oral presentation shows using illustrative pictures provided by collaborators of many countries different types of grazing systems throughout the world: Spanish dehesa, Portuguese montado, Brazilian faxinal, Mexican ranches, and intensive and extensive landless productions. They share a human rationale of natural resources exploitation (e.g. clearance of natural forest) although physical drivers such as aridity or human-induced problems such as overgrazing, pollution, GHG emissions, and land and water overutilization coexist with the different socio-economic reality of each territory. It evidences each grazing system is context-dependent and justifies the necessity of global studies comparing local cases that only can be afforded building transnational and multidisciplinary research networks on grazing.

Keywords: Livestock, Global figures, land management, rangelands, grasslands and landless production.

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A Deductive Remote Sensing Approach for The Assessment of Grassland Carrying Capacity with an Application in The Mountain Grasslands of Azerbaijan

Jan de Leeuw, Afag Rizayeva, Elmaddin Namazov, Jonathan Etzold and Regina Neudert

ISRIC, Wageningen, The Netherlands

The use of remote sensing in grassland carrying capacity assessments has not been significantly adopted in rangeland management. Possible reasons for this limited adoption include the advent of non-equilibrium thinking in rangeland management as well as costliness and complexity of existing remotely sensed carrying capacity assessment approaches. Here, we present a less demanding deductive approach for grassland biomass estimation based on the MODIS Net Primary Production (NPP) product. We demonstrate this approach through a carrying capacity assessment for the mountain grasslands in Azerbaijan. Based on publicly available estimates of fANPP, the fraction of NPP partitioned to aboveground NPP, we calculate the average annual aboveground NPP (ANPP) from 2005 to 2014. Validation of the predicted ANPP with independent field biomass estimates collected in 2007 and 2008 confirmed the accuracy of the ANPP product and its appropriateness for further carrying capacity assessments. The assessment revealed significant geographical variation in carrying capacity. While providing guidance on the strength and limitations of the approach we conclude that, given its generic nature and open access availability of most input data, it could be replicated in space and time. Hence, we advise considering its use where traditional carrying capacity assessments are difficult to implement.

Keywords: grassland, remote sensing, production, biomass

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Formal vs. non-formal environmental education for climate change adaptation

Cristina Halbac-Cotoara-Zamfir

Politehnica University Timisoara, Romania

Adapting to climate change and inherently hydrological climate hazards means implementing an approach based on anticipating the negative impacts of climate change, followed by taking appropriate measures to prevent or minimize the damage that they may cause or to take advantage of opportunities care could arise and involves the creation of a disaster-resistant society with a high adaptability capacity. Adaptation to climate change, as component of sustainable development, requires the educational framework to be approached through close collaboration with decision-makers and through actions to consult and understand the impacts and management of the impact of these changes. Education has been shown to be a fundamental instrument that contributes to behavioural changes within the society, which is ultimately translated into environmental citizenship.

New types of formal and non-formal environmental education breakthroughs should emerge in several dimensions such as innovations in curriculums, research paradigms, learning materials, educational interventions, business programs, civic participation, professionals and expertise. Thus, human resource, which is an important component in climate change adaptation strategies, will benefit of a series of educational tools for a better understanding of these processes and for identifying the most sustainable solutions in drawing and implementing climate change adaptation plans.

The different macro- and micro- level dimensions of formal and non-formal environmental education that could lead to implementing an efficient environmental educational system for climate change adaptation represents the core of this paper.

Keywords: climate change, environmental education

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The use of design thinking based on climate change and carbon sequestration

[1]Gabriel Gascó, [2]Ana Tarquis, [1]Antonio Saa and [3]Ana Méndez

[1]*Departamento de Producción Agraria, ETSI Agronómica, Alimentaria y de Biosistemas. Universidad Politécnica de Madrid, 28040 Madrid, Spain*
[2]*Departamento de Matemática aplicada, ETSI Agronómica, Alimentaria y de Biosistemas. Universidad Politécnica de Madrid, 28040 Madrid, Spain.*
[3]*Departamento de Ingeniería de Ingeniería Geológica y Minera, ETSI Minas y Energía, Universidad Politécnica de Madrid, Ríos Rosas 21, 28003 Madrid, Spain.*

Design thinking is a method for practical creative resolution of problems. It is a form of solution-based thinking with the intent of producing a constructive future result. Design thinking differs from scientific method by including consideration of the emotional content of the situation. The subject of Environmental Engineering of the Master in Environmental Engineering (Universidad Politécnica de Madrid, Spain) is a good opportunity for the introduction of students in the design thinking strategies. Firstly, professors explain to the students the environmental implications of production and biochar use on carbon sequestration and secondly, students are encouraged to display their ideas about soil C sequestration and CO_2 emission calculation. This strategy is developed during an incubation experiment of several months where students measure soil CO_2 emissions and different soil properties. Finally, students use different models to model CO_2 emissions at different temporal horizons.

Keywords: design thinking, CO2 emissions, climate change, environmental engineering

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Firebreaks as a natural attraction for feral goats in fire prevention

[1]Javier Pareja, [1]Jordi Bartolomé, [1]Emanuel Serrano and [2]Elena Baraza

[1]*Department of Animal and Food Science. Veterinary Faculty. Autonomous University of Barcelona*
[2]*Department of Biology. University of the Balearic Islands*

In this work, we have evaluated whether forest firebreaks resulted attractive feeding areas to feral goats (*Capra hircus*) in the Na Burguesa mountain, Mallorca island, Spain.
To assess browsing intensity of shrub vegetation, we covered 32 transects (16 in the forest border and 16 in the firebreaks) of 20 square meters each (20 x 1 m) on a monthly basis (July-September 2017). Browsing intensity was assessed according to a browsing score ranging from 0 (not used) to 3 (intensely browsed), whereas goat abundance by pellet counts.
Our results showed that the firebreak zones were preferred places for browsing being *Phillyrea angustifolia, Globularia alypum, Ampelodesmos mauritanica, Cistus albidus* and *Olea europaea* the most consumed plants. Along the same lines, the amount of pellets accumulated was three times higher in the firebreak area than in the forest one over the study period.
In conclusion, feral goats showed a clear preference for firebreaks contributing to biomass control and probably to fire prevention in such Mediterranean landscapes.

Keywords: Firebreaks, pellet counts, feral goats and browsing intensity

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Delineation of land units in livestock farms of SW Spain designed for management purposes

Jesús Barrena-González, Joaquín Francisco Lavado Contador, Álvaro Gómez Gutiérrez, Alberto Alfonso-Torreño and Manuel Pulido

GeoEnvironmental Research Group, University of Extremadura, Cáceres, Spain

Nowadays the need for land management alternatives that seek resources sustainability is widely recognized. Frequently, land units need to be determined to know the local-specific potentialities. In this study, a methodology is proposed for the delineation of land management units in farms of SW Spain mainly devoted to livestock rearing. Physical-environmental units were first determined where information about land management was added afterwards. The methodology is based on the analysis of spatial information coming from aerial and satellite images, in combination with land and livestock management and socio-economic information obtained from interviews to the land owners. The methods are based on OBIA technics (Object- Based Image Analysis) by considering a hierarchical approximation for the delimitation of the spatial objects, from those encompassing the main characteristics of the landscape morphology and vegetation cover to others reflecting the local-specific features. Using fuzzy algorithms, digital elevation models were used to produce morphometric variables that, in combination with information of the general soil cover, vegetation characteristics and productivity surrogates, were first aggregated to produce the main land units. Local land use and management information was considered afterwards to redefine the spatial objects, resulting in the definition of the main land units of the farms.

Keywords: Land management, local-specific potentialities, aerial and satellite images, OBIA technics, rangelands, Extremadura

ECO3: A biophysical and socio-economic approach to the fate of the Terroir

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Ranking under-stock-weeding-machines for sloping vineyards by a bundle of measurement methods

[1]Jesús Rodrigo-Comino, [1]Alexander Remke, [2]Artemi Cerdà and [1]Johannes B. Ries

[1]*Physical Geography, Trier University, 54286 Trier, Germany.*
[2]*Soil erosion and Degradation Research Group, Department of Geography. University of Valencia, 46010 Valencia, Spain.*

Soil erosion in vineyards is a well-known environmental problem in Germany, especially on the steep slopes of the Mosel Valley (Rodrigo-Comino et al., 2017; Richter, 1980; Rodrigo-Comino et al., 2017). Unfortunately, soil erosion mitigation measures are either very costly or tedious (Galati et al., 2015; Marques et al., 2015). In order to achieve connectivity assessments and soil erosion measurements in sloping vineyards for long-term periods and with non-invasive methods, the improved stock unearthing method (ISUM) can be used (Rodrigo-Comino and Cerdà, 2018a). Recently, Rodrigo-Comino (2018b) included an improvement for this method by doing three extra measurements in the inter-row-areas, thus monitoring the surface between the vines (Rodrigo-Comino et al., 2018b). However, a shortcoming of both SUM and ISUM remains clear: the area between the cross sections is not scanned at all. Therefore, an exact accuracy for soil erosion estimations has not been reached.

In order to fill this vast data gap, we can recognize Structure-from-Motion-Technique (SfM) as a suitable supplement. In this way, we want to present a combination of ISUM and SfM, which my enable an estimation of soil erosion with higher accuracy. Therefore, applying the erosion-deposition equation described by Paroissien et al., (2010), soil loss rates could be estimated. Thus, the main aim of this research is to combine both methods (ISUM and SfM) to map the actual top soil level and assess the connectivity of the processes and estimate soil erosion rates. This methodological research presents an improved easy, quick and low-cost method to assess connectivity soil erosion rates in vineyards with higher accuracy.

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Keywords: Soil erosion; ISUM; SfM; vineyards; connectivity; pedon scale

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Determining Soil Erosion Processes in Sloping Vineyards. A Comparison Between Ruwer-Mosel Valley (Trier, Germany) and Montes De Málaga (Málaga, Spain)

[1]Jesús Rodrigo-Comino, [2]José María Senciales, [1]Manuel Seeger, [3]Eric C. Brevik, [1]Johannes B. Ries and [2]José Damián Ruiz-Sinoga

[1]*Physical Geography, Trier University, 54286 Trier, Germany.*
[2]*Department of Geography, University of Málaga, 29071, Málaga, Spain*
[3]*Department of Natural Sciences, Dickinson State University, Dickinson, ND, USA*

Sloping vineyards are ones of the most degraded agricultural activities by human impacts and rainfall events. Specifically, in the vineyards of the Almáchar in the Montes de Málaga (Axarquía, Spain) and Waldrach in the Ruwer-Mosel valley (Trier, Germany), where the popular Moscatel and Riesling grape varieties are produced, land degradation have been reported by several authors, but not real quantifications of sediment and water losses.

Both of them are characterized by silty soils mainly on Palaeozoic schists and slates with different degrees of metamorphism, steep slopes (>30%), high rock fragment cover (>30%) and occasional generation of rills and gullies due to the use of heavy machinery, extreme rainfall events and trampling effect. Anyhow, farmers take measures against soil erosion, such as building rills to canalize the surface flow (called “agri-spillways”) and small walls of stones (“albarradas”) or the use of grass cover to reduce soil and water losses. However, they are not enough to avoid completely the problem.

Therefore, the two main aims of this work are: i) to measure the spatiotemporal variations of the hydrological and geomorphologic processes in two specific sloping vineyard´s plots with conventional land use management under two different climate environments (Mediterranean and Continental climate); and, ii) to find the main key factors (natural and anthropogenic) that could influence on soil erosion processes after natural rainfall events and soil tillage practices.

Results demonstrated that sloping vineyards in the Montes de Málaga (Spain) and the Ruwer-Mosel valley (Germany) on bare soils can experience high soil erosion rates, but clear patters were not demonstrated due to the human impact. The spatiotemporal distribution of hydrological and geomorphological processes is uneven and highly conditioned by several factors such as soil properties, tillage, rainfall intensity, the age of plantation and the hillslope morphology.

Keywords: Terroir, erosion, soil vineyards

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Non-tillage improves the quality of the soil in a vineyard under Mediterranean conditions.

Sebastia Capó-Bauçà, Natalia Llopis-Vidal, Alicia Marquès-Prieto, Josefina Bota and Elena Baraza

Departament of Biology, Universitat de les Illes Balears, Mallorca, Spain.

The climate change is a challenge for crops, especially in sensitive areas such as the Mediterranean. In view of this, we must search for new agricultural management that allows the crop to adapt better to new circumstances. We tested the effect of the presence of green cover compared to traditional soil tillage management during winter in the soil characteristics of a Mediterranean vineyard. Green cover resulted in higher organic carbon content, larger aggregates size and lower bulk density. Furthermore, this combination of properties favours a higher functional diversity of the microbial community measured with BIOLOG™ EcoPlates technology. Moreover, soils under green cover showed higher density of mycorrhizal spores. These results show that the maintenance of the cover of spontaneous species during the winter improves the chemical, physical and biological characteristics of the soil, which can improve ecosystem services associated. The control of weeds during the spring and summer to avoid possible negative effects on the vines can be done through mechanical mowing, thus avoiding soil degradation and maintain vineyard production.

Keywords: Climate change, aggregate size, soil microbiota, BIOLOG™ EcoPlates, mycorrhizal spores, spontaneous

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Effects of soil management on runoff and erosion response to rainfall events of sloping vineyards in the Monferrato area (NW Italy)

Marcella Biddoccu, Giorgia Bagagiolo, Danilo Rabino and Eugenio Cavallo

Institute for Agricultural and Earthmoving Machines (IMAMOTER), Italian National Research Council (CNR), Strada delle Cacce, 73 – 10135 Torino, Italy

The climate changes have a considerable impact on runoff and soil erosion in hilly vineyards since rainfall erosivity is strongly related to rainfall intensity and precipitation patterns. Moreover, in sloping conditions, the erosional processes are highly affected by seasonal climatic fluctuations and soil management practices. The use of controlled grass cover in the inter-rows is one of the most used and effective soil conservation practices adopted in temperate climates, nevertheless, the protective effect of grass cover may decrease according to seasonal pattern.

This study presents the results of two experiments recording runoff and soil losses in two rain-fed hillslope vineyards, with different row orientation, located in the Monferrato region, NW Italy. The objectives of the study are to compare the effects of different inter-row managements and rainfall characteristics on runoff and soil loss in hillslope vineyards.

Rainfall, runoff and erosion were monitored in vineyard plots, managed with conventional tillage (CT) and grass cover (GC). The first experiment (75 events) was carried out in the Vezzolano Experimental Farm in the period 1992-1997 in two portion of a vineyard with rows along the contour lines. The second experiment (about 120 events) is currently running, since 2000, at the Tenuta Cannona Experimental Centre, and includes two plots with rows along the slope. The results related to the first experiment showed the fundamental role of contour-slope row orientation in reducing the water and soil losses. Nevertheless, very high erosion rates (up to 12.3 Mg ha-1) were observed in the tilled plots during a single storm. In the vineyard with rows along the slope the highest erosion rates were observed during autumnal events and amount to 21.2 and 3.4 Mg ha-1, in the CT and GC plot, respectively. In both cases, the grass cover was especially effective in reducing soil losses during summer storms.

Keywords: Vineyard, Soil management, Row orientation ,Runoff, Erosion, Piedmont.

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Terroir and Human Health: Connecting People to Soil

[1]Eric C. Brevik, [2]Jesús Rodrigo Comino and [3]Artemi Cerdà

[1]*Department of Natural Sciences, Dickinson State University, Dickinson, ND, USA.*
[2]*Instituto de Geomorfología y Suelos, Department of Geography, University of Málaga, 29071, Málaga, Spain*
[3]*Department of Geography, Universitat de València, Valencia, Spain*

Soils provide many services that are essential to human life. Among these are several that positively influence human health, including food production and nutrient supply, water purification/filtration, supply of medicines, and exposure to soil organisms. There are also a number of ways that soils can negatively impact human health, including exposure to toxic levels of heavy metals, radioactive materials, or organic chemicals, contact with pathogens, inhalation of soil-derived dust particles, or consumption of crops grown in low-fertility soils. A common theme among soils that negatively impact human health is degradation. We have a pressing need to find ways to connect people to soils in a way that will encourage better stewardship. Terroir is an ancient concept that creates a connection between people, food products, and the land where that food was produced. Terroir is a holistic concept that combines aspects of the biological and physical environment, which includes soil, with cultural practices. The French use of terroir shows a strong desire to maintain the integrity of environmental spaces and ecosystems, the quality of food, and the identity and integrity of organisms, in other words, to care for the land that produces valued crops. While terroir originally established a connection between those who love wine and the soils that produce those wines, the connection has been extended to many other food products including cacao, cheese, coffee, fruits, olive oil, and water sources, meaning there may be room to further expand it to human health benefits. Furthermore, the concept of terroir has been shown to be an important factor determining the value of property in areas where wine is produced. People care for and take care of things they value. Therefore, terroir may be a concept that could improve human and soil health through better care for the land.

Keywords: terroir; soil and human health; stewardship; soil degradation

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Tractor Impacts on Soil Compaction in a Vineyard Located in Croatia

[1]Igor Bogunovic, [2]Paulo Pereira, [1]Ivica Kisic, [3]Marta Birkás and [4]Jesus Rodrigo Comino

[1]*Faculty of Agriculture, University of Zagreb, Svetosimunska 25, Zagreb, Croatia*
[2]*Environmental Management Center, Mykolas Romeris University, Ateities g. 20, LT-08303 Vilnius, Lithuania*
[3]*Szent Istvan University, Institute of Crop Production, H-2103 Gödöllö, Hungary*
[4]*Physical Geography, Trier University, 54286 Trier, Germany.*

Vineyards management in Croatia is normally done with machinery, approximately 12 – 16 times a year, depending on climate. The main objective of this work is to study the spatial and temporal changes of soil compaction on a Stagnosols at different depths. The research was conducted in the experimental station of Jazbina in northwest Croatia. During 2014 in May, August and October soil core samples (0 - 10; 10 – 20 and 20 – 30 cm) were collected from a row position between vine (ROW), tilled interrow position (IRT) and interrow position covered by grass covered (IRGC). At each sampling date, 108 undisturbed soil samples were collected, 324 in total. The variables measured were bulk density (BD) and gravimetric water content (GWC). During the same dates penetration resistance (PR) was determined with 177 measurements at each sampling date, 531 in total. In comparison to May, in October PR at IRT increased at 0 – 10 cm, 10 – 20 cm and 20 – 30 cm for 117%, 126% and 62%, respectively. Likewise, at same layers in October at IRGC position PR was high for 74%, 100% and 67%, compared to May. BD mean values showed the same behaviour: from 1.52 to 1.51 g cm-3 at the beginning of the season to 1.57 – 1.59 g cm-3 at the end after intensive traffic. In the subsoil (20 – 30 cm) PR was higher than 2.0 MPa, reducing root growth. No significant differences were found in BD between IRT and IRGC, while ROW showed significantly lower BD values. In October, topsoil PR was significantly lower in IRT than to IRGC, while in subsoil there were no differences. Therefore, annual soil loosening by subsoiling should be applied to break soil compaction at the end of season, while roto harrowing operation, every second interrow is a questionable practice for Croatian soil management.

Keywords: soil water content, soil compaction, bulk density, penetrometer resistance, Stagnosols

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Soil Erosion as Environmental Concern in Vineyards. The Case Study of Celler Del Roure, Eastern Spain, by Means of Rainfall Simulation Experiments

[1]Cerdà, A., [2]Rodrigo-Comino, J., [3]Giménez-Morera, A., [4]Novara, A., [5]Pulido, M., [6]Brevik, E. and [7]Keesstra, S.D.

[1]*Soil Erosion and Degradation Research Group. Department of Geography, Valencia University, Blasco Ibàñez, 28, 46010 Valencia, Spain.*
[2]*Department of Physical Geography, Trier University, D-54286 Trier, Germany*
[3]*Departamento de Economía y Ciencias Sociales, Escuela Politécnica superior de Alcoy, Universidad Politécnica de Valencia. , Paseo del Viaducto, 1 03801 Alcoy, Alicante, Spain.*
[4]*Dipartimento di Scienze Agrarie e Forestali, University of Palermo Italy,*
[5]*GeoEnvironmental Research Group, University of Extremadura, Faculty of Philosophy and Letters, Avda. de la Universidad s/n, 10071 Cáceres, Spain.*
[6]*Department of Natural Sciences, Dickinson State University, EEUU.*
[7]*ageningen University, Droevendaalsesteeg 4, 6708PB, Wageningen, The Netherlands.*

Soil erosion in vineyards has to be considered as an environmental concern as deplete soil fertility and produces damages in the fields and downstream (Dotterweich, 2008). Non-tolerable soil and water losses decrease soil quality, and subsequently, can reduce the quality of the grapes and wine (Martínez-Casasnovas and Sánchez-Bosch, 2000; Arnaez et al., 2007; Rodrigo Comino et al., 2018a; 2018b). This paper surveys the soil erosion losses the Celler del Roure vineyards, Eastern Spain. We applied rainfall simulation experiments (20 plots) to characterize the soil erodibility, runoff discharge and soil erosion rates under low frequency high magnitude rainfall events. We found that the runoff rates were 25 % of the rainfall, sediment concentration was 22 gl-1 and the soil erosion rates 3 Mg ha-1 h-1. The results show that the erosion rates in vineyards are one of the highest found in the literature and we suggest that the vineyard management should be improved to reduce sustainability such as using organic farming (Kirchhoff et al., 2017) to avoid the depletion of the soil fertility (Novara et al., 2018).

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Keywords: vineyards, soil erosion, rainfall simulators, runoff, sediment yield.

FIRE1: Fire effects on fluxes in the landscape

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Wildfires in Spain in 2017 The rural population, victims and perpetrators

[1]Cristina Santín, [2]Javier Jimenez, [3]Virginia Carracedo and [4]Juan Picos

[1]*College of Science, Swansea University, UK*
[2]*Fire Investigation Team (Bripas) of the Principality of Asturias, Spain*
[3]*Department of Geography, Urbanism and Spatial Planning, University of Cantabria, Spain*
[4]*Department of Natural Resources and Environment Engineering, University of Vigo, Spain*

2017 has been a tragic fire year in different regions of the world. In Spain, despite the general decreasing trend of both number of fires and area burnt in the last 20 years, 2017 has resulted in almost 5,000 fires, with ~175,000 ha burnt, substantial economic damage and several lives lost. Importantly, 2017 also holds the record for the highest number of 'large fires' (>500 ha). Climatic and weather factors have played a role in this severe fire season. October, for example, has been the driest and one of the warmest of this century, with the winds from the tropical storm Ophelia making things worse. However, their effects should not distract the focus from the main contributor: the human factor. In Spain, 96% of the wildfires are human-caused, with 55% of them ignited by arson. In the north-western region of Spain, the percentage of arson fires reaches 76%.

This presentation will give an overview of the 2017 Spanish fire season with a strong focus on the fire issue in NW Spain (Galicia, Asturias, Cantabria, Basque Country, León and Zamora). Despite being the wettest and greenest, this region experiences by far the highest number of fires every year. In 2017, fires in the NW accounted for 74% of the total area burnt in Spain, with most ignited by arsonists. Fire here is an extremely complex cultural-driven issue. The rural population is both victim and perpetrator and fire can be seen as 'just' a symptom of a deep structural problem. Here we will explore the main driving factors underlying these fires such as the rural abandonment, the currently inappropriate "culture of fire", and the failing ways in which the administrations and the rural population interact.

Keywords: North-West Spain, human ignitions, large forest fires, Common Agricultural Policy, rural abandonment, social science.

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Lessons learned: Perspectives on recent fire activity in the western North America through the lens of multi-decadal fire science research

Deborah A. Martin

U.S. Geological Survey, Emeritus

The 2017 wildfire season in western North America has continued the trend of recent wildfire seasons: large areas burned, houses destroyed and lives lost. Post-fire flood and erosion responses have threatened life, property and water supplies. In this talk I will give a brief overview of the 2017 wildfire season and share perspectives I have gleaned from studying wildfire and its impacts over a multi-decade career as a fire scientist. I will explore lessons learned from field and laboratory research and my own experience living in the wildland-urban interface that shape my perspective about wildfire, post-wildfire responses, and conducting research in burned areas. Several leitmotifs emerge as persistent themes in my research including thresholds, non-linear responses, spatial and temporal scales, multiple disturbances, resilience, recovery and collaboration. Collaborations and friendships have been the spark that sustained my research over multiple decades and myriad international locations. Grateful thanks are in order to all of my fellow fire scientists, collaborators and friends.

Keywords: Wildfire, Western North America, flooding, erosion, disturbance, wildland-urban interface

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Forest fires in Portugal in 2017 - Chronicle of an announced tragedy

António Bento-Gonçalves

Geography Department and CEGOT, University of Minho

In Portugal, forest fires are a common phenomenon, especially during the hot and dry months and the causes are very diverse (negligence or arson), but with the possibility of highlighting the regeneration of pastures.One of the main problem is the occurrence of an extremely high number of ignitions, indeed, the climate allows a rapid growth of the vegetation in the winter, which gets very dry in the summer, and, fires are an important land use tool in Portugal, so, the traditional use of fire in rural areas, generates an excessively high number of fires.
Nevertheless, only a small number of forest fires causes the highest percentage of burnt areas, and, the more populated areas have a greater number of forest fires, while areas with lower population densities have a larger amount of burnt areas.
Nowadays, as Large Forest Fires become recurrent, their intensity and dimension have increased and they have taken on catastrophic proportions, therefore losing their role as catalysts of ecosystem renewal. Large Forest Fires (or even Mega Fires) are likely to increase, and the period of its occurrence will widen throughout the year, as a result of climate and other global changes, making the regime of extreme fires in the normal fire regime.
In fact, Portugal has witnessed this reality year after year, for if, by 1986, we had never been plagued by a fire of more than 10,000 hectares, 2003 saw the mark of 20,000 hectares and 2017 twice, of the 25,000, twice the 30,000 and, once, the 40,000 hectares.
In 2017, more than 100 people died in Portugal, trapped by extreme fires, in only two days, June 17 (66 people) and October 15 (45 people), before and after the “normal” fire season, where, only 1.26% (214) of the total of the ignitions burned 93% (412781 ha) of the total burned area.
In fact, it was an extremely dry year and there were some rare phenomena (eg, the tropical storm Ophelia), but, from the moment that forest is composed by monocultures of highly combustible species, such as pines (Pinus pinaster) and eucalyptus (Eucalyptus globulus), without real territorial planning, civil protection or environmental education policies, the consequences of fires can be tragic.

Keywords: Portugal, forest fires, ignitions, new fire regime, tragedy.

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The erosional and hydrological impact of traditional slash and burn "hormiguero" in the Macizo del Caroig, Eastern Spain

[1]José Rafael Pérez Borredá, A., [2]Pulido, M, [3]Rodrigo-Comino, J, [4]Keesstra, S.D, [5]Antonio Giménez Morera and [1]Cerdà, A.

[1]*Department of Geography, Valencia University, Blasco Ibàñez, 28, 46010 Valencia, Spain.*
[2]*GeoEnvironmental Research Group, University of Extremadura, Faculty of Philosophy and Letters, Avda. de la Universidad s/n, 10071 Cáceres, Spain.*
[3]*Department of Physical Geography, Trier University, D-54286 Trier, Germany*
[4]*Soil Physics and Land Management Group, Wageningen University, Droevendaalsesteeg 4, 6708PB, Wageningen, The Netherlands*
[5]*Departamento de Economía y Ciencias Sociales, Escuela Politécnica superior de Alcoy, Universidad Politécnica de Valencia. , Paseo del Viaducto, 1 03801 Alcoy, Alicante, Spain.*

Shifting (slash and burn) agriculture disappeared from the Mediterranean mountains with the arrival of chemical fertilizers and the intense migration of population to coastal areas and urbanization during the second half of the XX century. Slash and burn agriculture opened the mountain terrains to the pioneer farmers during the expansion of the agriculture from the Middle East ten millennia ago. Later, slash and burn agriculture took place as a farming strategy adequate for low-density population societies and resulted in deep soil and landforms changes (Soto et al., 1995; Giardina et al., 2000; Ketterings et al., 2000; Lasanta et al., 2006; Rumpel et al., 2006).

In the Mountains of the Mediterranean fire was widely used to increase the fertility of the soils (by the ash). The local "hormiguero" slash and burn consisted of collection of shrubs from the rangelands, and then mixing them with the upper few centimetres of soil to allow a low intensity fire. The burning of the shrubs was done yearly or when the soil fertility was exhausted. "Hormiguero" as the rural societies of the Macizo del Caroig called them, was widely used for millennia, but we know little about the environmental impacts this strategy caused.

This paper evaluates the legacy impact of slash and burn agriculture on runoff and sediment yield at pedon scale in the Macizo del Caroig. Our research reproduced the burning of the shrubs (Quercus coccifera, Ulex parviflorus, Rosmarinus officinalis, Globularia alypum and Cistus albidus) with the 2 upper centimetres of the soil. The soil and the shrubs were collected from the Enguera range and burnt with the soil. In total, 500 Kg of soil were mixed with 50 Kg of shrubs (dry weight. A laboratory plot of 100 (length) x 50 (width) x 20 (depth) cm was filled with sand (18 cm) and the burnt soil (2 cm) on the surface. A 1-hour rainfall simulation was carried out at an intensity of 55 mm h-1 in 10 paired plots (original soil and the soil affected by the slash and burn).

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The result shows that the runoff coefficient was in average 1.45 time higher on the slash and burn soil and the sediment concentration was 7.5 time higher. Those results show that the impact of the traditional use of the slash and burn in the Mediterranean go to explain a ten-fold increase in soil erosion rates in comparison to the soil erosion on soils without the impact of burning. The increase of one order of magnitude of the soil losses in comparison to the agriculture fields that do not use the slash and burn, is part of the problem of the intense soil erosion in the Mediterranean Mountains. The removal of the vegetation and the sediment-laden runoff also contributed to the land degradation of the Mediterranean landscapes.

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Keywords: Fire, Slash and burn, Mediterranean

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Comparing transient and steady-state analysis of single-ring infiltrometer data for an abandoned field affected by fire in Eastern Spain

[1]Simone Di Prima, [2]Laurent Lassabatere, [3]Jesús Rodrigo-Comino, [1]Roberto Marrosu, [4]Manuel Pulido, [5]Xavier Úbeda, [6]Saskia Keesstra, [7]Artemi Cerdà and [1]Mario Pirastru

[1]*Dipartimento di Agraria, Università degli Studi di Sassari, Viale Italia 39, 07100, Sassari, Italy.*
[2]*Université de Lyon; UMR5023 Ecologie des Hydrosystèmes Naturels et Anthropisés; CNRS ; ENTPE ; Université Lyon 1; 3 rue Maurice Audin, 69518 Vaulx?en?Velin, France.*
[3]*Instituto de Geomorfología y Suelos. Department of Geography, Málaga University, Campus of Teatinos s/n, 29071 Málaga, Spain.*
[4]*GeoEnvironmental Research Group, University of Extremadura, Faculty of Philosophy and Letters, Avda. de la Universidad s/n, 10071 Cáceres, Spain.*
[5]*GRAM (Mediterranean Environmental Research Group), Dept of Physical Geography and Regional Geographic Analysis, University of Barcelona, Montalegre, 6. 08001 Barcelona, Spain.*
[6]*Soil Physics and Land Management Group, Wageningen University, Droevendaalsesteeg 4, 6708PB, Wageningen, The Netherlands.*
[7]*oil Erosion and Degradation Research Group. Department of Geography, Valencia University, Blasco Ibàñez, 28, 46010 Valencia, Spain.*

Assessing fire effects on soil hydraulic properties in Mediterranean area is crucial to evaluate the role of fire on land degradation and erosion processes. Among soil hydraulic properties, field saturated hydraulic conductivity, Kfs, exerts a key role on the partitioning of rainfall into runoff and infiltration. Therefore, estimates of Kfs are essential for evaluating the hydrological response of fire affected soils. This study aimed at determining Kfs of an abandoned unmanaged field affected by fire and its evolution during a 5-yr period by means of single-ring infiltrometer runs and use of transient and steady-state data analysis procedures. Sampling and measurements were carried out in November 2012 in a fire affected (on July 15th) field (burnt site) and in a neighboring non-affected site (control site).

The predictive potential of two data analysis procedures (i.e., transient and steady-state) to yield proper Kfs estimates was investigated. In particular, the transient WU1 method and the WU2 and OPD methods were compared. Three different fitting methods, referred to as cumulative infiltration (CI), cumulative linearization (CL) and derivative linearization (DL), were also tested to apply the WU1 method.

Values of Kfs ranging from 0.04 to 8.91 mm h 1 were obtained, depending on the considered data analysis method. The WU1 method did not yield significant different Kfs estimates between the

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sampled sites throughout the 5-year period, because of a generally poor performance of the fitting methods, which spoiled the soil hydraulic characterization. In particular, the DL method yielded poor fits in all cases and probably led to erroneous estimates. Good fits were only obtained in 26% and 58% of the cases with the CI and CL methods, respectively. This inefficiency was due to the high sorptive nature of the sampled soils, where capillarity exerted a dominant role during the first stage of the infiltration process.

The WU2 and the OPD methods, with a characterization based exclusively on a stabilized infiltration process, yielded an appreciably lower variability of the Kfs data ($19.9 < CV < 74.7.1\%$) as compared with the WU1 method ($82.4 < CV < 373.1\%$). In addition, both the methods revealed a slight but statistically significant ($P < 0.05$) decrease of Kfs values at the burnt site from 2012 to 2017. It was concluded that steady-state methods resulted to be more appropriate to detect slight changes of Kfs in the post-fire soil hydraulic characterization. Clearly, the choice in the method of soil hydraulic characterization may lead to contrasting conclusions, thus highlighting the need to choose the appropriate methods.

Keywords: Post-fire soil hydraulic characterization, infiltration, single-ring infiltrometer, field-saturated soil hydraulic conductivity, data analysis procedures.

FIRE2: Wildfires in urban areas

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Land Use-Land Cover interfaces to model wildfire occurrence in Europe. Global and regional data sources for modelling

Lara Vilar, Jesús Garrido and M. Pilar Martín

Centre of Social and Human Sciences, Spanish National Research Council, c/Albasanz 26-28, 28037 Madrid, Spain

Wildfires in Europe and especially in the Mediterranean basin are mostly human-caused. Land Use Land Cover (LULC) Interfaces represent a proxy to socio-economic factors related to human-caused wildfires. Previous works had shown existing relationships between human activities in these areas and wildfire. Wildland-Urban interface (WUI), Forest-Agricultural interface (FAI) and Forest-Grassland interface (FGI) have been calculated from two land use sources: Climate Change Initiative-Land Cover (CCI-LC) and Corine Land Cover (CLC) from the year 2012. Fire data as response variable used for this analysis was MODIS Terra and Aqua Burned Area MCD64A1, global and monthly gridded 500 m resolution product. It contains the date of the burn. Wildfire ignitions happened in ~20%, ~17% and ~12% of the WUI, FAI and GFI respectively. However some differences were observed by land use data source. General Additive Models (GAM) were used to explore wildfire occurrence in Europe in 2012 by LULC Interfaces from the above mentioned land use sources. The estimated effects of the LULC Interfaces were significant in both models. LULC Interfaces showed mostly the same trends in both models. FGI had and increasing trend that was more evident in the case of CLC LULC models. Both WUI and FAI presented a decreasing trend. Using LULC Interfaces provide fine approach to estimate human-caused wildfires. Global and regional data sources as CCI-LC and CLC are available homogenously in time and space allowing analyzing broad areas in different time periods.

Keywords: CCI-LC, LULC Interfaces, Europe, GAM, Wildfire, WUI

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Evaluation of erosion risks in burned areas and identification of emergency intervention measures experimental area in 2017 Braga fire affected areas

[1]António Vieira, [1]António Bento-Gonçalves and [2]Gustavo Baptista

[1]*Geography Department and CEGOT, University of Minho (Portugal)*
[2]*Geography Department, University of Brasilia (Brazil)*

The great forest fire that affected the municipality of Braga on October 15, 2017, burned about 1007 hectares (967 hectares of stands and 40 hectares of bushes), in an area where eucalyptus was predominant, but with significant patches of oak trees and cork trees, unprotecting the steep and disordered wildland-urban interface of the city of Braga.
The natural characteristics of the burned areas, with steep slopes, shallow soils, affected by significant and concentrated values of rainfall, and located in a WUI, reveal a high risk of soil erosion. These characteristics lead us to implement different techniques for erosion mitigation in the experimental area, in order to evaluate not only their effectiveness, but also their cost/benefit relation.
The fire produced a continuous burnt area which was subject to different fire intensities and severity. In order to evaluate the severity of the fire on the affected area, we analyzed the satellite images from before and after the forest fires.
The result was validated in the field, where fire severity was evaluated using the BAER methodology presented by Parsons et al. (2010). Based on the distribution of the severity of fire we implemented an analysis of the erosion risks, identifying the critical areas, and considering the survey implemented in the field and topographic and land-use conditions, an experimental area was defined, in order to implement the erosion mitigation techniques.
The implementation of the different techniques was made in close collaboration with the Civil Protection Department of the Municipality of Braga and landowners of the burned area.
This work synthesizes the analysis made on the burned area and the identification of the areas at risk, as well as the experimental design implemented to prevent erosion processes.

Keywords: Forest fires, Braga (Portugal), severity, soil erosion, mitigation techniques.

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Valorization of Vegetable Biomass Could it Be a Tool for Prevention of Severe Wildfires?

Ricardo MF da Costa, Maria da Graça Carvalho and Jorge MPL Canhoto

Faculty of Sciences and Technology of the University of Coimbra, Portugal.

Wildfires are a major economical, societal and ecological concern in Iberia, particularly in Portugal and Galicia, as they destroy soil and other ecosystem resources, ruining means of subsistence and causing human loss. Despite Mediterranean-type ecosystems being prone to wildfires, climate change and arson have played major roles on recent severe wildfires. Unarguably, the attenuation of severe wildfires primarily depends on effective minimization of anthropogenic climate change, and elimination of impunity in cases of criminal arson. However, from a pragmatic perspective, the reduction of biomass fuel load is one strategy to make woodland more resilient to fire.

In Portugal, the abundance, and unrestrained spread of invasive non-native plant species majorly exacerbates wildfire severity. In this context, our work consists of a pre-fire approach to manage plant biomass to preempt severe fires, while prospecting additional sources of income.

At this preliminary stage, our main focus is to test potential applications of these biomasses for liquid biofuel production. In this presentation, we will showcase our concepts and discuss possible solutions for the problem that wildfires represent in our societies. Our main premise is that by generating economic incentives to harvest invasive plants, vegetation would be culled more frequently, thus helping minimize wildfire severity and frequency. If successful, our approach will further motivate landowners to keep their properties resilient to fire and other forms of land degradation. Furthermore, by highlighting the existence of potentially novel feedstocks, these may be industrially explored. This, in turn, may stimulate Portuguese industry, as the country recovers from the last decade's economic crisis. Ultimately, by adding value to invasive plant species, this will promote a new outlook on these resources and highlight the need for well-planned action on invasive species and land use management.

Keywords: Vegetable biomass; Wildfire; Novel feedstocks; Invasive plant; Industry; Land use.

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Nutrient Fluxes at Hill-Slope Scale in a Burned Mediterranean Area.

[1]J. Campo, [2]M. Fernandez-Raga, [1]E. Cammeraat, [3]E. Gimeno-García and [3]V. Andreu

[1]*Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, Science Park 904, 1098 XH Amsterdam. The Netherlands.*
[2]*Department of Applied Chemistry and Physics, University of Leon. Leon Spain?*
[3]*Desertification Research Centre, Spanish National Research Council, Valencia, Spain?*

The International Panel on Climate Change indicated a higher degree of confidence that meteorological conditions associated to climate change will be propitious to increasing extreme events. Impacts on land degradation will also be manifested in bigger and more frequent wildfires. In the Mediterranean area, forest fires are a serious problem since they can change top soils with drastic consequences for important ecosystem services, such as water availability and carbon sequestration. Erosion processes are also enhanced, increasing soil loss, together with its organic matter, iron and nutrients.

Whereas it is well documented that wildfires produce significant changes on hydrological and erosion processes, the associated redistribution and fluxes of iron and nutrients have received less attention. This research assesses this gap by studying the transport, redistribution and fate of calcium, potassium, sodium, magnesium, ammonium, nitrate, crystalline and amorphous iron in coupled hillslopes (burned: BU, 39°50\'45.11\"N, 0°22\'20.52\"W and control: CO, 39°51\'08.7\"N, 0°22\'17.6\"W) at the Natural Park of Sierra de Espadán, Azuébar, Spain. The fire occurred the 28/08/2014, with high severity. Soil was sampled (19-9-2014) in the foot's slope (deposition), middle part (transport) and top (eroding) at two depths (<2 cm, 2-5 cm), and in two environments (under canopy soil: UC; bare soil: BS). Sediments were collected from four sediment fences constructed at the foot's slope, and together with soils samples, analysed with regard to iron and nutrient contents. The main objective of this work is to increase the understanding on the iron and nutrient fluxes in Mediterranean burned areas experiencing soil erosion and deposition.

Based on the data of the closest pluviometre (Sot de Ferrer: 4.5 km), 4 erosive rain events were considered in this study. These were registered in 29/11/2014, 23/3/2015, 15-16/6/2015 and 2/11/2015 with total volumes of 64.2, 103.2, 41.2 and 131.6 L m2, respectively. These events did not produce any sediment in CO hillslope, but in the BU one high yields were measured. Thus, sediment collected after each rainfall were 12.7, 143.6, 12.6 and 62.2 kg corresponding to 10.4, 41.5, 5.0 and 14.6 kg C ha-2, respectively.

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There are significant differences in the availability of iron and nutrients between BU and CO. The distribution of nutrients also changed due to fire. On the CO hillslope this is influenced by the environment, since more nutrients were found UC than in BS, but depth seems to be more important for the distribution on BU. Regarding the position on the hillslopes, significantly different amounts of iron were observed at the deposition and eroding sites. Erosion by rain events after forest fire caused high nutrient availability in sediments. This means the fertility of the soil on the hillslope decreased due to erosion after fire.

Concluding, the nutrient and iron contents are significantly influenced by erosion after forest fires. Although the fertility of the soil can increase strongly at first, erosion will cause a fast decrease in nutrients availability. Fire can cause to a new distribution of nutrients and iron, which is not advantageous for the erosion zone and for the soil on 2-5 cm depth. This means soil fertility and therefore soil quality would be decreased by high severity fires at hillslope scale, despite the fact that significant amounts of nutrients are released by forest fire at short term.

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Keywords: fire, nutrients, climate change

FIRE3: Effects of pre- and post-fire management on vegetation recovery

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Shrub clearings and extensive livestock: an action of the administration to control the fires in the Mediterranean mountain

[1]Khorchani, M., [2]Sáenz-Blanco, R., [3]Nadal-Romero, E. and Lasanta, T.

[1]*Instituto Pirenaico de Ecología*
[2]*Consejería de Agricultura, Ganadería y Medio Ambiente. Gobierno de La Rioja*
[3]*Departamento de Geografía. IUCA. Universidad de Zaragoza*

The marginalization and abandonment of Mediterranean mountains throughout the 20th century has involved an intense process of revegetation, manifested especially in the plant encroachment of previously cultivated or pastured areas. One of the negative effects is the increase of forest fires with very negative impacts on the landscape and the natural heritage.
In order to control fires and promote the development of extensive mountain livestock, the La Rioja Government launched in 1986 a plan for shrub clearing, and until 2016 almost 25% of the area occupied by shrubs in the mountains of La Rioja was cleared.
In the Leza valley, between 1986 and 2016, 5,390 ha were cleared: 29.5% of the scrubland area or 18.1% of the extension of the Valley. In this period, livestock censuses increased from 1.834 to 7.208 UGM. Both facts have had important repercussions in the control of forest fires. Between 1983 and 1985, 340.5 ha were burned, while between 1986 and 2017 only 29.8 ha.
The application of fire risk indexes shows that, after clearing and the extensive livestock activity, the high structural risk of fire is reduced to 16.6% of the territory, due to: (i) the elimination of combustible material, and (ii) due to the creation of a landscape with a mosaic structure, that, in case of fires, allows a better control. In fact, before the clearing, no outbreaks of fire were recorded, while after clearing 58% of the damages remain in outbreaks. However, more important than the reduction of structural risk is that farmers don´t burn shrubs to regenerate pastures, since the Administration performs this function.

Acknowledgment:
This research was supported by ESPAS project CGL2015- 65569-R funded by the MINECO-FEDER. Makki Khorchani benefited from a pre-doctoral contract FPI (Spanish Ministry of Economy and Competitiveness, MEC). Estela Nadal-Romero benefited from a “Ramón y Cajal” postdoctoral contract (Spanish Ministry of Economy and Competitiveness, MEC).

Keywords: Shrub clearing, forest fires, extensive livestock, Mediterranean mountains.

CC3: Impacts of climate change on soils in drylands: recent advances and challenges ahead

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Physical and chemical properties of soils and carbon pools in global drylands

[1]Cesar Plaza, [2]Claudio Zaccone, [3]Kasia Sawicka, [4]Ana Méndez, [5]Ana Tarquis, [6]Gabriel Gascó, [7] Edward A.G. Schuur and [7]Fernando T. Maestre

[1]*Instituto de Ciencias Agrarias, Consejo Superior de Investigaciones Científicas, Madrid, Spain.*
[2]*Department of the Sciences of Agriculture, Food and Environment, University of Foggia, via Napoli 25, 71122 Foggia, Italy.*
[3]*School of GeoSciences, University of Edinburgh, King\'s Buildings, Edinburgh, United Kingdom*
[4]*Departamento de Ingeniería de Ingeniería Geológica y Minera, ETSI Minas y Energía, Universidad Politécnica de Madrid, Ríos Rosas 21, 28003 Madrid, Spain.*
[5]*Departamento de Matemática Aplicada, ETSI Agronómica, Alimentaria y de Biosistemas. Universidad Politécnica de Madrid, 28040 Madrid, Spain.*
[6]*Departamento de Producción Agraria, ETSI Agronómica, Alimentaria y de Biosistemas. Universidad Politécnica de Madrid, 28040 Madrid, Spain.*
[7]*Departamento de Biología y Geología, Física y Química Inorgánica, Escuela Superior de Ciencias Experimentales y Tecnología, Universidad Rey Juan Carlos, 28933 Móstoles, Spain.*

Soils are key components of drylands, supporting these highly vulnerable ecosystems that cover almost half of global land surface and are home to more than one third of the global population. The latest climatic data available indicate that aridity has increased globally in the last seven decades, and drylands are expected to further expand because of global warming. In this communication, we will present an updated description of the major physical and chemical properties of dryland soils, with special emphasis on organic and inorganic C contents. For this purpose, we used the WISE30sec geo-database, which to the best of our knowledge represents the most recent and detailed global soil inventory currently available. We found that dryland soils store about 650 Pg of organic C and 1200 Pg of inorganic C to 2 m. This information is essential and highly needed to face the challenges of increased population, food security, land degradation, and climate change in global drylands.

Acknowledgments: This project has received funding from the European Union\'s Horizon 2020 research and innovation programme under the Marie Sk?odowska-Curie grant agreement No. 654132 (http://vulcan.comule.com)

Keywords: drylands, soils; carbon, global warming

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Biotic controls of soil functioning in global drylands under climate change

Fernando T. Maestre

Departamento de Biología y Geología, Escuela Superior de Ciencias Experimentales y Tecnología, Universidad Rey Juan Carlos, c/ Tulipán s/n, 28933 Móstoles, Spain

Substantial research efforts are being devoted to predict how biotic attributes such as species richness, composition and diversity will respond to ongoing climate change. However, their impact on the relationships between biotic attributes and soil processes is virtually unknown. Therefore, much remains unknown on the potential effects of climate change on the soil processes and ecosystem services that depend on biotic communities. This is particularly true for drylands, were biotic attributes such as the cover, type and spatial pattern of vegetation and biological soil crust patches largely affect soil functioning. In this communication, I will summarize the results of recent and ongoing studies evaluating how biotic attributes (species richness, evenness and composition, cover and spatial pattern) modulate multiple ecosystem functions (multifunctionality) in drylands and their response to climate and land cover changes. These studies use multiple experimental approaches (manipulative and natural experiments), biotic communities (vascular plants, microbial communities and biocrusts dominated by mosses, lichens and cyanobacteria), spatial scales (from local to global) and ecosystem processes linked to hydrology, plant productivity and nutrient cycling. Overall, our results indicate that biotic attributes are key drivers of soil functioning in drylands worldwide, and may partially buffer the negative effects of climate change on ecosystem functioning in these water-limited ecosystems.

Keywords: drylands, biological soil crusts, spatial pattern, species richness, soil functioning, climate change.

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The impacts of drought and its adaptations in a semiarid forest ecosystem: a look into the total and active soil microbial communities

[1]F. Bastida, [2]J.L Moreno, [3]M. Andrés-Abellán, [3]F.R. López-Serrano, [1]T. Hernández, [4]N. Jehmlich and [1]C. García

[1]*CEBAS-CSIC, Spain*
[2]*CEBAS-CSIC, Spa*
[3]*University of Castilla-La Mancha (UCLM), Spain*
[4]*Helmholtz-Centre for Environmental Research, Germany*

Droughts are expected to impact semiarid ecosystems and will affect the competition for resources in plant and microbial communities. We evaluated the predicted impacts of climate change through rainfall exclusion (6 years) and their interactions with forest management (thinning vs no-thinning) in the soil microbial community of a semiarid forest ecosystem. Genomics (16S rRNA gene and ITS sequencing) and metaproteomics were used to track the responses of the microbial community. Microbial biomass was analysed through phospholipid fatty acids (PLFAs). Microbial-mediated functionality was evaluated by soil enzyme activities. Overall, the PLFA content and soil enzyme activities decreased in drought-treatments but this decrease was more important in non-thinned plots. Drought had a significant impact in the diversity and structure of the active community (evaluated by metaproteomics), while did not impact to total bacterial community (evaluated by genomics). Thinning in plots without drought increased the active diversity while the total diversity was not affected. Thinning fostered the resistance of soil enzyme activities to drought and this resistance was related to changes in the active microbial community. Protein-based phylogeny was revealed as an adequate predictor of the impacts of drought and forest management in semiarid ecosystems.

Keywords: semiarid soil, drought, forest management, soil microbial communities, diversity.

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Land use legacy shapes the responses of soil microbial community against drought in a Mediterranean agroecosystem

José Luis Moreno, Carlos García and Felipe Bastida

CEBAS-CSIC. Department of Soil and Water Conservation and Organic Resources Management. Campus Universitario de Espinardo, Murcia, Spain

We aim to predict how land use influences the responses of the soil microbial community from Mediterranean agroecosystems against drought. We hypothesized that land uses has lead variations in soil microbial community that determine the response of soils against drought and will cause differences in the C dynamics. A sampling area was selected, where four land-use plots were distinguished: 1) a natural forest plot dominated by pine; 2) an agricultural plot with almond trees under rainfeed conditions; 3) a drip-irrigated organic plot cropped with vegetables; and 4) agricultural abandoned soil without plant cover. Soil samples were collected from each of the land uses and incubated under two different moisture levels (60 and 20% WHC) for 4 and 50 days. TOC and water soluble C contents, enzyme activities and PLFA biomarkers of different microbial groups were analyzed at 4 and 50 days of incubation. In parallel, the mineralisation of soil organic matter (SOM) and fresh-organic matter (FOM) were evaluated by tracking the isotope signature of CO2 after addition of 13C-enriched plant tissue. In addition, the microbial diversity and populations were analyzed with amplicon sequencing (16S rRNA gene and ITS biomarkers) after 50 days of incubation. The obtained results suggest that: i) the interaction between land use and drought influenced the PLFA content of Gram-, fungi and actinobacteria; ii) the interaction between land use and drought influenced polyphenol oxidase and dehydrogenase activity, but it did not affect hydrolase activities (alkaline phosphatase, ?-glucosidase and urease), iii) land use drought and their interaction influenced significantly total soil respiration, fresh-organic matter mineralization FOM and priming effect; iv) the interaction between drought and land use influenced fungal diversity but it did not bacterial diversity.

Keywords: Soil microbial community, land use, drought, phospholipid fatty acids, enzyme activity, priming effect

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Predicting climate change effects on Mediterranean drylands through plant functional traits

[1]Alice Nunes, [1]Melanie Köbe, [1]Pedro Pinho, [2]Paula Matos, [1]Francesco de Bello, [1]Otília Correia and Cristina Branquinho

[1]*Centre for Ecology, Evolution and Environmental Changes, Faculdade de Ciências, Universidade de Lisboa, Campo Grande, C2, Piso 5, 1749-016 Lisboa, Portugal*
[2]*Institute of Botany, Czech Academy of Sciences, CZ-37982 Trebon, Czech Republic*

Climate change models forecast an overall increase in aridity in drylands in the near future. Drier conditions are expected to increase the vulnerability of drylands to desertification and land degradation, hampering ecosystems' functioning, and the delivery of ecosystem services. Hence, it is crucial to understand and predict the consequences of climate change for dryland ecosystems. Functional traits determine species' responses to environment, and their influence on ecosystem processes, thus providing a mechanistic tool to monitor ecosystems' response to climate.
To understand potential impacts of climate change on Mediterranean drylands, we modelled the response of plant functional traits to climate in Holm-oak woodlands, using a spatial climatic gradient to predict changes over time.
We identified nine plant traits responding to aridity along space, and validated that response over time. Increasing aridity was associated to a lower functional diversity for most traits. Inter-annual climatic fluctuations greatly affected functional trait community metrics, and functional diversity showed a similar response in space and over time to climatic limitations. Multi-trait functional diversity decreased non-linearly with aridity and responded in a more predictable way to aridity than species diversity. Thus, it can be used as an indicator to map areas at risk of desertification. We further discuss the consequences of a decrease in plant functional diversity for ecosystem functioning. We also explored the relative effect of climate, topography and soil characteristics on plant communities' functional traits. We found that topographic and edaphic factors largely determine the relative cover of shrubs in relation to herbaceous cover, suggesting that climate change will not have a strong impact on shrub encroachment in Mediterranean drylands. We discuss the implications for land management strategies to deal with shrub encroachment. Our findings contribute to a better prediction of climate change effects on Mediterranean drylands, and to optimize land management strategies.

Keywords: Aridity; desertification and land degradation, Functional diversity, Holm-oak woodlands, inter-annual climatic variability, shrub encroachment.

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Influence of urban waste biochar on Typic Xerofluvent biochemical properties

[1]Iria Benavente, [1]César Plaza, [2]Jorge Paz-Ferreiro, [3]Ana Méndez and [4]Gabriel Gascó

[1]*Instituto de Ciencias Agrarias, Consejo Superior de Investigaciones Científicas, Serrano 115 bis, 28006 Madrid, Spain.*
[2]*School of Engineering, RMIT University, GPO Box 2476, Melbourne 3001, VIC, Melbourne, Australia.*
[3]*Departamento de Ingeniería de Ingeniería Geológica y Minera, ETSI Minas y Energía, Universidad Politécnica de Madrid, Ríos Rosas 21, 28003 Madrid, Spain.*
[4]*Departamento de Producción Agraria, ETSI Agronómica, Alimentaria y de Biosistemas. Universidad Politécnica de Madrid, 28040 Madrid, Spain.*

The amount of organic waste is increasing in the last years, with its associated impacts on the environment. The European Union demands its Member States to diminish the volume of biodegradable municipal waste disposed in landfills by 2016-2020. The purpose of this work was to study the influence of biochars produced under different conditions (temperature and residence time) by pyrolysis of the organic fraction of urban waste in the biological properties of a Typic Xerofluvent (Madrid, Spain). Treated soil was incubated and CO2 emissions, microbial biomass C and the enzymes dehydrogenase, phosphomonoesterase and ?-glucosidase were measured after 70 days. Data shown that pyrolysis temperature was the main factor controlling soil microbial activity. It was concluded that the production of biochar from urban waste organic fraction and its soil application is a novel approach to sustainable waste management that can improve soil quality contributing to soil carbon sequestration.

Keywords: biochar, soil enzymes, CO2 emissions

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Life the Green Link: Restoring Degraded Areas with the Cocoon Ecotechnology

[1]CARABASSA, Vicenç, [1]DÍAZ, Elisa, [2]FRANCO, Katherine, [2]KALLEN, Sven, [3]CAMPO, Julián, [3]ANDREU, Vicente, [3]GIMENO, Eugènia, [4]GONZÁLEZ, Francisco, [5]VIERA, Gustavo, [6] CRESCENZO, Valerio, [7]BERTAINA, Fabiano, [7]CASTRO, Antonio J, [7]GUTIÉRREZ, Inés, [8] KOURKOUMPAS, Dimitrios, [8]GRAMMELIS, Panagiotis and [9]ALCAÑIZ, Josep Maria

[1]*CREAF, Cerdanyola del Vallès 08193, Spain*
[2]*VOLTERRA ECOSYSTEMS*
[3]*Centro de Investigaciones sobre Desertificación (CIDE-CSIC), Moncada (Valencia) 46113, Spain*
[4]*Consejería de Medio Ambiente y Emergencias. Cabildo de Gran Canaria. Agustín Millares Carló 14, 1 35003 Las Palmas de Gran Canaria. Spain*
[5]*Gestión y Planeamiento Territorial y Medioambiental. Gobierno de Canarias Fco. Gourié 107, 35002 Las Palmas de Gran Canaria. Spain*
[6]*Biopoplar srl*
[7]*Andalusian Center for the Assessment and Monitoring of Global Change (CAESCG), Department of Biology and Geology, Ctra. Sacramento s/n, La Cañada de San Urbano, Universidad de Almería, 04120 Almería, Spain*
[8]*Centre for Research and Technology Hellas/Chemical Process and Energy Resources Institute (CERTH/CPERI), 52, Egialias str., Maroussi, 15125 Athens, Greece*
[9]*Univ Autònoma Barcelona, Cerdanyola del Vallès 08193, Spain*

The impacts of climate change in the Mediterranean area are becoming increasingly perceptible. Many semi-arid regions are suffering significant declines in water availability. This led to faster desertification and to increase forest fires occurrence. Therefore, implementing adaptation and mitigation measures is needed to reduce the vulnerability of these Mediterranean ecosystems and strengthening their resilience.

The Green Link is a collaborative LIFE project (LIFE15 CCA/ES/000125) that aims to demonstrate the environmental and economic benefits of an innovative tree growing method. This consists of replacing traditional planting techniques with the “Cocoon”, a low-cost and biodegradable device that improves water supply to seedlings during the first months.

To prove the viability of the Cocoon technology and demonstrate its potential, the project has planted a variety of woody species on different soil types located in areas on a climate gradient from semi-dry to extremely dry across the Mediterranean basin and the Canary Islands. As a whole, 7 experimental areas located in Italy, Greece and Spain, covering more than 70 ha and 30 plant species (4 subspecies).

The main expected results of the project are:

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1. Demonstrate that the Cocoon technology allows planting woody species in dry climates and poor soils to combat desertification phenomena.

2. Offer a competitive market solution to plant trees without the need of irrigation, using the Cocoon device.

3. Improve long-term soil quality through microorganisms and mycorrhiza facilitation that will enhance the association among roots and soil.

4. Improve ecosystem services, mainly by increasing biodiversity and soil carbon stock over time.

First characterization of the seedlings, planted autumn-winter 2016-17, was conducted in May-June 2017, according to a monitoring protocol. Despite the measurements were previous to the summer drought, important survival differences were detected between controls and Cocoon treatments. Globally, 9% of the seedlings were classified as dead trees, but referring to the controls this percentage increased to 30% while in Cocoons group the mortality ratio was only 3%.

Keywords: land degradation, arid and semi-arid ecosystems, climate change adaptation, ecological restoration, ecosystem services, Cocoon ecotechnology

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Barley crop as affected by warming and altered drought-precipitation events in semiarid agricultural soils amended with biochar

[1]Iria Benavente, [1]Pedro A. Soler-Rovira, [1]M. Esther López-de-Sá, [2]María del Mar Delgado, [2]José Valero Martín, [3]Raimundo Jiménez-Ballesta, [4]Ana Méndez, [5]Gabriel Gascó, [1]Juan Carlos García-Gil and [1]César Plaza

[1]*Instituto de Ciencias Agrarias, Consejo Superior de Investigaciones Científicas, 28006 Madrid, Spain.*
[2]*Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria, 28040 Madrid, Spain.*
[3]*Departamento de Geología y Geoquímica, Fac. de Ciencias, Universidad Autónoma de Madrid, 28049 Madrid, Spain.*
[4]*Departamento de Ingeniería Geológica y Minera, ETSI Minas y Energía, Universidad Politécnica de Madrid, 28003 Madrid, Spain.*
[5]*Departamento de Producción Agraria, ETSI Agronómica, Alimentaria y de Biosistemas. Universidad Politécnica de Madrid, 28040 Madrid, Spain.*

Environmental manipulation studies are needed to determine consequences of soil degradation processes associated to climate warming and its effects on crop production. The objective of this research was focused on assessing the impacts of a climate change scenario on rainfed barley cropped in a Typic Xerofluvent soil amended with biochar. Unamended plots were used as control. Experimental manipulation of drought and precipitation events and warming were performed by means of rainout shelters and open-top warming chambers (OTWCs) to assess the combined effects of a 30% reduction of annual rainfall and an average 2 ºC temperature increase. The results showed significant decreases in aboveground biomass, crop yield, number of spikes, and number of grains per spike under reduced rain conditions, especially when combined with warmer temperatures. The weight of 1000 grains, grain bulk density and harvest index showed no statistical differences, which may point out that these parameters are cultivar dependent and not causally associated with grain yield.

Acknowledgments: to the MICINN (MINECO, AEI, FEDER, EU) for supporting the research projects CGL2015-65162-R and AGL2016-75762-R.

Keywords: biochar, rainout shelters, warming chambers, barely crop

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Is the Microbial Community of Restored Semiarid Soils Able to Confront Drought?

Felipe Bastida, José Luis Moreno, Teresa Hernández and Carlos García

CEBAS-CSIC, Murcia, Spain

Soil amendment with organic wastes has been shown as an adequate strategy for improving soil quality in semiarid abandoned agricultural areas. However, there is little knowledge on how these soils will confront the impacts of climate change. Given the importance of microbial communities for the maintenance of soil ecosystem services, we aim to understand the responses of the microbiota from restored soils against drought. We selected soils that were restored 15 years ago with a single application of composts and sludges, and submit them to drought under laboratory conditions.

Soil samples were either incubated at 60% of the water-holding capacity (WHC) (optimal watered conditions) and at 20% of the WHC (induced drought) for 45 days. The diversity, community composition, biomass and activity of the soil microbial communities were evaluated with amplicon sequencing (16S rRNA gene and ITS biomarkers), phospholipid fatty acids (PLFAs) and soil enzyme activities. In parallel, we evaluated the mineralization of soil organic matter (SOM), fresh-organic matter (FOM) and priming effects through tracking the isotope signature of CO2 after addition of 13C-enriched plant tissue (97 atom %). Our results suggest that: i) restoration positively influences the resistance of soil microbial biomass, but not soil enzyme activities, against drought; ii) drought impacted negatively SOM and FOM mineralization; and iii) the responses of microbial populations against drought were shaped by organic restoration. A multi-level evaluation of soil microbiota is fundamental for a better understanding of the responses of restored soils against drought.

Keywords: semiarid soil, organic amendments, drought, microbial community, C cycle

SP4: Education in Environmental Science

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Education in Environmental sciences

[1]Roel Dijksma and [2]Bertrand Vandoorne

[1]*Hydrology and Quantitative Water Management group, Wageningen University, the Netherlands*
[2]*ISA, Catholic University of Lille, France*

Environmental science needs a constant influx of young well-trained experts, as well for the continuity of fundamental research as for the application of all new knowledge gained. Nowadays the educational programmes of institutions like universities and polytechnic schools are under regular visitation and have to indicate the link to society. Given the increasing number of papers published in the field of Environmental science and the rapidly changing environment, it might be wise to train well-equipped disciplinary experts with a good knowledge on this specific domain. However, this can result in a large amount of sub-communities within Environmental Science, with hardly any or even no interdisciplinary links. An alternative is to create broad educational programmes at different levels related to Environmental Science, creating young generalists. Or should we do both?

The poster will give an overview of some educational programmes and their focus and hopefully will lead to a discussion on which kind of educational programmes are needed in the coming decade.

Keywords: scientific education, specialist training, interdisciplinary approach

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Degrees Received by Undergraduate Soil Science Students in the United States

Eric C. Brevik

Department of Natural Sciences, Dickinson State University, Dickinson, ND, USA

Soil science training in the USA has historically been aligned with agricultural programs, but a study of the degrees students are receiving as they prepare to work as soil scientists has not been conducted recently. This study used lists of soil science programs developed by the NRCS and SSSA, which are not restricted to undergraduate programs. Each university's website was evaluated to see if they offered a degree that met the criteria to prepare students for a soil science career as established by the federal government. Fifty-seven universities were identified that offer such a B.S. degree. Using the strictest definition of a soil science degree, only three universities were found that currently offer a B.S. degree in "Soil Science". An additional seven offer a degree with "soil" as the first word in the degree (Soil and Crop Sciences; Soil & Land Resources; Soil and Hydrologic Sciences; etc.). Sixteen universities offer degrees that have "soil" in the primary name of the degree (Agronomy and Soils; Crop and Soil Science, Environmental and Soil Sciences, etc.). Thirty-one universities (54%) offer a concentration, emphasis, option, or track attached to degrees in areas such as agriculture, agronomy, crop or plant sciences, or environmental science. Twenty (35%) of the programs have clear connections to agriculture. Another 10 (18%) are associated with plant sciences and also likely have a strong agricultural focus. Eighteen (32%) of the programs are strongly associated with environmental and water sciences, as they have "environmental", "water", or "hydrologic" in the primary name of the degree. In addition, 10 of the 30 agriculture, agronomy, crop science, and plant science based degrees have the terms "environmental" or "water" in the name of the concentration, emphasis, option, or track. This gives 28 (49%) of the B.S. level degrees a connection to environmental and/or water sciences.

Keywords: soil science education, soil science degree, USA, environmental science education

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Online Homework and Student Grades: Impact in an Introduction to Physical Geology Class

Eric C. Brevik

Department of Natural Sciences, Dickinson State University, Dickinson, ND, USA

Online homework assignments were added to my GEOL 105 – Physical Geology class beginning in the Fall semester of 2014. After fall semester 2016, I analyzed student performance in the three years prior to adopting online homework and compared it to performance over the three years since adopting online homework. Prior to adopting online homework, the average class grade was 73.8%; afterwards it was 81.3%. Most of that improvement was in average test scores, which increased by 6.3% (67.4% prior to 73.6% after). The online homework did not improve the performance of the top students, but it did improve the performance of the other students. Prior to adopting online homework, grade distribution in the class was 15% A (90-100% scores), 32% B (80-90%), 19% C (70-80%), 19% D (60-79%), and 15% F (<60%). After adopting the online homework, the grade distribution was 13% A, 48% B, 24% C, 13% D, and 2% F. Therefore, students who either passed the class but didn\'t excel or who struggled with the class prior to online homework adoption saw improvements in their performance, while students who showed truly outstanding performance remained constant. Test grades showed a similar trend. The average test scores for those who received an A in the class were 88.0% prior to and 88.6% after adopting online homework, while test averages for students who received less than an A were 63.9% prior to and 71.4% after adopting online homework. Therefore, it was concluded that the addition of online homework had a positive effect on student scores. While students who would excel regardless of the format (those who received A grades) showed the same performance under both class formats, those who didn’t do as well without online homework showed significant improvement with the use of online homework assignments.

Acknowledgement: The integration of online homework assignments into the Introduction to Physical Geology class was funded by a Summer Faculty Fellowship from the North Dakota Space Grant Consortium.

Keywords: geology education, novel teaching methods, student performance, online homework