EGU General Assembly 2020

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SSS2.5

Soil erosion and driving factors of soil carbon distribution: a worldwide threat

Convener: Leticia Gaspar

Co-conveners: J.J. Le Roux, Jose Alfonso Gomez, Ivan Lizaga, Lionel Mabit, Ana Navas, Saidi Mkomwa, Ikenna Osumgborogwu

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EGU2020

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EGU General Assembly 2020

TIME ZONE
around the world

MONDAY, 04 May, 16:15 - 18:00

16:15 - 18:00	**VIENNA Austria**, Spain, South Africa, Belgium, Italy, Switzerland, Germany, Egypt
10:15 - 12:00	US, Chile, Bolivia
11:15 - 13:00	Argentina
14:15 - 16:00	Morocco
15:15 - 17:00	UK, Nigeria, Congo
17:15 - 19:00	Cyprus, Russia
22:15 - 24:00	Taiwan, China

EGU2020

SSS2.5 Soil erosion and driving factors of soil carbon distribution: a worldwide threat

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PROGRAM online chat

- Monday, **04 May, 16:15 - 18:00** (CEST)
- 105 minutes
- 10 presentations
- 10 minutes per presentation
- 5' explain the contribution + 5' questions and interactively discussion.

16:00	Chat will be available 15 minutes before the session starts
16:15	WELCOME by conveners
16:17	D2148 | EGU2020-5833 (Chairperson: Leticia Gaspar) Soil Organic Carbon Distribution and Isotope Composition Response to Erosion in Cropland under Soybean/Maize Production **Greg McCarty**, Xia Li
16:27	D2149 | EGU2020-11147 (Chairperson: Leticia Gaspar) Visual assessments and model estimations of soil erosion and relations to soil organic carbon **Hakan Djuma**, Adriana Bruggeman, Marinos Eliades
16:37	D2150 | EGU2020-3947 (Chairperson: Jay Le Roux) Soil erosion and sediment transport in South Africa: an overview John Boardman, **Ian Foster**
16:47	D2151 | EGU2020-8802 (Chairperson: Jay Le Roux) South Africa's agricultural dust sources and events from the MSG SEVIRI record **Frank Eckardt**, Johanna Von Holdt, Nickolaus Kuhn, **Anthony Palmer**, Jonathan Murray
16:57	D2152 | EGU2020-3913 (Chairperson: Jay Le Roux) Determining Sub-Catchment Contributions to the Suspended Sediment load of the Tsitsa River, Eastern Cape, South Africa **Laura Bannatyne**, Ian Foster, Ian Meiklejohn, Bennie van der Waal
17:07	D2153 | EGU2020-1186 (Chairperson: Jay Le Roux) Gully Initiation on the Quartzite Ridges of Ibadan, South West, Nigeria **Olutoyin Fashae**, Rotimi Obateru, Adeyemi Olusola
17:17	D2156 | EGU2020-494 (Chairperson: Lionel Mabit) Are human activities main drivers of soil organic carbon losses in mountain rainfed agroecosystems? **Ivan Lizaga**, Leticia Gaspar, Laura Quijano, Maria Concepción Ramos, Ana Navas
17:27	D2160 | EGU2020-17676 (Chairperson: José Alfonso Gómez) Lateral transport of SOC induced by water erosion in a Spanish agroecosystem **Leticia Gaspar**, Lionel Mabit, Ivan Lizaga, Ana Navas
17:37	D2163 | EGU2020-10027 (Chairperson: Iván Lizaga) Erosion and sediment enrichment ratio in volcanic soils **Ludmila La Manna**, César Mario Rostagno, Manuela Tarabini, Federico Gomez, Ana Navas
17:47	D2166 | EGU2020-2228 (Chairperson: Jay Le Roux) Quantitative assessment of gully erosion dynamics using a GIS implementation of Sidorchuks' DYNGUL model in Southern KwaZulu-Natal, South Africa **Adel omran**, Dietrich Schroeder, Christian Sommer, Volker Hochschild, Aleksey Sidorchuk, Michael Maerker
17:57	GENERAL discussion
18:00	CLOSING by conveners

TIPS & HINTS for using chat

- We recommend having **2 windows of your internet browser open simultaneously**: **One for the chat** and **another for viewing the presentation** uploaded by the speaker. The speaker could refer to some slides or figures included in the presentation during the text-based chat. (see attached screenshot) NEXT PAGE
- The speaker can copy and paste pre-composed text during the online chat
- We encourage you to download and view the loaded presentations before the online chat
- The chat SSS2.5 is not yet open. It will be available on 04 May, 16:00–18:30
- Ensure to enter the chat early enough, ideally 15 minutes prior to session start, and check the time in your time zone
- The link to access into the chat will be given at SSS2.5 session in the online programme: https://meetingorganizer.copernicus.org/EGU2020/displays/35024
- Please follow the nickname guidelines (name + affiliation + role)
- Conveners posts shown in light red, participant posts shown in grey, your posts shown in blue
- Only text, unfortunately graphics or tables cannot be used during the online chat
- When replying to a specific comment or question please clarify which comment you are addressing by referring to the originator's nickname
  Example: @JohnSmith please name your model used.

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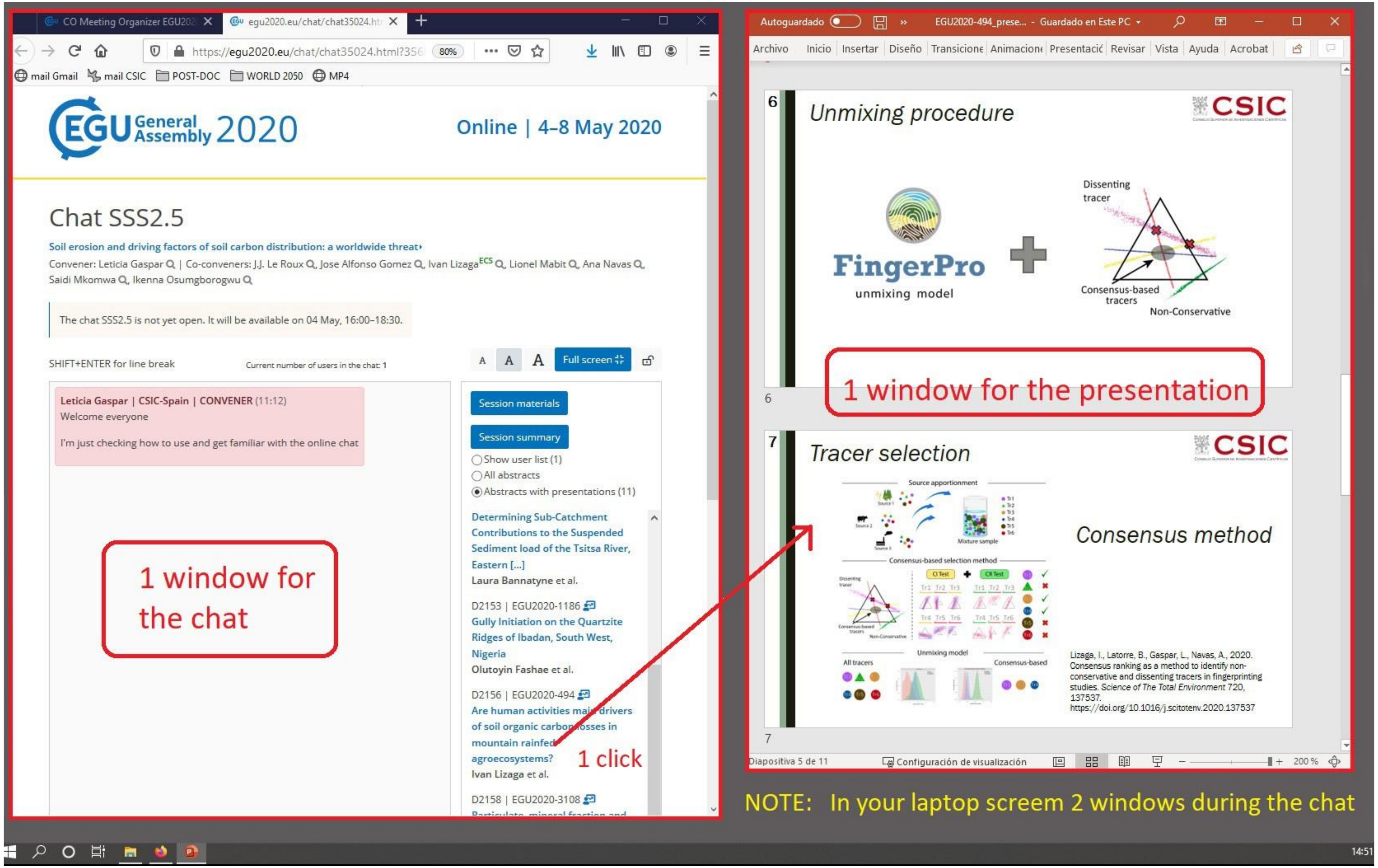

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D2147 | EGU2020-11546 | **Highlight**
Soil erosion leads to significant mobilisation of terrestrial organic and inorganic carbon
Laura Turnbull and John Wainwright

D2148 | EGU2020-5833
Soil Organic Carbon Distribution and Isotope Composition Response to Erosion in Cropland under Soybean/Maize Production
Greg McCarty and Xia Li

D2149 | EGU2020-11147
Visual assessments and model estimations of soil erosion and relations to soil organic carbon
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D2150 | EGU2020-3947
Soil erosion and sediment transport in South Africa: an overview
John Boardman and **Ian Foster**

D2151 | EGU2020-8802
South Africa's agricultural dust sources and events from the MSG SEVIRI record
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Determining Sub-Catchment Contributions to the Suspended Sediment load of the Tsitsa River, Eastern Cape, South Africa
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D2153 | EGU2020-1186
Gully Initiation on the Quartzite Ridges of Ibadan, South West, Nigeria
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D2154 | EGU2020-3065 | **Highlight**
Accumulation of soil carbon and nutrients along a 127-yr soil chronosequence in the Hailuogou Glacier retreat area
Shouqin Sun, Genxu Wang, and Xinbao Zhang

D2155 | EGU2020-6349
Coupling of land use change, soil erosion and carbon dynamic on the Chinese Loess Plateau
Jianlin Zhao

D2156 | EGU2020-494 | **Highlight**
Are human activities main drivers of soil organic carbon losses in mountain rainfed agroecosystems?
Ivan Lizaga, Leticia Gaspar, Laura Quijano, Maria Concepción Ramos, and Ana Navas

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SOC and soil total nitrogen stocks, soil quality and vegetation composition during natural revegetation processes in a Mediterranean mid-mountain area
Estela Nadal Romero, Pedro Sánchez Navarrete, **Makki Khorchani**, Luis Miguel Medrano-Moreno, and Teodoro Lasanta

D2158 | EGU2020-3108
Particulate, mineral fraction and water extractable organic carbon in the soil and in the sediments transported by runoff
Maria Concepción Ramos

D2159 | EGU2020-10221
Temporal variability in soil organic carbon in response to erosion in mountain agricultural landscapes
Jessica Vasil'chuk, **Leticia Gaspar**, Ivan Lizaga, and Ana Navas

D2160 | EGU2020-17676
Lateral transport of SOC induced by water erosion in a Spanish agroecosystem
Leticia Gaspar, Lionel Mabit, Ivan Lizaga, and Ana Navas

D2161 | EGU2020-5593
Linking soil C pools and N in radiotraced soils of Grey lake area (Torres del Paine, Chilean Patagonia)
Alejandra Castillo, Leticia Gaspar, Ivan Lizaga, Gerd Dercon, and **Ana Navas**

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Distribution of nutrient pools in recently formed soils of Andean high wetlands (Huayna-Potosí, Bolivia)
Michele Nuñez-Quiroga, Edson Ramírez, Gerd Dercon, and **Ana Navas**

D2163 | EGU2020-10027
Erosion and sediment enrichment ratio in volcanic soils
Ludmila La Manna, César Mario Rostagno, Manuela Tarabini, Federico Gomez, and **Ana Navas**

D2164 | EGU2020-18155
Simulating heavy rainfall events for parameterizing a first application of the physically based soil erosion model EROSION3D in South Africa
Andreas Kaiser, Michael Geißler, Jay Le Roux, Marike Stander, George van Zijl, and Jussi Baade

D2165 | EGU2020-1208
Pragmatic, fast and easy to use Model for Predicting Susceptibility to Concentrated Flow Erosion in a GIS in data-sparse regions
Liberty Lazarus Orapine Mgbanyi, Matthew Johnson, and Colin Thorne

D2166 | EGU2020-2228
Quantitative assessment of gully erosion dynamics using a GIS implementation of Sidorchuks' DYNGUL model in Southern KwaZulu-Natal, South Africa
Adel Omran, Dietrich Schroeder, Christian Sommer, Volker Hochschild, Aleksey Sidorchuk, and Michael Maerker

SSS2.5 Soil erosion and driving factors of soil carbon distribution: a worldwide threat

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CONTRIBUTIONS session SSS2.5 (pag.5/5)

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[Soil Degradation in Argan Woodlands, South Morocco]
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Eric Lutete Landu, Guy Ilombe Mawe, Charles Bielders, Fils Makanzu Imwangana, Olivier Dewitte, Jean Poesen, and Matthias Vanmaercke

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Soil erosion on Mauritius (withdrawn)
Paul Sumner

D2171 | EGU2020-9864
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EGU2020-11546
https://doi.org/10.5194/egusphere-egu2020-11546
EGU General Assembly 2020

Soil erosion leads to significant mobilisation of terrestrial organic and inorganic carbon

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Soil carbon content is greatly affected by soil degradation – in particular erosional processes – which cannot be ignored in the context of the global C cycle. Soil degradation, driven largely by wind and water erosion, affects up to 66% of Earth's terrestrial surface. Understanding how soil degradation affects soil organic carbon (SOC) and soil inorganic carbon (SIC) stocks is an essential component of understanding global C cycling and global C budgets, and is essential for improved C management and climate-change mitigation policies.

In this study, we quantify the distribution of SOC and SIC, and estimate their combined effects on carbon mobilisation via water and wind-driven erosion. We estimate spatially variable water-driven erosion rates for different land-use systems and degradation severities using values obtained from a meta-analysis of soil erosion rates, and undertake stochastic simulations to account for possible uncertainty in our estimates. For wind-driven soil erosion rates we use modelled dust emission rates from AeroCom Phase III model experiments for the 2010 control year, for 14 different models. We use the Harmonized World Soil Database v1.2 to calculate SOC and SIC stocks, the GLASOD map of soil degradation to estimate soil degradation severities and the Land Use Systems of the World database to estimate water-driven erosion rates associated with different land-use systems.

We find that 651 Pg SOC and 306 Pg SIC (in the top 1-m of soil) is located in degrading soils. We estimate global water-driven soil erosion to be 216.4 Pg yr^{-1}, which results in the mobilisation of ~2.9536 Pg OC yr^{-1}. Accounting for the enrichment of organic carbon in eroded sediment increases these estimates up to 12.2 Pg SOC yr^{-1}. A minimum estimate of SIC mobilisation by water erosion is ~0.5592 Pg IC yr^{-1}. Dust emission model ensemble results indicate that ~19.8 Pg soil is eroded for the 2010 AeroCom reference year, with ~11.1 Pg deposited via dry deposition and ~7.2 Pg deposited via wet deposition. The total amount of SOC and SIC mobilised by water-driven erosion is greater than wind-driven erosion, and the spatial patterns of SIC and SOC mobilisation by wind and water vary considerably. Across all land-use types, water-driven carbon mobilisation is higher than wind. Water-driven SOC mobilisation is highest in cropland (~ 2.6602 Pg OC yr^{-1}) where high erosion rates coincide with average SOC content of 68.4 tonnes ha^{-1}. SIC mobilisation follows the same pattern in relation to land use, with highest water-driven mobilisation in cropland (~0.4660 Pg IC yr^{-1}) and highest wind-driven mobilisation in bare areas (0.05 Pg IC yr^{-1}). Overall, wind-driven erosion mobilises more IC than OC.

Future land-use change has great potential to affect global soil carbon stocks further, especially with increases in the severity of soil degradation as human pressures on agricultural systems increase.

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EGU2020-5833
https://doi.org/10.5194/egusphere-egu2020-5833
EGU General Assembly 2020

Soil Organic Carbon Distribution and Isotope Composition Response to Erosion in Cropland under Soybean/Maize Production

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Soil erosion and deposition patterns can affect the fate of soil organic carbon (SOC) in agroecosystems. Topographic constraints affect soil redistribution processes and create spatial structure in SOC density. We combined isoscape (isotopic landscape) analyses for $\delta^{13}C$ and cesium-137 (^{137}Cs) inventory via digital terrain analysis quantifying SOC dynamics and soil redistribution patterns to gain insight on their responses to topographic constraints in an Iowa cropland field under soybean/maize (C3/C4) production. Additionally, historic bare soil orthophotos were used to determine soil carbon distribution before the 1960s (prior to global ^{137}CS fallout). Topography□based models were developed to estimate ^{137}Cs inventory, SOC density, and $\delta^{13}C$ distributions using stepwise principal component regression. Findings showed that spatial patterns of SOC were similar to soil erosion/deposition patterns with high SOC density in depositional areas and low SOC density in eroded areas. Soil redistribution, SOC density, and $\delta^{13}C$ signature of SOC were all highly correlated with topographic metrics indicating that topographic constraints determined the spatial variability in erosion and SOC dynamics. The $\delta^{13}C$ isoscape indicated that C3□derived SOC density was strongly controlled by topographic metrics whereas C4□derived SOC density showed much weaker expression of spatial pattern and poor correlation to topographic metrics. The resulting topography□based models captured more than 60% of the variability in total SOC density and C3□derived SOC density but could not reliably predict C4□derived SOC density. This study demonstrated the utility of exploring relationships between $\delta^{13}C$ and ^{137}Cs isoscapes to gain insight on fate of SOC within eroding agricultural landscapes.

EGU2020-11147
https://doi.org/10.5194/egusphere-egu2020-11147
EGU General Assembly 2020

Visual assessments and model estimations of soil erosion and relations to soil organic carbon

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Visual soil erosion assessment methods and erosion models are widely applied around the globe. The objective of this research is to assess the relation between soil organic carbon (SOC) concentrations (sampled) and two different soil erosion estimates (visual assessment and model). For the visual assessment, the method of the World Overview of Conservation Approaches and Technologies (WOCAT) was used, which is based on expert field observations per land cover unit. For the model assessment, the Pan-European Soil Erosion Risk Assessment (PESERA) model was used to simulate hill slope soil loss based on land cover, soil texture, meteorological data and slope profile. The research was conducted in Peristerona watershed in Cyprus (surface area: 106.4 km^2, elevation: 300 to 1,540 m above sea level, average annual precipitation: 270 mm downstream and 750 mm upstream). The WOCAT questionnaires were completed by a trained specialist during site visits for 79 mapping units in 15 different land cover types. These results were compared with SOC concentrations from 29 points in the same watershed (0-25 cm depth, grid-based sampling, variety of land covers). For erosion modelling comparison, SOC concentrations from 11 paired sites of productive and abandoned terraced vineyards (0-10 cm depth, random sampling) were compared to the PESERA estimates of the same sites. A transect was drawn from the slope top to the SOC sampling point and erosion was estimated for the slope section where sampling was performed. Both the visual assessment and the modelling method showed that SOC concentrations were lower for areas with higher soil erosion. The mean SOC concentration was 1.7% (n=19) for areas ranked as "light erosion" in the WOCAT assessment and was 0.8% (n=10) for areas ranked as "moderate erosion". Similarly, the abandoned sites that showed higher PESERA estimated erosion than the productive sites (more than 10 times higher erosion rate (n=2)) had lower SOC concentrations than their productive counterpart (half the SOC concentrations). The SOC concentrations almost doubled for abandoned sites compared to the productive sites when PESERA estimated erosion went from 10 times more to 5 times more (n=6) for the abandoned sites. Results from both methods indicate that soil erosion rates and top soil SOC concentrations are related and need to be considered in erosion models.

EGU2020-3947
https://doi.org/10.5194/egusphere-egu2020-3947
EGU General Assembly 2020

Soil erosion and sediment transport in South Africa: an overview

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We have few direct measurements of erosion in the country and those that we have are for relatively small areas (badlands) or for experimental plots. We therefore have to rely on sediment yields from rivers and reservoirs, mapping based on remote sensing (gullies) and some modelling. All methods have their disadvantages. With sediment yields the problem of scale is acute and estimates range from <5 to > 11,000 t km^{-2} yr^{-1}. The great range of estimates partly reflects rainfall/runoff variability but it also strongly reflects the intensity of land use and connectivity or dis-connectivity within catchments. Elements in the landscape such as gullies (dongas) were initiated under conditions in the past of intense land-use (overstocking) and perhaps climatic pressure. Many gullies are inactive at the present day but have been shown to improve landscape connectivity. However, overgrazed land continues to contribute large quantities of sediment to freshwater systems and to the infilling of reservoirs. The protection of inadequate water resources, threatened by erosion, is a currently urgent problem. More information is needed about the origin of sediments using techniques such as fingerprinting.

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EGU2020-8802
https://doi.org/10.5194/egusphere-egu2020-8802
EGU General Assembly 2020

South Africa's agricultural dust sources and events from the MSG SEVIRI record

Frank Eckardt[1], Johanna Von Holdt[1], Nickolaus Kuhn[2], Anthony Palmer[3], and Jonathan Murray[4]
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[2]University of Basel, Basel, Switzerland
[3]Institute for Water Research, Grahamstown, South Africa
[4]Imperial College London , London, England

Our aim was to determine South Africa's major dust sources using the MSG (Meteosat Second Generation) SEVIRI (Spinning Enhanced Visible and Infra-red Imager) image record from 2006-2016. A total of 334497 images were examined, which revealed 178 discrete dust plumes on 75 dust-producing days. These originated largely from the Free State to the north of Bloemfontein. Landsat derived National Geospatial data suggests that emission areas consist mostly of grass and low shrublands as well as commercial rainfed agriculture.

The dust emission season from June to January overlaps with the dry season and coincides with the maize harvest period. 2015 and 2016 saw almost half of all event days in the 11-year record, which is matched by a severe drought index (SPEI Standardised Precipitation-Evapotranspiration Index) and strong winds (ERA5). This period is also accompanied by a below average NDVI (Normalized Difference Vegetation Index) response for cropland areas, while DAFF (Department: Agriculture, Forestry and Fisheries) crop data reports a notable decline in Free State maize cover from 1.2 to 0.6 million hectares and a pronounced increase in fallow land from 140 thousand to 790 thousand hectares over the same time span.

Dust events adhere to distinct diurnal patterns, are almost entirely midday occurrences and are accompanied by hourly average windspeeds of up to 11 m s^{-1}. HYSPLIT (Hybrid Single Particle Lagrangian Integrated Trajectory) suggests that aerosols would largely head towards the Indian Ocean with the passing of cold fronts. South Africa's major dust sources in the SEVIRI record appear to be mostly anthropogenic in nature and a function of both land cover and land management practices associated with rainfed agriculture on soils rich in silt and sand. The soil textures in the Free State, especially those associated with arenosols extend into the wider drier interior, including the Kalahari, where future climate scenarios have predicted increases in dust emissions from both soils and dunes. Notwithstanding other land-use practices, we would argue that the 2015-2016 dust season in South Africa provides an insight into potential future regional scenarios, given increases in drought, associated bare cover and an increase in windiness.

EGU General Assembly 2020

EGU2020-3913
https://doi.org/10.5194/egusphere-egu2020-3913
EGU General Assembly 2020

Determining Sub-Catchment Contributions to the Suspended Sediment load of the Tsitsa River, Eastern Cape, South Africa

Laura Bannatyne[1], Ian Foster[2], Ian Meiklejohn[1], and Bennie van der Waal[1]
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In South Africa, as in many developing countries, the suspended sediment (SS) data required to support catchment scale hillslope restoration and rehabilitation programmes are typically scarce or absent, leading to a reliance on modelled SS loads and yields that are generally not validated by measured SS data. An exception is the Tsitsa River catchment in the Eastern Cape Province, where modelled SS yields were high (21 – 50 t/ha/yr), leading to the establishment of a Citizen Technician-based monitoring programme (2015 – 2019) that has provided flood-focused, sub-catchment scale SS data at sub-daily timestep for 11 sites throughout the 4000 km^2 catchment.

A confluence-based SS fingerprinting and tracing exercise was undertaken in the catchment (2018). Analysis of the distinctive physicochemical properties of resuspended fine sediment sampled above and below major confluences allowed the percentage of SS contributed by each tributary to be apportioned, and compared with findings from both the SS monitoring campaign and from existing models.

EGU2020-1186
https://doi.org/10.5194/egusphere-egu2020-1186
EGU General Assembly 2020

Gully Initiation on the Quartzite Ridges of Ibadan, South West, Nigeria

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Gullies are morphological evidences that reflect the impact of environmental changes on landscape. In an attempt to emphasize the importance of topography on gully initiation and development in an area of uniform geology, this study examined the morphological characteristics of hillslope and the role of topographic mechanism in gully initiation on a quartzite terrain of Ibadan, South western Nigeria. Four prominent quartzite ridges exist in Ibadan namely Mokola, Mapo, Eleyele and Ojoo, each of which except the latter is characterized with significant gully systems. Field measurement was carried out to determine the gully morphological characteristics such as length, width, depth, area and depth of gully head, width/depth ratio, gully sinuosity and gully shape while Digital Elevation model (DEM) was used to examine the slope-area relationship. The slope-drainage area threshold was established for each of the gully systems.

The average gully density of the study area is 2.48km/km^2 and the gully frequency is 9.72 gullies/km^2. Although an investigation into the variation of the gully morphology and initiation show that human activities and vegetation are contributary factors to their development. However, topographic characteristics exhibit a dominant role in the gullying process. The ridges were observed to trend in NNW-SSE direction with slope angles ranging between 5^o and 30^o. The inverse relationship derived between the topography and gully dimension (r = 0.462), suggested that gully initiation processes are dominant on gently sloping ridges due to extensive surface area on a deeply weathered regolith that enhances fluvial processes of material detachment on the one hand and anthropogenic conditions on the other hand. Thus, further geomorphological assessment of landform units in Ibadan is necessary with a view of identifying potential geomorphic risk prone areas, an essential component of risk management for dense urban areas of the tropics.

EGU2020-3065
https://doi.org/10.5194/egusphere-egu2020-3065
EGU General Assembly 2020

Accumulation of soil carbon and nutrients along a 127-yr soil chronosequence in the Hailuogou Glacier retreat area

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Climate change is resulting in accelerated retreat of glaciers worldwide, leaving behind bare soil and succeeding vegetation at ecological sites that share similar attributes but represent different ages across chronosequences of primary succession. These glacial succession chronosequences provide a space for time exchange opportunity to investigate the development of soil and vegetation from the very beginning. In this study we investigated how soil carbon (C), nitrogen (N) and phosphorus (P) nutrients were accumulated along a 127-yr primary successional chronosequence on Hailuogou glacier, China, where the soil samples were collected at 1-cm depth interval from 9 sectioned profiles with ages ranged from 27 yr to 127 yr on the glacial retreated area. Soil organic C (SOC) and TN showed an increasing trend along the chronosequence. The organic C and N accumulation was minimal after 27 yr of succession; with succession the soil had slightly C and N accumulation at the surface 0-1 cm depth after 45 to 53 years, and had obvious accumulation at the 0-2 cm depth after 59-72 years; the SOC and N accumulation extended to the 0-5 cm depth after 87 yr and to the 0-10 cm depth after 102 yrs. In contrast soil total P exhibited a depleting trend along the succession. Results indicated that the C and N accumulation along a glacier retreat chronosequence is not linear, but a slow increase in accumulating rates in the first 72 years, followed by a sharp increase between 72 to 87 years and then slow down with succession proceeded.

EGU General Assembly 2020

EGU2020-6349
https://doi.org/10.5194/egusphere-egu2020-6349
EGU General Assembly 2020

Coupling of land use change, soil erosion and carbon dynamic on the Chinese Loess Plateau

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Land use change can significant impact on carbon dynamics by directly changing the carbon stock on soil and biomass and by controlling the magnitude of soil erosion which indirectly influences the erosion-induced carbon sink or sources. Whether land use change causes a net carbon sink or source to the atmosphere, an integrated analysis that considers both the direct effects of land use changes on vertical fluxes as well as its effects on the erosion-induced carbon sink is therefore necessary.

The Chinese Loess Plateau (CLP) is an ideal case for an integrated assessment of the influence of land use change on OC dynamic, given that CLP has experienced significant land use change during last two decades and is the most eroded regions in the world which potentially target the relative higher magnitude of erosion-induced carbon sink. Therefore, the objectives of this study are to carry out an integrated analysis of the influence of land use change and soil erosion on regional carbon dynamics during 1990-2010.

Our results indicated that CLP experienced two inverse tendencies of land use change and carbon dynamics between 1990 and 2010. During 1990 to 2000, a net decrease of vegetation cover land (grass and woodland) has happened on the CLP which induced a carbon loss by 4.85 Tg C yr^{-1} on soil and biomass, which was mainly due to the cutting of native forest and the conversion of grassland to arable land. While, based on the assumes that 50% of the mobilised carbon is finally buried and that full replacement takes place at the erosion sites, the erosion-induced sink would compensate about 55% of the carbon loss due to land use change. Thus, between 1990 and 2000 the CLP was a net carbon source to atmosphere. Due to the implementation of the Grain for Green Project, permanent vegetation cover land has gradually increased between 2000 and 2010. The net rise of vegetation cover land resulted in an annual carbon sink of soil and biomass by 1.67 Tg C yr^{-1}. Meanwhile, soil conservation measures (terrace) and land use change constrained the strength of erosion-induced carbon sink. The total amount of carbon mobilised declined to ca. 5.00 Tg C yr^{-1} and the erosion-induced carbon sink was ca. 2.50 Tg C yr^{-1} (based on the same assumes of carbon replacement rate and carbon burial efficiency). Therefore, CLP was a carbon sinks during 2000-2010. Again, changes in land-atmosphere carbon fluxes due to land use change were far more important than changes due to erosion reduction.

due to the Grain for Green Project remains uncertain. Meanwhile, the magnitude of the erosion-induced carbon sink is also uncertain, and estimates need to be further refined and constrained by more accurate data and the use of more explicit models. Nevertheless, our current understanding allows us to clearly identify the direction of change in carbon fluxes brought about by the combined effects of land use change and erosion reduction.

EGU General Assembly 2020

EGU2020-494
https://doi.org/10.5194/egusphere-egu2020-494
EGU General Assembly 2020

Are human activities main drivers of soil organic carbon losses in mountain rainfed agroecosystems?

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One of the principal soil degradation problems affecting European agroecosystems is the loss of topsoil by water erosion. In dry climates, soil erosion is led by two main factors, human activities such as agriculture and extreme episodic rainfalls. However, agriculture plays a crucial role in leaving the soils unprotected during part of the year. Thus, extreme rainfall can easily remove the topsoil with the subsequent removal of nutrients in surface soil layers and the reduction of soil quality.

To assess the effects of extreme storms in rainfed agriculture catchments on soil organic carbon removal, surface soil samples from different land uses were collected in a medium-sized catchment at the foot of Santo Domingo range. The study area was mostly cultivated at the beginning of the 19th century but changed to rangeland and afforestation forest in the last 50 years. The remaining cropland area is mostly rainfed agriculture that leaves soils unprotected in periods when erosive storms occur (autumn convective rainfalls). The main land uses are croplands, pine afforestation, scrubland and Mediterranean forest. To track the export of soil organic carbon associated to mobilised sediment occurring under storm events, channel bed sediment samples were collected along the principal streams of the drainage network during regular flow, after a regular storm event, and after an extreme storm event. The contents of soil organic carbon (SOC), SOC fractions and grain size were analysed and compared for the three sampling campaigns. The results show a gradual decrease of the fine fraction from regular flood samples to samples collected after the extreme event. However, the SOC showed a sharp decrease in the post-extreme event samples, with higher decreases in the active carbon fraction (ACF) than in the stable carbon fraction (SCF).

Our findings highlight the substantial in situ hazards of extreme rainfall events removing soil organic carbon from topsoils and exporting fine sediment and nutrients out of the catchment with important indirect impacts on water resources both quantity and quality.

EGU2020-18475
https://doi.org/10.5194/egusphere-egu2020-18475
EGU General Assembly 2020

Soil organic carbon and soil total nitrogen stocks, soil quality and vegetation composition during natural revegetation processes in a Mediterranean mid-mountain area

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Mediterranean mid-mountain areas have been subject to significant human pressure through deforestation, cultivation of steep slopes, fires and overgrazing. However, during the 20th century, the mountainous areas of the northern rim of the Mediterranean region were affected by abandonment of cultivated fields and natural revegetation processes. Natural revegetation occurred in most of the lands where human activity (farming on steep slopes, grazing) declined in intensity or was abandoned, resulting in the expansion of shrubs, bushes and forests. What are the consequences of such processes on soil quality, soil organic carbon (SOC) and soil total nitrogen (TN) stocks and vegetation composition? What are the differences between the different land uses and land covers (LULCs)? The general aim of this study is to study the effects of natural revegetation processes after land abandonment on soil quality, SOC and soil TN stocks and vegetation composition in the Leza Valley (Iberian System, Spain). We hypothesized that natural revegetation processes improves soil quality and higher SOC and TN stocks. For this purpose, we analyzed 60 soil samples, from 5 LULCs and four depths (0-10, 10-20, 20-30, 30-40 cm): pasture, shrubs characterized by the presence of Cistus laurifolius, bushed characterized by the presence of Juniperus communis, Young forest (Quercus faginea), and old forest or dehesa. In addition, plant species inventories were carried out in each LULC.

The results related to physico-chemical soil properties indicated: (i) significant differences in soil quality between the first stages of natural revegetation (pasture and shrubs) and young forest (limited to the first 20 cm between shrub and young forest); (ii) significant differences in SOC stocks between the first stage of natural revegetation (pasture) and young and old forests; (iii) significant differences in soil TN stocks between pasture and shrubs and young and old forests; and (iv) significant differences between the shrub families. Final results obtained through a Principal Component Analysis with all the variables differentiate forests from shrubs, bushes and pastures confirming our first hypothesis. We can conclude that natural revegetation is an effective strategy to improve soil quality and increase SOC and soil TN stocks.

EGU2020-3108
https://doi.org/10.5194/egusphere-egu2020-3108
EGU General Assembly 2020

Particulate, mineral fraction and water extractable organic carbon in the soil and in the sediments transported by runoff

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Erosion is the most widespread process that cause land degradation. It produces changes in soil properties and contribute to the depletion of organic matter content as well as to the loss of nutrients. The changes have an additional effect on the infiltration and on water retention capacity, which all together influence crop productivity. Water erosion occurs due to natural forces rainfall. But in areas with Mediterranean climate, most of erosion losses occur in a reduced number of events of high intensity. In this research, the effect of high intensity rainfalls on soil carbon mobilization was analysed in a vineyard, which is maintained with scarce soil cover most of the year. The research was carried out under simulated rainfall in a commercial vineyard located in Raimat, Costers del Segre Denomination of Origin, Lleida, NE Spain). The soil type in the analysed plot is classified as Haploxeralf fluventic located in a gentle slope (about 5%). Soil samples from 0-2 cm were collected in two locations in the field, before the rainfall simulation for texture characterization and chemical analysis. Plots 1m length*0.5 m width were delimited in the field at each location and subjected to simulated rainfall using a rainfall simulator consisted, which had a dropper system placed 2.5 m above the ground. The rainfall intensity was fixed for the experiment in 60 mm/h. The simulations were done in triplicate. Runoff was collected every 10 minutes during 1h and the sediment transported by runoff was separated and weighted after dried. Total organic carbon (TOC) was analysed in the soil before and after the simulation. In addition, in the original soil and in the sediments recorded in each simulation, the particulate organic carbon (POC) and the mineral-associated organic carbon (MOC) (Cambardella and Elliott, 1992), as well as the water extractable organic carbon (WEOC) (Gigliotti et al., 2002) were analysed. The soils had 50.2 and 49.5% of silt, 25.5 and 23.2% of clay and 24.3 and 27.3% of sand, respectively. Runoff started between 4.5 and 7 min after the beginning of the simulations, and runoff rates were of about 50% after the first 20 minutes of rainfall. Sediment concentration in runoff ranged between 13 and 18 gL^{-1} in the three simulations. The TOC in the original soils were 14.09±0.67 gkg^{-1} and 13.56±0.8 gkg^{-1}, respectively, while after the simulation the TOC was near 10% lower. In the sediments, TOC were 12.29±1.13 gkg^{-1} and 12.84±1.19 gkg^{-1}, respectively in both soils. The POC and the MOC represented 24.7% and 75.3% of TOC in the original soil, and no significant changes were observed in the sediment transported by runoff (values ranging between 25.90 to 28.47 % for POC and between 71.5 and 74.1% for MOC). However, the WEOC fractions were higher in the sediment (7.7 and 7.5%) than in the original soil (5.26%).

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EGU General Assembly 2020

EGU2020-10221
https://doi.org/10.5194/egusphere-egu2020-10221
EGU General Assembly 2020

Temporal variability in soil organic carbon in response to erosion in mountain agricultural landscapes

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Soil erosion leads to the loss of fertile topsoil, resulting in one of the principal soil degradation problems in agricultural landscapes worldwide. Soil redistribution processes affect the spatial and temporal variability of soil properties and nutrients, as soil organic carbon (SOC) which is linked to soil quality and soil functions. In the context of climate change mitigation as well as soil fertility and food security, there has been considerable interest in monitoring soil and carbon loss, especially in erosion-affected agricultural landscapes.

In this study, we attempt to evaluate the temporal variation of SOC and carbon fractions in a Mediterranean mountain agroecosystem. To this purpose, repeating soil sampling and carbon measurements within the same sites was undertaken in 2003 and in 2016. The sampling sites were located in agricultural areas where erosion or deposition preferably occurs based on soil redistribution rates obtained by using ^{137}Cs measurements. The content of soil organic carbon (SOC) and the active and stable SOC fractions, (ACF and SCF, respectively) contents were measured by the dry combustion method using LECO RC-612 equipment.

Although statistically significant differences between the two surveys were not found, the mean content of SOC, ACF and SCF were slightly lower in the survey taken in 2016 than the one in 2013. Repeated topsoil sampling (0-5 cm) after 13 years reveals SOC and ACF losses for almost all the agricultural soils selected in this research. It's important to highlight that the biggest differences between the two surveys are identified in the sites located in areas with steep slopes, while small variations occurred in the sites located in gentle slopes where deposition processes predominate. However, even if SCF losses were detected, especially in the erosive sites located in steep slopes, the content of SCF slightly increases for the second survey in sites located in depositional areas. To date, there have been few attempts to monitor soil carbon in Mediterranean soils, and this study represents a preliminary investigation that may be suitable for tracking absolute changes in SOC and carbon fractions in agricultural landscapes.

EGU General Assembly 2020

EGU2020-17676
https://doi.org/10.5194/egusphere-egu2020-17676
EGU General Assembly 2020

Lateral transport of SOC induced by water erosion in a Spanish agroecosystem

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The main route for the lateral movement of soil organic carbon (SOC) is water erosion. Awareness of the distribution and magnitude of land carbon mobilization is important both for improving models of the carbon cycle and for management practices aimed to preserve carbon stocks and enhance carbon sinks. There is a need to consider the global significance of soil erosion from soil organic carbon cycling schemes and for this reason, the movement of SOC during erosion processes should be elucidated.

Our study aims to estimate the SOC redistribution induced by water erosion during a 40 years period in an agroforestry mountain ecosystem located in northern Spain. To this purpose, topographically driven transects were selected with mixed land uses to i) assess what factors modify the runoff patterns with impact on soil and carbon redistribution and ii) evaluate the mobilization of topsoil organic carbon along the transects.

The lateral movement of SOC shows similar spatial patterns with that of soil erosion. To identify whether erosional or depositional processes have been predominant in the sampling sites we used ^{137}Cs inventories and the characterization of terrain attributes of the study with a detailed analysis of the main runoff pathways. Results indicate that SOC losses were related to an increase in water flow accumulation, while the highest SOC gains were recorded at concave positions. Soil erosion processes and the content of SOC in soils are the two main factors controlling carbon budgets. The topographical and geomorphological characteristics of the transects, the spatial distribution of land uses and the presence of landscape linear elements such as terraces or paths, affect runoff and determine the sediment connectivity and carbon dynamics along the slopes.

The interactions between topography and land use produce significant positive or negative effects on SOC accumulation, particularly in areas with complex topography, as the results obtained in our study sustain. Even though the effect of topography and land use/land cover and their interactions on the horizontal distributions of carbon remains largely unknown, our approach contributes to better understand the pattern of gains and losses of soil organic and inorganic carbon induced by water erosion.

EGU General Assembly 2020

EGU2020-5593
https://doi.org/10.5194/egusphere-egu2020-5593
EGU General Assembly 2020

Linking soil C pools and N in radiotraced soils of Grey lake area (Torres del Paine, Chilean Patagonia)

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The Grey Glacier, located in the Torres del Paine region, belongs to the Patagonian ice sheet that suffered several glacial fluctuations during the Quaternary resulting in spectacular glacial landscapes. Similar as in other world mountains, glaciers in the Andean Patagonia are declining and the Grey Glacier has experienced during the last 80 years a clear retreat. Important ice mass collapses occurred in 1996 and recently in 2017 and 2019. In the proglacial environment of Grey Lake, the most characteristic glacial landforms are the Last Glacial Maximum moraine belts while landforms of the Little Ice Age reveal the advance of ice in modern times in the lake surroundings. At present the most active formations are composed of glacial deposits exposed after the recent retreat of Grey glacier. In this rapidly changing environment new soils are developing becoming a relevant framework to assess the trends in the pedogenesis dynamic and the variations of nutrient pools.

During a 15 days field campaign in the frame of the IAEA INT5153 project main proglacial landforms were identified and soil sampling was undertaken to assess if there were differences in the soil status and the nutrients pools in function of the geomorphic characteristics. Previous research in the area (Navas et al., 2019) revealed the usefulness of combining ^{137}Cs with soil organic carbon (SOC) for deriving information on soils generated on recently exposed glacial deposits linked to soil redistribution patterns. Our study aims to evaluate what is the status of the SOC pool in soils formed in the Grey Lake area in relation to ^{137}Cs proxies of soil stability. Analyses of ^{137}Cs (Bqkg^{-1}), and of contents of SOC and its fractions, and nitrogen (N) were done for characterizing the soils of the study landforms. We found that the most recent glacial deposits that are highly unstable in this paraglacial environment had the lowest contents of SOC and N along with negligible activities of ^{137}Cs. In parallel with the highest ^{137}Cs activity found in more developed soils on forest slopes, high SOC and N contents though less than in swamps indicated higher soil stability in forest slopes than in recently exposed glacial deposits. In the C pool, the stable fraction was most abundant in soils on forest slopes and on vegetated moraines in accordance with more abundant vegetation cover on relatively more developed soils. Though all landforms had much higher proportion of the active fraction, specially swamps, the contribution of the active fraction to SOC was also much higher in swamps, followed by forest and vegetated moraines. However, in comparison with the rest of glacial deposits and forest slopes, swamps presented the lowest contribution of the stable fraction to SOC evidencing their fragility to degradation processes that would rapidly eliminate the more labile fraction disrupting the natural cycle of C towards more stable fractions. Our results show that combination of ^{137}Cs derived information with data from nutrients pools can be an important aid for interpreting changes in paraglacial landscapes where soils are forming on recently exposed glacial deposits.

EGU General Assembly 2020

EGU2020-9621
https://doi.org/10.5194/egusphere-egu2020-9621
EGU General Assembly 2020

Distribution of nutrient pools in recently formed soils of Andean high wetlands (Huayna-Potosí, Bolivia)

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The Andean glaciers are experiencing since 1980 an accelerated decline associated with an increase in air temperature across the region. Encompassing the shrinking of mountain glaciers new soils are formed as deglaciation facilitates biogeochemical processes and the subsequent development of vegetation. Under extreme environmental conditions high-altitude soils are constrained by climate, substrate and geomorphological characteristics of recently deglaciated surfaces that control soil features in high mountains. At the foot of Huayna-Potosí, the glacier retreat is gradually exposing mineral substrate, which is being colonised by soil biota and plants. The subsequent accumulation of organic matter is progressing rapidly especially in wetlands developed in the proglacial area thus accelerating the processes of soil formation. The characterization of soil organic carbon (SOC) pools is necessary to understand SOC dynamics in soils and a relative measure of C stability in soils.

In this study we attempt to evaluate the distribution of SOC, C fractions and nitrogen in glacial deposits and high altitude wetlands to relate it with that of ^{137}Cs as indicator of soil stability. To this purpose topsoil sampling of moraines, colluvium and peat soil in wetlands was undertaken during a two weeks expedition to Huayna-Potosí Glacier area in the frame of IAEA INT5153 project in May 2017 and contents of SOC and its fractions (i.e. active and stable carbon fractions), nitrogen and ^{137}Cs activity (Bq kg^{-1}) were determined.

The high wetlands both at favourable flat topographic positions and slopes have high organic rich soils showing large carbon sink capacity. More abundant depleted values of ^{137}Cs in moraines and colluvium indicate greater impact of soil erosion processes in comparison to wetlands, whereas a higher ^{137}Cs content is related to higher carbon contents and more abundant vegetation that would preserve soil from erosion. The size of the nutrient pool such as carbon and nitrogen is much higher in wetlands than in glacial deposits. In the carbon pool, the active fraction is more abundant than the stable fraction but in wetlands the ratio active/stable is much higher (mean: 31) than in glacial deposits (mean: 5). The contribution of the active fraction to SOC is also higher in wetlands (c.a. 1), while the opposite was found for the stable fraction contribution to SOC with almost a ratio of 0 in wetlands compared to 0.24 in glacial deposits. Paralleling the evolution of vegetation the enrichment in soil nutrients affects carbon (C) dynamics in the new soils that all are in the early forming stages with low C stability. Despite wetlands soils having the largest SOC content, the imbalance in the proportions of the C fractions with almost negligible stable C evidence the risk of interrupting the C cycle by loosing the more labile fraction. Therefore, focus should be directed to preserve the fragile new forming soils but specially wetlands because their key role in regulating the hydrological system and maintaining high altitude ecosystems.

EGU General Assembly 2020

EGU2020-10027
https://doi.org/10.5194/egusphere-egu2020-10027
EGU General Assembly 2020

Erosion and sediment enrichment ratio in volcanic soils

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Patagonian Andean region is widespread affected by soil degradation and erosion processes. The subhumid sector, which corresponds to the transition (ecotone) between the Andean forests and the Patagonian steppe, has suffered the highest human pressure and overgrazing, accelerating the soil erosion processes.

Near Esquel town (Subhumid sector of Chubut province, Argentina), where soils are mainly developed from volcanic ashes, erosion studies based on fallout radionuclides (Caesium-137) and simulated rainfalls were performed. Studies based on Caesium-137 showed that soil losses in the last 50 years were higher than 30 m^3 ha^{-1} $year^{-1}$ under different land uses.

Rainfall simulation experiments, carried out under the same conditions (Rain fall intensity: 100 mm h^{-1} for 30 minutes; Drop diameter: 2.5 mm; Drop velocity: 5.3 m s^{-1}) showed that erosion rates are highly affected by land use. Potential erosion rates in degraded rangelands varied between 143 and 750 g m^{-2}, depending on soil characteristics (such as texture and presence of non-crystalline materials), soil cover and slope. In mature exotic conifer afforestations, with soil completely covered by litter, soil erosion was negligible, varying between 0 and 10 g m^{-2}. Erosion rates increased both in young afforestations with open canopies (8 a 44 g m^{-2}), and in mature afforestations where fresh litter and duff layers were removed (35 a 200 g m^{-2}).

In the different studied systems, soil losses involved not the detachment of individual particles, but of soil micro aggregates rich in organic matter. Sediments enrichment ratio was always higher than 1, varying between 1.2 and 1.8. These results show that the sediments were enriched with organic matter, as compared to the contributing soils, indicating its selective removal. The erosion studies performed evidence the high erodibility of volcanic soils when their cover is lost, and the close link between erosion and carbon losses in these systems.

EGU General Assembly 2020

EGU2020-18155
https://doi.org/10.5194/egusphere-egu2020-18155
EGU General Assembly 2020

Simulating heavy rainfall events for parameterizing a first application of the physically based soil erosion model EROSION3D in South Africa

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Soil erosion is a frequently tackled field of research and plays a major role in land degradation. Representing a discontinuous process soil loss is strongly determined by single events, which leads to high demands on modelling approaches.

Here we present a first application of the physically-based soil erosion model EROSION3D in a South African setting within the framework of the project SALDi (South African Land Degradation Monitor). Parameterization of the model requires intensive field work in accordance to land use and management patterns, soil types and topography. The experimental determination of physical and hydrological processes for selected sites allows for an improvement of the modelling results. Thus, rainfall and runoff simulation campaigns were carried out on various sites with a 3 x 1 m^2 mobile rainfall simulator. Additionally, UAV and TLS surveying, soil sampling, laboratory analysis and digital soil mapping complemented the approach. The created datasets are firstly handled in EROSION2D to calibrate soil erosivity and hydraulic conductivity and then introduced to EROSION3D for including land use, precipitation, elevation, multi-layered soil properties, organic carbon content and additional model input parameters.

The modelling procedure was applied within the boundaries of a research catchment close to Ladybrand in the Free State for first test runs. Furthermore, the same approach showed distinct differences on a conventionally tilled field vs. a conservational approach. An upscaling to larger catchments will then be carried out in basins with protected soils within Kruger National Park to directly compare them to results from intensively cultivated agricultural sites adjacent to the park boundaries.

EGU2020-1208
https://doi.org/10.5194/egusphere-egu2020-1208
EGU General Assembly 2020

Pragmatic, fast and easy to use Model for Predicting Susceptibility to Concentrated Flow Erosion in a GIS in data-sparse regions

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Less Economically Developed Countries (LEDCs) are at particular risk of gullying due to climate change, land-use change, poor agricultural practices and widespread farming intensification, but in these areas, the data required to apply most predictive models are usually unavailable. Therefore, an urgent need for a practical and rapid predictive tool for assessing gullying potential in data-sparse regions, to inform planning, agricultural practices and environmental management decision-making is required. Given the difficulty in applying existing empirical models to developing areas, where input data is sparse, but the risk of gullying is high, alternative methods need to be developed to identify areas susceptible to gullying. Here it is hypothesised that detailed data is required to apply existing models of soil loss from agricultural areas because they focus on predicting the quantities of sediment lost after agriculture has commenced. The data requirements for successful model application could be less if the focus were instead on identifying areas that are susceptible to gullying. The decision to avoiding soil loss by either protecting them from agricultural development or at least applying soil conservation measures from the outset, without attempting to predict the extents or the specific metre-scale locations of individual gully channels will come much handy. The Compound Topography Index (CTI) meets the criteria for that candidate predictive model for concentrated flow erosion in the data-sparse regions. The CTI, however, required quality and high-resolution data(<5m LiDAR DEMs) available in data-rich regions to perform, but with weak quality and low-resolution data(30m DEM) found in the data-sparse regions, fuzzy logic data applied to this data before using it as input into the CTI model to at least on identifying areas that are susceptible to gullying. The accuracy of the model was moderately improved when used with high-resolution data, and consistent in prediction for coarse resolution DEMs. A key finding is that the fuzzy CTI reveals that much of the landscape has the potential to suffer gullying – i.e. there is sufficient planform and profile curvature to concentrate and accelerate overland flow. Soil degradation and loss of soil structure, or removal of natural vegetation and, especially forests, could exacerbate the condition rapidly lead to widespread gullying based on the occurrence of concentrated overland flow driven by the topography, while the incorporation of soil structural stability index in the fuzzy CTI slightly improved it performance as per modelling concentrated flow erosion. The calculation of CTI is easy, repeatable, require less comprehensive, sophisticated data collection and not over extended periods and could widely be an applicable predictor of gullying, for use in sparse data regions.

EGU2020-2228, updated on 25 Apr 2020
https://doi.org/10.5194/egusphere-egu2020-2228
EGU General Assembly 2020

Quantitative assessment of gully erosion dynamics using a GIS implementation of Sidorchuks' DYNGUL model in Southern KwaZulu-Natal, South Africa

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Soil erosion is considered as one of the main threats affecting both rural and urban areas in many different parts all over the world. Therefore, increasing attention has been attributed to soil erosion in the last decades. This can also be documented by an increasing number of studies targeting soil erosion assessment using qualitative and quantitative models. However, gully erosion phenomena have been widely neglected in erosion modelling due to the nature and complexity of the related processes and hence, it is also more difficult to simulate, predict and to visualize its effects. Sidorchuk (1999) established a Fortran based dynamic erosion model called DYNGUL to describe the first quick stage of gully development, coinciding with the main changes in gully morphology; like changes in volume, area and elevation of the longitudinal profile. The DYNGUL model is based on the solution of the equations of mass conservation and gully bed deformation. The model of straight slope stability was used to predict gully side wall inclination and of the finite morphology of the gully. The objective of this contribution is to establish a GIS tool for a quantitative gully erosion assessment and to predict gully evolution over time. The tool will help: i) to cope with or mitigate gully erosion processes and ii) to plan measures to stabilize the landscape affected by gully erosion. Therefore, we developed a Python-based tool that can be applied in a GIS environment. The model was tested its performance and the sensitivity of physical parameters with data from a gully in the Drakensberg Mountains, KwaZulu-Natal, South Africa. The results of the gully erosion model showed that their sensitivity to lithological and hydrological factors is rather high.

EGU General Assembly 2020

EGU2020-11249
https://doi.org/10.5194/egusphere-egu2020-11249
EGU General Assembly 2020

Soil Degradation in Argan Woodlands, South Morocco

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The argan tree (Argania spinosa) populations, endemic to South Morocco, have been highly degraded. Although the argan tree is the source of the valuable argan oil and is protected by law, overbrowsing and -grazing as well as the intensification and expansion of agricultural land lead to tree and soil degradation. Young stands cannot establish themselves; undergrowth is scarce due to the semiarid/arid climate and thus, goats, sheep and dromedaries continually browse the trees. Canopy-covered areas decrease and are degraded while areas without vegetation cover between the argan trees increase.

On 30 test sites, 60 soil samples of tree and intertree areas were studied on their soil physical and chemical properties. 36 rainfall simulations and 60 single-ring infiltration measurements were conducted to measure potential differences between tree/intertree areas in their runoff/erosion and infiltration properties. Significant differences using a t-test were found for the studied parameters saturated hydraulic conductivity, pH, electric conductivity, percolation stability, total C-content, total N-content, K-content, Na-content and Mg-content. Surface runoff and soil erosion were not statistically significant, but showed similar trends due to the higher complexity of runoff formation. The soil covered by argan trees generally showed less signs of degradation than intertree areas. With ever-expanding intertree areas due to the lack of rejuvenation of argan trees a further degradation of the soil can be assumed.

EGU General Assembly 2020

EGU2020-831
https://doi.org/10.5194/egusphere-egu2020-831
EGU General Assembly 2020

Gully Erosion: A Threat to Livable Cities in Developing Countries

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The United Nations Centre for Human Settlement in 2007 estimated that out of about 6 billion people in the world, 3 billion (50%) live in urban cities. A projection of about 61% of the total world population will be living in urban cities by 2030. As these cities grow, certain aspects of the urban space are significantly affected due to this unavoidable growth especially in developing countries. Aspects such as demographic, environmental and economic are severely altered. This study employs a 'mixed approach' to explaining how gully erosion, is a threat to liveable settlements/cities in the 21st century. The first part of the study is a meta-research on gully erosion and how it affects human settlements in Nigeria, then a field study on gullies within Osogbo Metropolis, southwestern Nigeria, its morphology and distribution. The morphology (width and depth) of each of the identified gully was determined using standard instruments. Structures around the gullies were also identified spatially using a handheld GPS (Global Positioning System). Gully clusters were analysed using Moran I index. The identified gullies within Osogbo Metropolis at its deepest section are about 10metres, while the widest of the gullies is 2.5metres. On the average the measured gullies are about 0.7meteres wide and 1.7meteres deep. All the measured gullies are still undergoing downcutting and almost all of them are affecting one structure or the other within their catchment area. Given a z-score of -0.40 and -1.15 Moran I index I, the pattern does not appear to be significantly different than random. Hence, the occurrence of these gullies cannot be said to be associated with natural factors like lithology or soil properties. Out of the twelve major gullies identified, nine (9) were as a result of poor engineering, largely due to the on-going urban renewal process. Osogbo and elsewhere in Nigeria suffer from the havocs of gully erosion. Urban sprawl coupled with urban renewal processses in many parts Nigeira (particularly in the Third World) leads to the rapid development of large gully channels (urban gullies) endangering the bearing function of soils and causing damage to infrastructure and private property. The implication of the result is that, as good as the renewal process being carried out mostly in southwestern cities is a good one especially to achieve livable cities in the 21st century, there is the need for such planning to ensure that most engineering works adhere to best practices. The government at all levels in Nigeria and stakeholders in environmental management should ensure proper planning and make it a duty to create cities that are livable and healthy.

EGU General Assembly 2020

EGU2020-10739
https://doi.org/10.5194/egusphere-egu2020-10739
EGU General Assembly 2020

Understanding the effectiveness of measures aiming to stabilize urban mega gullies in Kinshasa

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Kinshasa, the capital of the D.R. Congo, is strongly affected by urban mega gullies. There are currently hundreds of such gullies, having a total length of >100 km. Many of these gullies (typically tens of meters wide and deep) continue to expand, causing major damage to houses and other infrastructure and often claiming human casualties. To mitigate these impacts numerous efforts are being implemented. The type and scale of these measures varies widely: from large structural measures like retention ponds to local initiatives of stabilizing gully heads with waste material. Nonetheless, earlier work indicates that an estimated 50% of the existing urban gullies continue to expand, despite the implementation of such measures. As such, we currently have very limited insight into the effectiveness of these measures and the overall best strategies to prevent and mitigate urban gullies. One reason for this is that gully erosion is typically very episodic with long periods of stability, followed by sudden expansion events. As a result, understanding the dynamics of gully expansion in urban environments requires observations over sufficiently long time periods. However, most current initiatives to stabilize urban gullies happen on a rather isolated basis and are rarely evaluated afterwards.

This work aims to improve our understanding of this issue by constructing a large inventory of measures implemented to stabilize urban gullies in Kinshasa and statistically confronting these measures with observed vegetation recovery and long-term gully expansion rates (derived from high-resolution imagery over a period of >10 years). Our preliminary results (based on a dataset of > 140 urban gullies) shows that the most commonly applied measures are revegetation and reinforcement of gully heads with sandbags or household waste material (implemented in around 50% of the cases). Also retention ponds and water storage tanks are frequently implemented (around 30% of the cases). Surprisingly, our results indicate that urban gullies with higher expansion rates tend to have more measures implemented in their upstream catchment. While this seems counterintuitive, it may point to the fact that more actively retreating gullies create a larger sense of urgency and therefore instigates a higher number of (often ineffective) initiatives.

More research is needed to confirm this. Furthermore, the stability of gullies seems to be strongly linked to vegetation cover in the gully. Nonetheless, it is not always clear if vegetation is the cause or the result of this stability. Overall, this study provides one of the first large scale assessments of the effectiveness of gully control measures in urban tropical environments. With this study, we hope to contribute to a better prevention and mitigation of this problem that affects many cities of the tropical Global South.

EGU General Assembly 2020

EGU2020-9864
https://doi.org/10.5194/egusphere-egu2020-9864
EGU General Assembly 2020

A Study of Sediment Yield in the Deji Reservoir Watershed Using Risk Analysis

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Deji Reservoir Watershed was used as a sample site to understand the sediment yield using risk analysis. The historic typhoon and/or torrential storm events were collected to estimate the excessive runoff for each event. The distribution of SCS-CN is obtained by combining the maps of land use and soil texture, and the excess rainfall (Pe) and the maximum water storage (S) for each event were then calculated according to SCS-CN. Regression analysis shows that there is a good relationship between estimated runoff (x) and measured runoff (y); $y=0.9561x+3*10^6$, $R^2= 0.9414$. Topographic wetness index (TWI) and sediment delivery ratio (SDR) were derived from DEM. The risk model developed to assess the sediment yield is calculated from the multiplication of hazard (Pe), vulnerability (TWI), and exposure (SDR). The total siltation amount of Deji Reservoir from 2009 to 2017 was taken as the measured value, and the estimated amount of sediment yield was calculated from the aforementioned formula to obtain the potential index of sediment yield. The results show that there is also a good relationship between estimated sediment yield (x') and measured sediment yield (y') annually; $y'=10^{-11}x'^2-0.0223x'+9*10^6$, $R^2= 0.74$.

Keywords: Risk Analysis, Curve Number, Sediment Delivery Ratio

Thank you very much for your participation

Useful Links

- Live chat walkthrough video for authors and attendees: https://www.youtube.com/watch?v=xTCPKDmgSVw

- Live chat walkthrough for conveners: https://www.youtube.com/watch?v=RafRUF3k8kw

- More information: https://egu2020.eu/sharing_geoscience_online/how_to_use_the_chats.html