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EU Soil Observatory 2021

Review and reflections

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Contents

Abstract

The scope of this document is to provide a synthesis of the achievements of the EU Soil Observatory (EUSO) during its first year of existence. The EUSO aims to become the principal provider of reference data and knowledge at EU-level for all matters relating to soil. The EUSO will be a dynamic and inclusive platform that supports EU soil-related policymaking by providing its stakeholder base (i.e. Commission Services together with the broader soil user community) with the knowledge and data flows needed to safeguard and restore soils.

The policy context in which the EU Soil Observatory operates has evolved substantially in 2021 with the publication by the European Commission of the EU Soil Strategy and the announcement of a proposal for a Soil Health Law (due in 2023). This confirms the growing recognition of the central role of soils to respond to several major societal challenges. EUSO is expected to play an important role in this new context, to help support and inform the policy agenda on soil, interact with the research activities and raise the public's awareness of the need for soil protection.

Since its launch on December 4th 2020, most efforts have focused on defining and developing concepts associated with the main tasks of the Observatory (monitoring, dashboard, support to R&I, citizen engagement). Efforts have also been made to consolidate and enhance the capacity and functionality of the European Soil Data Centre (ESDAC), which is at the heart of the Observatory.

Major developments for 2021 included the establishment of an interservice Steering Committee (chaired by the Director of JRC Sustainable Resources Directorate), the support to the EU Mission "A Soil Deal for Europe", the development of the knowledge base on soil through research at the JRC, and the organisation of the 1st EUSO Stakeholder Forum.

The EUSO Stakeholder Forum was attended by over 1 000 participants over a three-day period in October 2021. In this sense, it succeeded in bringing a EUSO community together and in establishing a two-way dialogue with its user base. A summary of the event is presented in this report.

The EUSO Stakeholder Forum also saw the establishment of five Technical Working Groups on the following topics: soil monitoring, soil data integration and sharing, soil erosion, soil biodiversity and soil pollution. The Technical Working Groups are composed of interested stakeholders and experts and will meet regularly to address the respective issues they focus on.

EUSO activities will intensify in 2022. Developments are expected from the various Technical Working Groups, through linkages with soil-related research projects and in support of EU soil policy development. Work towards the development of a functional Soil Health Dashboard will start in 2022 while the second edition of the EUSO Stakeholder Forum is expected to take place in the autumn 2022.

1 What is the EU Soil Observatory?

1.1 Policy context

The EU Soil Observatory (EUSO) was launched in December 2020 under the umbrella of the European Green Deal. With its creation, the European Commission turns the spotlight on the central role of soils in achieving several objectives of the Green Deal, including climate change, halting biodiversity or achieving zero pollution.

Soil-related targets are found in many of the strategies published as part of the European Green Deal, in particular:

- The Farm to Fork Strategy[1]
- The 2030 Biodiversity Strategy[2]
- The Zero Pollution Action Plan[3]
- The Fit for 55 Package[4].

The publication of the EU Soil Strategy[5] in November 2021 marks a major milestone in the field of soil protection in the EU. Importantly, the Strategy announces an EU Soil Health Law (due in 2023), which could grant soils a similar legal protection as air or water.

In parallel, the Horizon Europe research programme (2021-2027), structured around so-called Missions, includes a Mission on soil. Titled "A Soil Deal for Europe", its research activities are expected to significantly advance the state of knowledge and data available on soils in the EU.

One year after its creation, the EU Soil Observatory finds itself anchored into a strengthened policy context and a growing attention on the need to protect and enhance soil health. EUSO is expected to play in important role in this new context, to help support and inform the policy agenda on soil, interact with the research activities and raise the public's awareness of the need for soil protection.

1.2 Objectives and functions of the EU Soil Observatory

Vision

The EU Soil Observatory (EUSO) should become the principal provider of reference data and knowledge at EU-level for all matters relating to soil.

Mission

The EU Soil Observatory aims to be a dynamic and inclusive platform that supports EU soil-related policymaking. The EUSO will provide the relevant Commission Services, together with the broader soil user community, with the knowledge and data flows needed to safeguard and restore soils.

The EUSO will both support, and benefit from, EU Research & Innovation on soils while raising societal awareness of the value and importance of soils to the lives of citizens.

The EUSO will closely collaborate with relevant EU Agencies (e.g. EEA, EFSA, ECA) and Horizon Europe's Soil Mission.

[1] COM/2020/381 final
[2] COM/2020/380 final
[3] COM/2021/400 final
[4] COM/2021/550 final
[5] COM/2021/699 final

Ultimately, the EUSO will support EU policies by ensuring that the Commission is able to fully capitalise on the information made available through integrated data flows by transitioning from simply monitoring to understanding. In this manner, the EUSO will support the implementation of all soil related objectives of the European Green Deal.

To realise this vision and mission, the EUSO carries out a range of functions, which in turn, support the implementation of the various strategies and action plans of the European Green Deal and the EU Mission "A Soil Deal for Europe". Each function is underpinned by relevant services and tools (Figure 1).

Figure 1. Main functions of the EU Soil Observatory

Source: EUSO

The five main functions of the EU Soil Observatory are to:

1. Support the development of an operational **EU-wide Soil Monitoring System**: the EUSO supports the development of a harmonised soil monitoring system for the EU by integrating the current LUCAS Soil programme with national or regional soil monitoring activities. An important element is the close networking with the EU Member States, relevant Commission services and agencies. The eventual integrated monitoring system should contribute to indicators that reflect policy targets (e.g. SOC MRV, Soil Pollution Watch List, biodiversity, erosion, etc.). In addition to the practical considerations of sampling design for the monitoring network (geographical location, the parameters that are measured, both qualitatively and quantitatively), a shared data infrastructure (to collect, transmit, share, disseminate soil monitoring data) will be developed, based on INSPIRE principles, that integrates pan-European national reporting obligations[6] (also CAP Strategic Plans, Sustainable Use of Pesticides, Nitrates Directive, LULUCF[7]) and regional initiatives (e.g. Alpine Convention, devolved responsibility for soil

[6] NEC Directive (2016/2284): reporting under Article 9 (Monitoring air pollution impacts), further specified in Article 10 (reporting by MS) https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016L2284&from=EN

[7] Regulation on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry (LULUCF) into the 2030 climate and energy framework. For Monitoring, reporting and verification (MRV) see Raúl Abad Viñas et al. 2014, and Smith et al 2019.

protection). Through the implementation of the EU Soil Strategy and the work programme of the Mission "A Soil Deal for Europe", the EUSO will support Member States in establishing and operating national or regional monitoring systems to support the exchange of harmonized information about the state of soils (indicators), to be integrated at EU level. Outcomes of soil monitoring will flow to the European Soil Data Centre (ESDAC).

2. Further consolidate and enhance the capacity and functionality of the current **European Soil Data Centre (ESDAC)**: as the core of the EUSO in terms of managing data flows (both inputs and outputs), ESDAC will be consolidated and enhanced in terms of the capacity and functionality to support evolving knowledge needs. Consideration will be given to innovative data streams.

3. Establish an **EU Soil Dashboard** that reflects the state of soil health and trends in pressures affecting soil health: the EUSO is working on the development of a novel dashboard that reflects both the state and trends in pressures affecting soil health. Key policy messages will be developed through indicators that are populated by a range of data flows (e.g. monitoring, modelling, Copernicus, citizen science, big data, etc.). Some indicators will be provided by key stakeholders. The EUSO will assess and indicate the scientific robustness of indicators. Indicator development, together with policy thresholds, will evolve according to scientific developments (e.g. Horizon Europe projects). Additional elements will be developed to reflect the implementation of specific policy targets (e.g. Soil Strategy Action List, Clean Soil Monitoring and Outlook, Biodiversity Strategy, Soil Mission, SDGs, etc.). The EU Soil Dashboard will be closely linked to data flows to ESDAC.

4. Support **research and innovation** through the implementation of Horizon Europe's Mission "A Soil Deal for Europe": an integral part of the Horizon Europe framework programme for 2021-27 is the concept of Missions. These are targeted and integrated commitments to solve some of the greatest societal challenges. The EUSO aims to be a key component in the implementation of the "Soil Deal for Europe" Mission as well as the beneficiary of several outcomes. Specifically, the Mission funds a series of R&I Actions to support the EU's path to sustainable and regenerative soil management as part of the wider green transition in both urban and rural areas. The EUSO is supporting research calls developed under the evolving work programme of the Mission and will become a beneficiary of the knowledge produced by EU-funded research actions. A dedicated corner in the EUSO Portal will be established to host R&I outcomes.

5. Provide an **open and inclusive EUSO forum** that supports the drive towards a societal change in the perception of soil. The EUSO Forum is the principal focus for the EU Soil Observatory with regards to stakeholder engagement. Conceptually, the EUSO Forum is a multi-channel entity that uses a mix of participation methods to ensure a two-way dialogue between the Observatory and its user base. The Forum provides a) mechanisms to inform the EUSO stakeholder community of developments, b) support enhanced soil literacy and c) collect feedback on the operation of the Observatory. The Forum builds on the current operational solutions developed under ESDAC, which include access to a wide range of online resources, widely read newsletters and an active data helpdesk. New tools will provide clear messaging on how the European Green Deal will change the state of soil health across the EU (Dashboard, annual bulletins, etc.). Face-to-face dialogue on key issues has been established through Technical Working Groups and via a dedicated annual hybrid workshop, the EUSO Stakeholder Forum. The 2021 edition also included a Young Researchers Forum. Close links are being maintained with the European Soil Partnership (ESP) and key research networks (e.g. EJP SOIL, SoilBON, ENSA, ELSA). With the support of the "A Soil Deal for Europe" Mission, the EUSO will look to develop an 'EU4Soils portal' as an outlet for a coalition on Soil

Literacy that aims to connect diverse organisations, projects and people that contribute to soil literacy and the sustainable use and management of soils.

1.3 Basic operational principles of the EUSO

The EU Soil Observatory was established by the JRC and embedded within its regular institutional work programme in support of the European Green Deal (in particular the EU Soil Strategy) and of the Horizon Europe's Mission "A Soil Deal for Europe". The Observatory aims to:

- serve all EU policies relevant to soils in partnership with the relevant Commission Services (e.g. DG ENV, DG AGRI, DG CLIMA, DG SANTE, DG RTD, ESTAT, INTPA and others)
- closely network with relevant EU Agencies, such as the ECHA, EEA, EFSA and ESA, and developments related to the Land Information System
- build on the existing European Soil Data Centre (ESDAC), operated by the JRC for over a decade
- build on existing soil data collection projects and initiatives of the Commission (e.g. LUCAS, in house modelling) and closely network with experts in soil monitoring (e.g. INRAE, Alpine Convention, MS, Regions), soil research (e.g. EJP-SOIL) and soil-related reporting across Europe (e.g. EIONET-Soil), to design and propose a fully streamlined and harmonized system of soil data and information collection and diffusion for evaluation at EU scale
- work closely with REA and EU R&I Framework Programme (HORIZON Europe & HORIZON2020) projects on soils with the goal to become, after the end of the project, the beneficiary of the knowledge generated by these programmes
- support citizen engagement and awareness raising actions by promoting the European Green Deal aspirations on soil to society, through collaboration with NGOs, focus groups and institutions that are aiming to achieve a change in the public perception of soil
- interact and collaborate with international organisations such as the FAO, OECD, ESA, UNEP, IPCC, IPBES and UNCCD SPI, to ensure synergies are exploited and data at EU and global levels are consistent.

1.4 Organisation of the EUSO

The EUSO is established by, and operated within, the JRC's Sustainable Resources Directorate as a long-term commitment to enhance soil knowledge across the EU. It started as a deliverable of the JRC work programme 2021-2022 within the JRC Project Portfolio 20158 "Sustainable soil management for the European Green Deal" and will be an intrinsic part of JRC Work Programme during 2021-22 and beyond. Resources for the operation of the EUSO are provided by the JRC institutional and competitive projects operating within the portfolio. Additional resources may be added to the JRC core funding through contractual financing via ad hoc Administrative Arrangements with other DGs or Horizon Europe. The EUSO can be a key beneficiary of Horizon Europe R&I projects.

The following organisational elements are foreseen:

Steering Committee

The governance of the EUSO is ensured through a Steering Committee, supported by a Secretariat. In 2021, the interservice Steering Committee of the EUSO was established, chaired by the Director of JRC Sustainable Resources Directorate. The Steering Committee complies with the following criteria:

- The Steering Committee is composed of representatives of the main Commission Services with relevant to soil policy.
- The Steering Committee is chaired by the Director of JRC.D.
- The Steering Committee is expected to meet at least once per year.
- The Steering Committee supervises and steers the activities of the Observatory in line with the priorities of the European Commission.
- The Steering Committee discusses and endorses the annual work programme of the Observatory, as proposed by the JRC.

Secretariat

The JRC provides the Secretariat of the Observatory. The Secretariat:

- assures the daily operation of the EUSO and European Soil Data Centre (ESDAC),
- organises regular meetings of the Steering Committee (including updating the Terms of Reference), the Stakeholder Forum and relevant Working Groups,
- prepares and updates an Implementation Plan, as required,
- prepares an annual work programme,
- develops communication material (newsletters, bulletin, etc.).

Technical Working Groups

To support the implementation and operation of the EUSO, five Technical Working Groups were established in 2021.

- Each working group is chaired by the JRC together with (up to) two co-chairs, representing the respective policy driver from the Steering Committee and a recognised expert in the field.
- Technical Working Groups are composed of Stakeholders with a recognised background in the specific domain.
- The duration and scope of Technical Working Groups mirror the specific needs of the EUSO.
- Working Groups were launched at the EUSO Stakeholder Forum (ad hoc Working Groups can still be established at the request of the Steering Committee for urgent requests).

EUSO Stakeholder Forum

The EUSO Stakeholder Forum provides a mechanism for the EUSO to engage with the broad user community, to report developments and to collect feedback on the operation of the Observatory. The first EUSO Stakeholder Forum took place on 19-21 October 2021.

- Stakeholders included relevant European Commission services and agencies, together with international organisations, Member State representatives (ranging from policymakers to the research community), farming associations, industry representatives, NGOs and interested citizens.
- Members of the Forum can contribute to Technical Working Groups and provide feedback to public consultation requests.
- The Stakeholder Forum is a workshop/conference style event that aims to meet once every year, preferably in a hybrid format. The structure of the Stakeholder Forum should reflect the Implementation Plan and Annual Work Programme of the EUSO and the challenges facing the various strategies of the Green Deal (e.g. the Soil, Biodiversity and Farm2Fork strategies, Zero Pollution Action Plan) and Horizon Europe's Mission "A Soil Deal for Europe". Participants are encouraged to engage in

discussions and invited to contribute to the Technical Working Groups (as described above).

- In line with their cycles, a dedicated session of the Stakeholder Forum will be held in conjunction with the World Congress of Soil Science and the European Conference of Soil Science (EUROSOIL).
- The Stakeholder Forum should be the main public interface to the Technical Working Groups, who will report on progress.

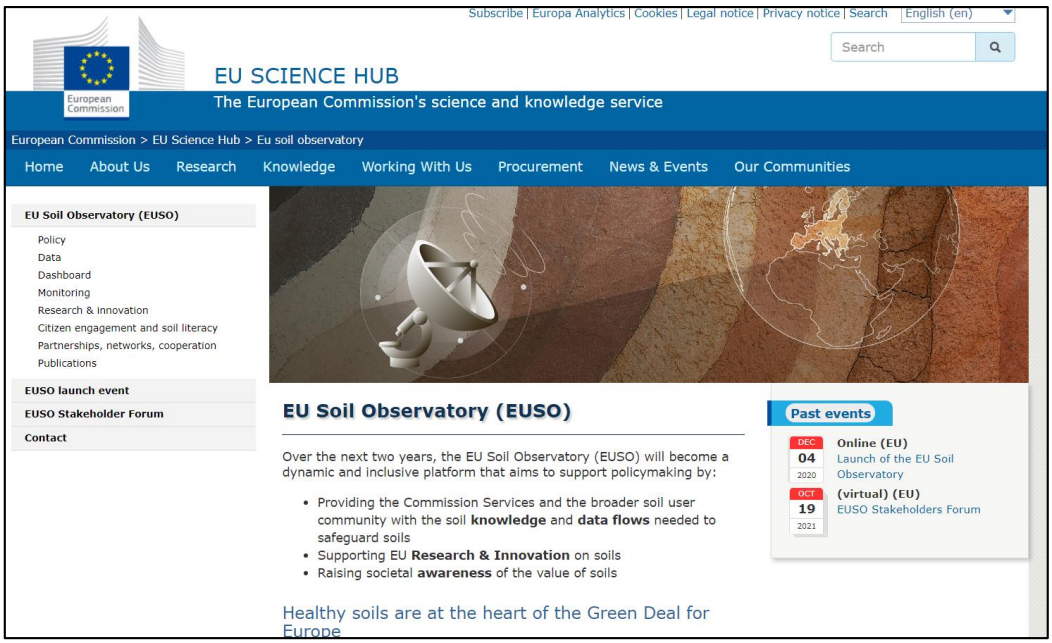
2 Outcomes

This section presents the main outcomes of the activities of the EU Soil Observatory in 2021.

2.1 EUSO Public Interface / European Soil Data Centre (ESDAC)

A public landing page was created on the JRC's Science Hub[8]. The site provides access to a range of background information. The intention is to further develop each of the thematic areas with a range of updated content (Figure 2).

Figure 2. Screenshot of the EU Soil Observatory webpage



Source: EUSO

During 2021, additional functionality on the ESDAC platform has been designed and tested to support the operational needs of the EUSO. These elements will be rolled out progressively during 2022.

2.2 EU-wide Soil Monitoring System

Initial discussions have taken place between EUSO and a number of Member States (MS), under the umbrella of the EJP Soil project and the Alpine Convention Working Group on Soil Protection, on the integration of the soil module of LUCAS with national or regional soil monitoring activities. In this context, LUCAS 2022 will contain a number of points specifically requested by MS.

Further bilateral contact has taken place with EJP Soil (Work Package 6) and national authorities. A survey has been carried out to assess ongoing or historical soil monitoring actions together with the identification of specific technical issues that need to be addressed to facilitate an integrated monitoring system at EU level. These include the practical considerations of sampling design for the monitoring network (geographical location, the

[8] https://ec.europa.eu/jrc/en/eu-soil-observatory

parameters that are measured, both qualitatively and quantitatively) as well as the shared data infrastructure (to collect, transmit, share, disseminate) that need to be developed, based on INSPIRE principles.

These issues will be further explored through the two EUSO Technical Working Groups on Monitoring and Data integration.

As the core of the EUSO in terms of managing data flows (both inputs and outputs), ESDAC will be consolidated and enhanced in terms of the capacity and functionality to support evolving knowledge needs. Consideration will be given to the integration of innovative data streams.

2.3 Research and innovation under EUSO

2.3.1 Support to the Mission "A Soil Deal for Europe"

The EUSO research team at the JRC contributed to the Mission "A Soil Deal for Europe" in developing its research calls for the first year of the Horizon Europe programme. This resulted in the launch of 9 soil-related calls published in 2021. The selected projects will kick off in the course of 2022.

Continued support is expected in the upcoming years to ensure alignment between EUSO and the development of research on soils in the EU.

2.3.2 Selected R&I outcomes developed under EUSO

Since its creation, a number of research results have been developed by scientists at the JRC under the umbrella of the EU Soil Observatory. A selection of such R&I outcomes is presented below.

Mercury (Hg) distribution in European topsoils

Mercury (Hg) distribution in topsoil (0-20cm) is influenced by climate, soil properties, vegetation. In addition to the natural factor, mercury has high values close to past mining activities and coal combustion sites. High Overall, the stock of Hg in EU topsoil is estimated to c.a. 44.8 Gg with a median concentration of 38.3 µg kg−1; 10% of the area exceeds the 84.7 µg kg−1 and 209 Hg hotspots (top 1%) have been identified with concentrations >422 µg kg−1. In a detailed investigation, 42% of the hotspots were associated with well-known mining activities while the rest can be related either to coal combustion industries or local diffuse contamination. In total 209 hotspots were identified, defined as the top percentile in Hg concentration (>422 µg kg−1). 87 sites (42% of all hotspots) were associated with known mining areas. The sources of the other hotspots may relate to unmined geogenic Hg or industrial pollution. In a recent research study we present soil Hg concentrations from the LUCAS topsoil (0–20 cm) survey mapped with Deep Neural Network (DNN) learning model.

https://esdac.jrc.ec.europa.eu/content/mercury-content-european-union-topsoilLUCAS

Land degradation in global arable lands

Land degradation is a global environmental issue that affects the world's arable lands on a large scale, thus threatening global food production systems. In a recent study, we analysed the land degradation footprint on global arable lands, using complex geospatial data on certain major degradation processes, i.e. aridity, soil erosion, vegetation decline, soil

salinization and soil organic carbon decline. By applying geostatistical techniques that are representative for identifying the incidence of the five land degradation processes in global arable lands, results showed that aridity is by far the largest singular pressure for these ag-ricultural systems, affecting ~40% of the arable lands' area, which cover approximately 14 million km2 globally. Also, it was found that soil erosion is the major land degradation pro-cess, affecting ~20% of global arable systems. Data available: https://esdac.jrc.ec.europa.eu/content/land-degradation-global-arable-lands

Understanding the links between Soil pollution and CancEr (SOLACE)

SOLACE is a JRC Exploratory Research Project that will investigate potential relationship between the occurrence of specific cancers and levels of soil pollution. The Project aims to develop a methodology that moves from measures of concentrations of carcinogenic substances in soil towards the identification of hazards and risk analysis that may help explain eventual potential pathways that cause cancers (i.e. soil-plant-food, erosion by wind and water, etc.). The project will investigate the potential links between contaminated soils as an environmental driver for cancer cases. https://esdac.jrc.ec.europa.eu/projects/solace

Global Applications of Soil Erosion Modelling Tracker (GASEMT)

The GASEMT database provides comprehensive insights into the state-of-the-art of soil erosion models and model applications worldwide. This database intends to support the upcoming country-based United Nations global soil-erosion assessment in addition to helping to inform soil erosion research priorities by building a foundation for future targeted, in-depth analyses. GASEMT is an open-source database available to the entire user-community. GASEMT is a result of reviewing 8471 scientific articles, selecting 3030 records and extracting 49 fields relevant to modelling. It is a collective effort of 67 soil-erosion modelers from 25 countries. The database is released together with two research articles: a) A global review of soil erosion models b) A bibliometric analysis. https://esdac.jrc.ec.europa.eu/content/global-applications-soil-erosion-modelling-tracker

State of knowledge of soil biodiversity - Status, challenges and potentialities

There is increasing attention to the importance of biodiversity for food security and nutrition, especially above-ground biodiversity such as plants and animals. However, less attention is being paid to the biodiversity beneath our feet, soil biodiversity, which drives many processes that produce food or purify soil and water. This report is the result of an inclusive process involving more than 300 scientists from around the world under the auspices of the FAO's Global Soil Partnership and its Intergovernmental Technical Panel on Soils, the Convention on Biological Diversity, the Global Soil Biodiversity Initiative, and the European Commission. It presents concisely the state of knowledge on soil biodiversity, the threats to it, and the solutions that soil biodiversity can provide to problems in different fields. It also represents a valuable contribution to raising awareness of the importance of soil biodiversity and highlighting its role in finding solutions to today's global threats.

https://www.fao.org/documents/card/en/c/cb1928en

Soil Organic Matter (SOM) fractions

Soil carbon sequestration is seen as an effective means to draw down atmospheric CO2, but at the same time warming may accelerate the loss of extant soil carbon. By separating soil carbon into particulate and mineral-associated organic matter (POM and MAOM, respectively) aids in the understanding of its vulnerability to climate change and identification of carbon sequestration strategies. Arable and coniferous forest soils contain the largest and most vulnerable carbon stocks when cumulated at the European scale. In

a recent publication in Nature Geoscience, we show a lower carbon loss from mineral topsoils with climate change (2.5 ± 1.2 PgC by 2080) than those in previous predictions. Therefore, we urge the implementation of coniferous forest management practices that increase plant inputs to soils to offset POM losses and the adoption of best management practices to avert the loss in arable soils.

Data are available: https://esdac.jrc.ec.europa.eu/content/soil-organic-matter-som-fractions

Mercury stocks and fluxes to river-basins and sea outlets

JRC scientists modelled the Hg pool in EU topsoils, which totals about 44.8 Gg, with an average density of 103 g ha-1. As a following step, we coupled the estimated Hg stocks in topsoil with the pan-European assessment of soil loss due to water erosion and sediment distribution. In the European Union and UK, we estimated that about 43 Mg Hg yr-1 are dis-placed by water erosion and c.a. 6 Mg Hg yr-1 are transferred with sediments to river basins and eventually released to coastal Oceans. The Mediterranean Sea receives almost half (2.94 Mg yr-1) of the Hg fluxes to coastal oceans and it records the highest quantity of Hg sediment. This publication couples soil diffuse contamination of an emerging pollutant (mercury) with sediment distribution models at continental scale. This work contributes to new knowledge in support of the policy development in the EU on the Zero Pollution Action Plan and the Sustainable Development Goal (SDGs) 3.9 and 14.1.

Data are available: https://esdac.jrc.ec.europa.eu/content/mercury-content-european-union-topsoil

Projections of soil loss by water erosion in Europe by 2050

Soil loss by water erosion is projected to increase by 13–22.5% in the EU and UK by 2050, mainly due to increased rainfall intensity. This soil loss is expected to be greatest in central and northern Europe, which could see losses of up to 100% in some areas. Soil erosion in southern Europe is projected to be largely unchanged due to a decline in precipitation patterns. Authors used 19 Global Climate Models and three different Representative Concentration Pathways (RCP2.6, 4.5, 8.5) to project soil loss by water erosion in Europe by 2050. They also simulated the crop dynamics and land use changes with CAPRI model. More details in a JRC-led article.

Data available here: https://esdac.jrc.ec.europa.eu/content/water-erosion-europe-2050

Soil microbial biomass and respiration

Using the LUCAS soil biodiversity samples in EU, we developed datasets predicting potential soil basal respiration at 20°C, soil microbial biomass as estimated by substrate-induced respiration, and soil microbial respiratory quotient (the ratio between potential basal respiration and microbial biomass) across Europe. Predictions were performed with structural equation models fit using the following predictive variables (published in the paper): mean annual temperature, annual precipitation, mean temperature, annual precipitation, soil sand content, soil water content, pH, soil organic carbon content, elevation, and latitude. We make available the datasets (for year 2018) of potential soil microbial basal respiration (bas), microbial biomass (Cmic), and respiratory quotient (qO2) predicted across Europe. Monthly maps for bas and Cmic are also available: https://esdac.jrc.ec.europa.eu/content/soil-microbial-biomass-and-respiration

Manure and Soil biodiversity

In the European Union (EU-27) and UK, animal farming generated annually more than 1.4 billion tonnes of manure during the period 2016–2019. Of this, more than 90% is directly

re-applied to soils as organic fertiliser. We reviewed the impact of manure from farmed animals on soil biodiversity by considering factors that determine the effects of manure and vice versa. In this review paper we explored the impact of manure from farmed animals on soil biodiversity and vice versa. This review considered 407 published papers and relevant legislative provisions. In addition, we evaluated whether benefits and risks on soil biodiversity are considered in manure management. This dataset includes the spatial distribution of manure in EU and UK (per country, animal type) plus the database of the literature used: https://esdac.jrc.ec.europa.eu/content/manure-and-soil-biodiversity

Land degradation debt data

We provide data for global land degradation in a 'debt' based approach. Environmental Debt is the difference between the natural potential condition and the current condition. Naturally, there could be 4.6 Gha of tree cover but currently there are only 3.2 Gha (Global tree cover debt is 1.4 Gha). The natural rate of soil erosion would be 10 Gt per year, but currently, it is 36 Gt (debt is 26 Gt – rising). Above-ground biomass would naturally be 871 Gt C, but currently, it is only 601 Gt C (debt 270 Gt C). Similarly, below-ground carbon, naturally should be 899 Gt C, but currently, there are only 863 Gt C (Debt 36 Gt C) in soils. This study contributes to the developments towards an improvement of Land Degradation Methodologies.

Data: https://esdac.jrc.ec.europa.eu/content/land-degradation-debt

Copper accumulation and export in European vineyard soils

Copper-based fungicides are used in European vineyards to prevent fungal diseases. Soil physicochemical properties locally govern the variation of the total copper content in vineyards. Using a machine learning model, a study found that the main variables to predict the Cu distribution in EU vineyards are precipitation, aridity and soil organic carbon. The estimated average net accumulation and net export of Cu in topsoil in European vineyards are respectively 24.8 and 0.29 kg Cu ha^{-1}.

Data: https://esdac.jrc.ec.europa.eu/content/copper-distribution-topsoils

Contribution to planning and design of soil component of LUCAS 2022

The JRC team contributed to the planning and design of the soil component of the LUCAS 2022. Working closely with Member States and surveyors, the team helped to refine the position of some LUCAS points and provided training material to ensure the quality of the soil sampling campaign.

2.4 ESDAC development

Since 2006, the European Soil Data Centre (ESDAC) is host to many EU-wide soil related datasets, among which the European Soil Database which is the only harmonized soil database for Europe. Over 84 datasets are under distribution and also include soil point data stemming from samples taken during the series of LUCAS Soil module campaigns (2009/2015/2018), and various chemical and physical soil property maps for Europe. All data can be freely obtained from http://esdac.jrc.ec.europa.eu/resource-type/datasets , after registration. Registration details include name, organisation and purpose for which the data are used. Interested parties come from all corners of the world and from various types of organisations (research, companies, NGO, governments, etc.). Also there is an enormous variety in the intended use of the data.

During 2021, more than 8,000 data licenses were given out. A 'helpdesk' accompanies the operation of ESDAC. In principle, user questions are answered almost immediately in first-line support; if the questions are technically or scientifically more complex, second-line support from colleague-experts is needed, and responses may take a few days.

This website is among the most popular within the European Commission Joint Research Centre with typically 1,000 unique visitors per day and with traffic growing yearly (Figure 3). In the context of the EU Soil Observatory, ESDAC aims to be the single reference point for EU-wide soil data. In addition, ESDAC publishes a monthly 1-page newsletter informing public users about the latest developments:

https://esdac.jrc.ec.europa.eu/newsletter

Figure 3. Example of the ESDAC newsletter

JOINT RESEARCH CENTRE

EUROPEAN SOIL DATA CENTRE (ESDAC)

ESDAC: http://esdac.jrc.ec.europa.eu ESDAC Newsletter No **136** (November 2021)

Land degradation debt data

We provide data for global land degradation in a 'debt' based approach. Environmental Debt is the difference between the natural potential condition and the current condition. Naturally, there could be 4.6 Gha of tree cover but currently there are only 3.2 Gha (Global **tree cover debt is 1.4 Gha**). The natural rate of **soil erosion** would be 10 Gt per year, but currently, it is 36 Gt (debt is 26 Gt – rising). **Above-ground biomass** would be naturally 871 Gt C, but currently, it is only 601 Gt C (debt 270 Gt C). **Below-ground carbon**, naturally, there would be 899 Gt C, but currently, there are only 863 Gt C (Debt 36 Gt C). This study contributes to the developments towards an improvement of Land Degradation Methodologies.

Data: https://esdac.jrc.ec.europa.eu/content/land-degradation-debt

EU Soil Observatory (EUSO) Stakeholders Forum: 19-21 October 2021

The JRC has organised the first ever EU Soil Observatory (EUSO) Stakeholders Forum. This three-day event reflected the challenges facing soil within the various strategies of the Green Deal and Horizon Europe's proposed Mission on Soil Health and Food. The event was followed by 274 participants in Webex and more than 2,000 people in streaming. The programme was **recorded** and you can follow it here. The forum established five **Working Groups**: soil monitoring, soil pollution, soil biodiversity, data integration, soil erosion. If you are interested to participate in any of the WG, please send an e-mail to the moderator or to the functional mail **EU-SOIL-OBSERVATORY@ec.europa.eu** by 29.11.21. https://ec.europa.eu/jrc/en/page/presentations-1st-euso-stakeholders-forum-189661

First Young Soil Researchers Forum: Special issue open.

The EU Soil Observatory Stakeholders Forum organized a 2.5-hours event with **young** scientists on five topics: soil biodiversity, soil erosion, soil contamination, data and soil organic carbon. The 100 young scientists who submitted an abstract for the EUSO forum are invited to submit their manuscript to an EUSO dedicated Special issue in the **European Journal of Soil Science** https://onlinelibrary.wiley.com/journal/13652389

EU Soil Strategy for 2030: reaping benefits of healthy soils for people, food, nature and climate

The new EU Soil Strategy sets out a framework and concrete measures for the protection, restoration and sustainable use of soils, in synergy with other European Green Deal policies. It also sets a vision and objectives to achieve healthy soils by 2050 and announces a new Soil Health Law by 2023. Key actions include: the promotion of Sustainable Soil Management, boosting the circular economy, restoration of degraded soils, prevent desertification, increase of research, the monitoring of soil and associated data collection, mitigation and adaption in relation to Climate change and the mobilisation of societal engagement and financial resources

https://ec.europa.eu/environment/publications/eu-soil-strategy-2030_en

Copper accumulation and export in European vineyard Soils

Copper-based fungicides are used in European (EU) vineyards to prevent fungal diseases. Soil physicochemical properties locally govern the variation of the total copper content in vineyards. Using a machine learning model, a study found that the main variables to predict the Cu distribution in EU vineyards are precipitation, aridity and soil organic carbon. The estimated average net accumulation and net export of Cu in topsoil in European vineyards are respectively 24.8 and 0.29 kg Cu ha^{-1}. Data: https://esdac.jrc.ec.europa.eu/content/copper-distribution-topsoils

More Details

Download the ESDAC Newsletter: PDF Format. **Feedback**: panos.panagos@ec.europa.eu

ESDAC Alerts are e-mailed to 12,000 scientists. Follow us @EU_ScienceHub; @lultimoalbero; @PanosPanagos33

Source: ESDAC

2.5 First EUSO Stakeholder Forum

One of the main EUSO activities in 2021 has been the preparation and organisation of its first Stakeholder Forum.

A key element of the EUSO is an open, inclusive and dynamic engagement with its diverse stakeholder base. These include:

- Relevant Commission services and European agencies
- International Organisations

- Member State representatives (ranging from policymakers to the research community)
- Farming associations
- Industry representatives
- NGOs
- Interested citizens.

To facilitate this interaction, the first ever EUSO Stakeholder Forum was held on 19-21 October 2021. This three-day event, built on six, focused, half-day sessions, mirrored the challenges facing soil within the various strategies of the Green Deal such as the Soil, Biodiversity and Farm2Fork Strategies, and the Zero Pollution Action Plan together with the Horizon Europe's proposed Mission "A Soil Deal for Europe".

In addition to a high-level panel on recent soil-related policy developments, the meeting established a series of dedicated Technical Working Groups to address pressing scientific and policy questions (e.g. soil monitoring, citizen engagement and increased soil literacy, soil pollution, erosion and biodiversity). Participants were encouraged to engage in discussions and were invited to formally join and contribute to the various Technical Working Groups.

For the first time, a Young Soil Researchers Forum was also organised to provide a platform to facilitate the exchange and promotion of the research carried out as part of PhD or post-doctoral projects on soil topics.

The final agenda of the Stakeholder Forum is presented in the Annex.

Presentations from the event can be accessed through the following link: https://joint-research-centre.ec.europa.eu/eu-soil-observatory-euso/presentations-1st-euso-stakeholders-forum_en .

The EUSO Stakeholder Forum was attended by over 1 000 participants over the three-day period in October 2021. In this sense, it succeeded in bringing the EUSO community together and in establishing a two-way dialogue with its user base.

2.5.1 Key take-home messages

The first meeting of the EU Soil Observatory Stakeholder Forum provided an opportunity to engage with the European soil community, in its broadest sense (as well as from other parts of the world). The EUSO Stakeholder Forum marks a scale change in the working of the Observatory as it marked the first steps in bringing the Observatory's user base into its development. EUSO aims to bringing science and knowledge to policy makers and collaborations with other agencies.

The Forum highlighted some of the key policy contexts and main drivers for the Observatory.

The Forum was split into seven focused sessions, with some running in parallel. An important development is that these sessions were springboards to launch five targeted Technical Working Groups, which will help deliver the goals of the Observatory and enrich the knowledge base of the European Soil Data Centre.

Working Groups on Soil Monitoring and on Data Integration will support the core data driven objectives of the Observatory while the Working Groups on Soil Erosion and on Soil Biodiversity will help us expand its underpinning knowledge base. A dedicated Technical Working Group on Soil Pollution was also set up to help prepare the Zero Pollution Action Plan's Clean Soil Outlook.

In addition, a Community of Practice on Citizen Engagement and Soil Awareness was launched to support the new Soil Strategy and the Mission.

2.5.2 Summary of latest developments in EU soil policy

It is clear that, in the context of the European Green Deal, soil is a key topic and relevant for implementing numerous political priorities. This was evident in the presentations where a number of Commission services set out how soil fits into their policy development.

On 17 November 2021, a new Soil Strategy[9] was adopted, driven by the concept of protecting and restoring soil health by considering soil as a solution to climate mitigation and adaptation, for circular economy (excavated soil, limited net land take, nutrient recycling), the role of soil biodiversity, and as a solution for healthy and clean water. Key actions include the prevention of soil and land degradation, by making sustainable soil management the norm while preventing soil contamination and preventing desertification while restoring degraded soils. To be effective, better soil knowledge is needed (including soil and the digital agenda, Destination Earth modelling, Land Information System for Europe) linked to more current soil data through improved monitoring (LUCAS, EUSO, etc).

The Soil Strategy complements the Communication for a Mission to deliver a Soil Deal for Europe, which was announced in September 2020. The Mission aims to deliver an impressive R&I programme, including specific actions to establish 100 living laboratories and lighthouse projects, support the development of an integrated soil monitoring system and enhancing soil literacy.

Meanwhile, in April 2021, the European Parliament made a strong statement by passing a resolution for soil protection with a strong majority for it, recognising a clear gap on soil protection legislation when compared to air and water.

A number of other soil related policies were announced and adopted during 2020 and 2021 e.g. the 2030 Biodiversity Strategy, the Farm to Fork Strategy, the Circular Economy Action Plan, the Chemicals Strategy, etc. The Zero Pollution Action Plan for air, water and soil foresees the publication of the first ever Clean Soil Outlook in 2022 (coordinated by the EEA) and the Soil Pollution Monitoring Report (coordinated by the EEA but with notable contributions from EUSO).

The European Environment Agency has also announced the development of a Land Information System for Europe (LISE). EUSO will ensure a close level of collaboration and synergies with it.

Presentations in the high-level policy session were given by

- Claudia Olazabal (European Commission DG ENV) on the new EU Soil Strategy
- Nathalie Sauze-Vandevyver (European Commission DG AGRI) on the EU Mission: A Soil Deal for Europe: 100 living labs and lighthouses to lead the transition towards healthy soils by 2030
- Joachim D'Eugenio (European Commission DG ENV) on the Zero Pollution Action Plan
- Martin Hojsík (Member European Parliament) on the EP resolution on soil protection
- Andrus Meiner (European Environment Agency) on the Land Information System for Europe

[9] COM/2021/699 final

2.5.3 Summary of the workshop on Soil Monitoring

Moderators and chairs: Arwyn Jones and Anne Maréchal of the European Commission Joint Research Centre

Objectives

The scope of this workshop was to address the improvement or development of soil monitoring systems, and access to data on soils from a range of sources. An essential part of the Soil Strategy is to be able to describe the condition of our soils and assess whether policies are making an expected impact, at the right speed.

Currently, soil monitoring in the EU is fragmented, incomplete and not harmonised. Data are often not public. Several monitoring systems are present at MS level but many are inactive or not addressing current policy priorities. LUCAS provides harmonised data on field measurements but it needs to be integrated with similar activities in Member States. The EEA also provides indicators, on soil sealing and land take, yet for these higher resolution data, higher frequency of measurements and harmonisation of monitoring approaches is required.

The objectives of the workshop were two-fold:

a) Highlight the policy needs; and

b) Summarise the policy needs relating to specific soil environments

Summary of the presentations and the discussion

a) Highlight the policy needs

- Mirco Barbero (EC ENV) highlighted that soil monitoring is an essential component of the EU Soil Strategy, specifically to assess the policy's impact, address data gaps, produce diverse data flows to populate policy relevant dashboards and indicators.
- Annette Schneegans (EC AGRI/ Secretariat for EU Mission "A Soil Deal for Europe") explained that soil monitoring is an essential building block of the mission. The Mission is proposing a set of 8 indicators to start the discussion on defining soil health and proposes an eight step approach towards soil monitoring. R&I activities will investigate the potential of new technologies (e.g. earth observation, remote sensing and machine learning) to supply new and novel data flows.

b) Summarise the policy needs relating to specific soil environments

- Antonio Bispo (INRAE) outlined the work carried out by the EJP Soil WP6 to define soil monitoring issues in an agricultural context in order to populate indicators to map soil functions and threats to soil; to identify EJP Soil partners, to update soil monitoring systems at national level/LUCAS; to collaborate with the LUCAS 2022 campaign to define/identify additional sampling points. A stocktaking exercise was also undertaken to understand the situation of Soil Monitoring Systems (SMS) in EJP Soil countries. The results of this exercise are that: 5 countries have 2 or 3 SMS, some countries did not mention their forest soil monitoring system (because EJP is mostly interested in agriculture). SMSs serve different purposes and therefore include different types of parameters. Most countries have had between 1-5 campaigns. In 5 countries, the sampling is repeated every year. The density of sites also varies, although the majority have 1 site for less than 300 km^2. Sampling design: the majority use stratified representative sites, alternatively, a grid is used. Sampling depth also varies greatly from country to country. Organic carbon, pH, soil texture and micro/macro nutrients are the parameters most commonly monitored. The results of the survey show that many harmonisation options are limited/prevented because changing those would affect the time series of data they have (e.g. sampling design, sampling protocols, depth of samples, etc.). The recommendation drawn from this work is to carry out a comparison exercise between LUCAS and national sampling schemes and datasets. EJP soil will develop

and share with EJP Soil countries a method to do this consistently. It may involve to application of transfer functions to data to achieve harmonised datasets. Next steps in the project: harmonisation will be difficult as several SMSs are running for more than 2 years, so any change introduced will affect the time series. But some countries are willing to go through the comparison exercise, while a few countries don't have a SMS yet, offering an opportunity to develop a harmonised SMS.

- Bridgett Emmet (UK CEH) described monitoring needs in semi-natural landscapes. Perception is that semi-natural landscapes are low risk due to the lack of intensive management but in practice, these areas are very sensitive to a range of indirect drivers such as air pollution, fire and climate change. Monitoring is challenging due to the complexity of soil depths and vegetation mosaics, which are highly variable compared to monoculture systems. The UK approach since 1978 is based on a 1km grid with repeat measurements. The special challenges of monitoring peatlands were highlighted.
- Rainer Baritz (EEA) described how the European Topic Centre Urban, Land, Soil systems (ETC/ULS) is working on soil degradation detection, leading to a report on soil indicators and thresholds. Thresholds are conditioned by land use and type of soils. Monitoring is needed to calibrate modelled predictions, develop new concepts (soil biodiversity) and improve the validity of thresholds. Intensification of national and EU wide soil surveys is needed to improve reporting of soils. Improvement of indicator fitness for policy purposes is needed through investment in soil monitoring (responsiveness of monitoring, error detection, time series consistency).
- Andreas Baumgarten (AGES, Austria) described the LUCAS Austria project (LUCASA) to assess how LUCAS could be extended to support national needs. LUCAS is seen as a valuable data source but representativeness may differ depending on landscape structures. The validity of the time series depends on the precision of the sampling process. LUCAS can be part of a national monitoring system if there is good quality management of the sampling process and if any deviations from the grid are recorded. A higher flexibility with respect to the sampling grid would improve the quality and significance of the data set.
- Christian Steiner (in his position of Chair of the Alpine Convention Soil Protection Working Group) noted that achieving a harmonised soil monitoring is a difficult exercise. A stocktake exercise revealed the different approaches taken by the 8 countries he represents. The countries could not agree on developing a common permanent soil monitoring in the Alps. The next steps will be to provide guidance on how to take soil samples in Alpine terrain as part of LUCAS 2022 survey, with an accompanying webinar scheduled for LUCAS coordinators.
- Nicole Wellbrock (IPC forest). Forest soil monitoring takes place at two levels. IPC Forest carried out a comparison of LUCAS soil samples in forest areas. Results show that the LUCAS points' representativeness could be improved and this has implications on the LUCAS survey results (e.g. SOC changes). This is due to a lack of focus on the organic layer in mineral soils in LUCAS, which appears to boost the results for C stocks in forests compared to IPC survey results. The recommendation would be to sample the organic layer, sample deeper (up to 80 cm), measure bulk density and stone content at every plot, and to include/record what tree species are present. Soil scientists should do the sample to improve its quality. Germany started a separate peat soils monitoring. Funding also is a current issue for many countries.
- Franziska Tanneberger (Greifswald Mire Centre). Globally, peatland store more than twice the C stored in forests. Organic soils are insufficiently reported due to a low awareness of what peat is, incomplete activity data and poor quality emission factors. In Europe, about 54% of peatland are degraded. A Global Peatland map will be launched at COP26 in Glasgow. The recommendations would be to update existing data as the peat layer is being degraded fast. The ineligibility of rewetted peatland as part of CAP payments also an issue to be addressed.

- Zoltan Szantoi (ESA) described the WorldSoils carbon mapping project of the ESA. WORLDSOILS aims to develop a pre-operational Soil Monitoring System to provide yearly estimations of Soil Organic Carbon (SOC) at global scale, exploiting space-based EO data leveraging large soil data archives and modelling techniques to improve the spatial resolution and accuracy of SOC maps.
- Prezemyslaw Charzynski represented the SUITMA project, Soils of Urban, Industrial, Traffic, Mining and Military Areas. Technical issue prevented the presentation of the slides. A key message emerging from this project is that there is a major knowledge gap about what soil health means in an urban setting. Soils in urban areas provide different ecosystem services and also require different sustainable soil management actions, from those needed in agricultural areas for instance.

In addition to specific questions on the presentations, subsequent discussions addressed the harmonization of soil biodiversity monitoring across EU countries (MINOTAUR), the establishment of pollution thresholds (especially for contaminants of emerging concern), incentives for member states to start monitoring, and the need to monitor solid, liquids and gases flows through the soil.

Technical Working Group on Soil Monitoring

A Technical Working Group on Soil Monitoring was established, of interested stakeholders willing to contribute to the development of an integrated monitoring system for soils in the EU (a core EUSO objective). This Working Group will aim to engage with stakeholders active in the assessment and monitoring of soils from a range of perspectives, to address the technical challenges in establishing an eventual monitoring system that addresses a range of policy needs. The scope is to set out a roadmap for an integrated soil monitoring system, to be published for policy discussion in 2023, and with a view of testing the implementation in a future LUCAS Soil Module.

The roadmap will set out concrete ways in which a more integrated monitoring system could be achieved for EU soil data and knowledge, through the development/deployment of:

- Common soil indicators across policies, land uses, countries, sectors, etc.
- Comparison and potential harmonisation of national and LUCAS soil sampling strategies/schemes
- Comparison of national and LUCAS soil datasets
- Methods to combine national and LUCAS datasets
- Methods to combine existing maps
- Methods to integrate data from satellite observations, citizen data, or private company data willing to collaborate.

Overlaps are expected with the Technical Working Group on data sharing in terms of the tasks and requirements involved with the sharing of data. The Working Group on Soil Monitoring will establish a soil monitoring community to fully understand the policy contexts and needs, while exchanging practical experiences. Close links are foreseen with the data streams and integration Technical Working Group (led by Marc van Liedekerke).

The Technical Working Group will be chaired by EUSO (Arwyn Jones) with Rainer Baritz (EEA), Antonio Bispo (INRAE/EJP), Mirco Barbero (DG ENV), Annette Schneegans (DG AGRI/Mission) as co-chairs.

2.5.4 Summary of the workshop on Soil Pollution

Moderators and chairs: Piotr Wojda, Diana Vieira, Arwyn Jones of the European Commission Joint Research Centre

Objectives

This workshop on Soil Pollution as part of the EUSO Stakeholder Forum brought together different soil-related stakeholders, from policy makers to researchers, technology experts and national or trans-national networks. Its objective was to incentivise stakeholder engagement, to support enhanced soil literacy and to collect feedback. The final goal of this workshop was to establish a Soil Pollution Technical Working Group. This Technical Working Group is active and providing support to the Clean Soil Monitoring and Outlook Report.

The objectives of the session on Soil Pollution were as follows:

- To set the scene present the Zero Pollution Action Plan (ZPAP) and soil-related issues from different angles: from policy at EU level through to Member States' administrations to all stakeholders.
- To call for contributions to the Clean Soil Monitoring and Outlook Report.
- To create a Technical Working Group on Soil pollution within the EUSO.
- To identify the chairs, co-chairs and the TWG Members.
- To get involved, commit and perform the following tasks.

Summary of the discussion

The following presentations and space for discussions were provided during the Soil pollution workshop of the EUSO Stakeholder Forum:

- Introduction and Scope: Piotr Wojda, EC JRC
- Zero Pollution Action Plan: Joachim D'Eugenio, EC ENV
- Soil pollution in the EU Soil Strategy: Bavo Peeters, EC ENV
- Zero Pollution Monitoring: Ian Marnane, EEA
- Bauhaus and soil pollution, Alessandro Rancati, EC JRC
- Clean soil outlook, context, structure, inputs watchlist and roadmap: Piotr Wojda, EC JRC
- Diffuse pollution – plastic & pesticides: Nicolas Beriot, Wageningen University & Research, NL
- Diffuse pollution – metals: Panos Panagos, EC JRC
- Contaminated sites: Frank Swartjes, EIONET Soil Pollution Working Group/RIVM, NL
- Common Forum (MS) Dietmar Müller-Grabherr
- NICOLE Johan de Fraye (Chair)
- REMTECH Marco Falconi
- Contributions from the floor

All the presenters provided their views to be able to draw a full picture of the soil pollution. The Zero Pollution Action was presented with its important Zero Pollution Monitoring and Outlook Report. The latter is divided into two parts: monitoring and outlook. Integrated monitoring of pollution will substantially support better governance on zero pollution by offering new insights into overall pollution levels and impacts and by monitoring whether policy implementation is on track to achieve agreed objectives at EU and national level, also as part of the regular Environment Implementation Reviews and of the 8th EAP monitoring.

The Zero Pollution Outlook will analyse synergies and trade-offs between different EU policies, help translate 'early warnings' into recommendations on pollutants of increasing concern based on the latest research findings (e.g. on ultrafine particles or light pollution). The first Zero Pollution Monitoring and Outlook Report is planned for end 2022.

Soil pollution aspects in the EU Soil Strategy were then presented. The discussion on Bauhaus, contaminated sites/brownfields redevelopment followed, focusing on bioremediation techniques for instance. Diffuse pollution by plastic, pesticides and metals were discussed. Some exchanges on the diffuse pollution aspects took place and it was discussed whether the EU is able to create a toxic-free environment. A perceived obstacle is the lack of knowledge on the extent and impacts of diffuse pollution due to insufficient monitoring and research. Multidisciplinary modelling was introduced to highlight synergies between air, soil and water pollution and to identify knowledge gaps and propose future actions.

The focus then moved on contaminated sites, and specifically, on whether the EU will be able to meet on the targets of the EU Soil Strategy for 2030. To achieve this, the discussion identified that, firstly, significant progress should be made in the remediation of contaminated sites by 2030, and that, secondly, legally binding provisions on contaminated sites should be made to speed up their identification, inventorization and remediation. The session was assessing the inputs required to complete a DPSIR (Driver Pressure State Impact Response) assessment for contaminated sites in order to develop headline messages for the Outlook Report.

Industry, regulators and Member States administration views on soil pollution were collected.

Finally, the presented and discussed concept of the watchlist helped to provide a list of substances as potential or emerging contaminants. The watch list concept also needs a methodology to reach a consensus on its elements and to provide updates.

At the end of the session and in further communication, the objective of the Technical Working Group on Soil Pollution was fine-tuned as follows: to provide support to soil elements of the Zero Pollution Monitoring and Outlook Report and to investigate a contribution to the Zero Pollution Monitoring Report. Additionally, TWG will also help to incentivise stakeholders' engagement, to support enhanced soil literacy and to collect feedback. The Clean Soil Outlook Report will analyse synergies and trade-offs between different EU policies in relation to soil pollution, help translate 'early warnings' into recommendations on pollutants of increasing concern based on the latest research findings (e.g. microplastics, PFAS, pharmaceuticals, ...).

Technical Working Group on Soil Pollution

A Technical Working Group on Soil Pollution was established during the workshop. Its main task will be to provide support to the preparation of the Clean Soil Outlook report. In particular, the tasks of the Technical Working Group will include:

- To propose and establish the Table of Contents
- To discuss the Contaminated Sites related issues
- To reflect on and to create the Watchlist
- To produce and to put together contributions from stakeholders
- To contribute to the First Draft of the Clean Soil Outlook
- To revise the final draft of the Clean Soil Outlook

Proposed milestones of the Technical Working Group on Soil Pollution are presented in the following table.

Nr	Milestone	Focus	Date	Who	Comments
2021-2022					
1.	EUSO Stakeholder Forum	Clean Soil Monitoring and Outlook Report: Introduction and Scope	20/10/2021	Stakeholders	
2.	**EUSO WG1**: Soil and Zero Pollution	Reflections from the EUSO Forum, CSO ToC and Approach, Responsibilities and Request for contributions	15/11/2021		
	EIONET WG on Soil Pollution	*LSI003*	*15/12/2021*	*EIONET WG Members*	
	Common Forum meetings			*Common Forum Members*	
3.	**EUSO Zero Pollution TWG**	(AM) Contaminated Sites, First reflections on watchlist	15/02/2022		
		(PM) Diffuse pollution and watchlist			
4.	**EUSO Zero Pollution TWG**	Collect contributions from WG1 Members	15/04/2022		
5.	**EUSO Zero Pollution Working Group**	First draft of the CSO	15/06/2022		
6.	**EUSO Zero Pollution TWG**	Revision and input from and to EU Soil Expert Group (DG ENV)	15/09/2022		
7.	**EUSO Zero Pollution TWG**	Draft final report	15/11/2022		

2.5.5 Summary of the workshop on Data Integration

Moderator: Marc Van Liedekerke, European Commission Joint Research Centre

Objectives

The objective of the workshop on data integration was to discuss new data/information that would benefit from being incorporated into the EU Soil Observatory (as an extension of the European Soil Data Centre).

Summary of the presentations and the discussion

The moderator gave an introduction of where ESDAC currently stands and its perspective for the future, introducing 3 questions for discussion at the meeting and in the future work of the Technical Working Group on data integration.

The **vision** for the ESDAC, an essential part of the EU Soil Observatory, is to be a data repository and an open data platform where the public at large can access soil related datasets and the supporting documentation, at EU scale. And this vision was coupled to a tentative **mission** to that vision with a catchy slogan: '"EU-scale soil data: if you can't find them through ESDAC, you can't find them anywhere'.

The moderator gave an overview of which data are currently in ESDAC, and proposed to add the following:

- Data from EU research soil related projects (examples: SOILCARE, LANDMARK, ISQAPER, EJP) that typically generate EU wide datasets that at the end of the project (at least in the past) were are not accessible to public users. Our objective is to make them accessible.
- Future LUCAS SOIL campaigns data (point data; derived maps)
- Data from EU Soil Monitoring activities (in collaboration with the EUSO WG, discussed on Day-1 of this SF)
- Data from Indicators/Dashboard activities (is another WG needed?)
- EU-wide data possibly compiled on the basis of National data. But the question is: in which framework?
- EU wide soil data or reference to data associated to peer-review publications (to be found in literature).

The moderator also suggested the creation of a **hub** for accessing (not hosting) national soil data in EU. It would be a kind of compendium of sites where to find for EU countries country-wide soil property/functions/threats data.

Other candidates for inclusion in ESDAC are:

- Data on EU soil research (already handled by many projects, e.g. Bonares)?
- Data on EU-funded projects (at least a list of such projects with abstracts and links)?

The moderator stressed the **importance of Intellectual Property Rights** for any data/information to be included in ESDAC, with a special reference to data/information coming from EU projects.

Technically speaking, ESDAC will continue to act as a repository of static data and documentation, with commonly accepted and usable formats. Currently, there are no plans to integrate the various datasets into a common database. But, as ESDAC hosts many geographic datasets (maps), visual exploration of the data through a web MapViewer and external accessibility by GIS-clients through WMS (web mapping service) links will be offered.

The moderator then raised the **3 questions** to discuss:

- Question1: what else would you see as essential data that EUSO should incorporate? And where/how to get it?
- Question2: how could a working group concretely assist us? And, as this would be voluntary: what is in it for WG members?

- Question3: who could contribute? (with suggestions: EU projects? Representatives of EU countries for identifying authoritative soil data and providing suitable documentation/metadata? Soil Mission? EU soil related networks? Other … ?

After the introduction, **5 'seed' presentations** were invited that expressed some points of view on EU wide soil data in EUSO and partly answered some of the questions raised in the introduction, but also raised new questions on the relation with EUSO.

- In the first presentation "The integration of EU-project results in EUSO", Maria Jose' Amaral of the EU Research Executive Agency informed us about the mechanisms for EU projects to share the results and data to the world, and how EUSO could play a significant role into it, by being present from the start (influencing the content of the Grant Agreement).
- As one example of an EU-funded project, the presentation with title "EJP-SOIL as soil data provider to EUSO" by Maria Fantappie' from CREA (Italy) and Fenny Van Egmond (ISRIC, the Netherlands) explained very clearly the operational links with EUSO and REA when it comes to the definition of the outcomes of the various data deliverables, and the place it could take within ESDAC. The presentation ended with a good set of questions that need to be addressed by EUSO and could also be discussed in the future WG.
- The third presentation, by Maria Fantappie' with the hat of chair of the 'Pillar-4 on data' of the European Soil Partnership (regional branch of the GSP) tackled the question "Is there a role for the European Soil Partnership in contributing to the data in EUSO?" explained the ESP and its Pillar-4, and concluded with valuable suggestions on the interface between ESP/GSP, in essence about aligning international and European activities on indicators development and system design (with references to GLOSIS and INSPIRE) for delivering soil data in distributed fashion to stakeholders.
- The fourth presentation considered the view of one EU country (but we could have invited any) on the role of EU national soil data organizations in contributing to EUSO. In this case for France, Antonio Bispo from INRAE, explained carefully the various national soil data sources, the user access from the public, and thus the possibility of what can be shared or not with EUSO, in case EUSO would need access to national soil data to compile EU-wide data products.
- The last presentation by Rainer Baritz, responsible for the theme Soil in the European Environment Agency, covered the topic "EEA perspective on soil data integration and exchange". This provided the participants with a general view on data handling at EEA and on soil data in particular, concluding with a number of general key messages out of which can be highlighted: "Data products and knowledge exchanges with countries need to be deepened technically: improve Europe-wide mapping of soil functional parameters (based on improved basic geospatial soil data, e.g. soil type maps)", leaving open the role of EUSO in such endeavor.

Technical Working Group on Data Integration and Sharing

The moderator continued with a proposal on how to establish the EUSO Technical Working Group (WG) on Data Integration and Sharing. The WG will be chaired by Marc Van Liedekerke from JRC/EUSO.

The WG will be informal and totally voluntary. Maybe in a consecutive stage, a more formal approach could be envisaged (e.g. when establishing an 'official' soil monitoring system in EU). It could be useful to establish small subgroups to work on specific aspects (EU-projects; IPR; hub to link to national data, INSPIRE issues (including solutions for missing CodeLists, missing official high resolution grids specifications, etc.). Persons/organizations that want to contribute actively should send a mail to the WG Chair (marc.van-liedekerke@ec.europa.eu) and state their intentions for contribution. Among all persons volunteering to be part of the WG, one or two Vice-Chairs will be appointed to help the

Chair in the coordination work. The Chair will solicit candidates to become Vice Chair, and organise a vote per email among WG members.

The meeting concluded with the **next steps**:

- EUSO will write the minutes of this workshop;
- EUSO will identify some core tasks that could be done by the WG;
- EUSO will solicit among meeting participants for participation in the WG, and possibly sub-groups, asking which specific contribution they can make.
- EUSO will organize a follow-up workshop to discuss details and organize better the operation of the WG.

2.5.6 Summary of the workshop on Soil Biodiversity

Moderators and chairs: Alberto Orgiazzi and Arwyn Jones of the European Commission Joint Research Centre

Objectives

The main aim of the EUSO Soil Biodiversity Technical Working Group is to better integrate soil biodiversity into EU policies (environmental, agricultural and others). In this context, it will be relevant to figure out what is exactly needed from the policy side. A long-term commitment by JRC (since 2018) has been to develop a monitoring scheme for soil biodiversity at European scale as part of the LUCAS Soil Survey. Furthermore, the LUCAS Soil biodiversity survey is an open-access initiative sharing both methodologies (sampling and processing) and data. Opportunities are offered by the possibility to integrate small- and large-scale monitoring plans. Challenges are represented by the need for standard methodologies.

Summary of the discussion

Alberto Orgiazzi and Arwyn Jones (JRC/EUSO) gave a brief introduction. The floor was given to the panelists.

Mirco Barbero (DG ENV) gave an overview of the upcoming Soil Strategy (to be presented on 17th November 2021). Soil biodiversity will be fully integrated in the strategy. The specific actions related to soil biodiversity were listed (e.g., genetic assessment). Overall, the need to improve knowledge and understanding for a better integration into policy was highlighted.

Olivier Diana (DG AGRI) recognized the key role of soil biodiversity. That is especially true for the EU agricultural system. Soil biodiversity is subjected to several threats. Diana gave an overview of the main new initiatives (e.g., eco-schemes) associated with the new Common Agricultural Policy (CAP), with a special focus on those that could potentially affect soil biodiversity. Finally, Diana stressed the importance of having indicators. There is a wish from the policy side to include soil biodiversity into initiatives, but this requires the development of specific indicators.

Matteo Piombino (Corteva Agriscience) brought an example of how the private sector is starting to focus on soil biodiversity. Corteva Agriscience has a long-lasting programme of soil monitoring to inform farmers. Recently, the analysis of soil biodiversity through metabarcoding was carried out for a pilot project on vineyards across Italy. One of the final goals of this kind of project is to promote, at farm level, soil management techniques that improve soil biodiversity.

Alfred Grand (farmer) gave an overview of what is the farmer role on biodiversity in soil conservation and promotion. This can be achieved following three steps: realize, rediscover and regenerate. Farmers, and more in general everyone, can realize the benefits of biodiversity through storytelling and content-telling (scientific information). They can rediscover and learn about soil through hands-on activities: dig a hole, see, feel, and smell soil. Finally, farmers can regenerate their soil through a series of methods that promote soil biodiversity (e.g., agroecology, crop rotation, vermicompost and market gardening).

Rolf Sommer (WWF) presented challenges associated with telling soil to the public. Soil is often seen a too far away from people's daily life, is unknown and its biodiversity is not "cute". WWF is working on overcoming these issues by telling soils through different approaches (e.g., participatory formats, events for children and students). An effective way of doing may be to link soil biodiversity to climate change urgency (utilitarian approach), which has more attention in society. Besides citizens, Sommer stressed the need for politics to act on soil (biodiversity). In the European Union, that may be reached in four steps: political framework development, actions linked to Sustainable Development Goals, increasing communication and awareness and data collection for soil health monitoring.

Sarine Barsoumian (IUCN) gave an overview of the IUCN's Red List, which is a critical indicator of the health world's biodiversity and a powerful tool driving policy change on biodiversity conservation. The list is based on a thoroughly tested methodology that could be also applied to soil organisms. Currently, the number of soil species assessed by the list is limited (e.g., 224 out of 23,000 earthworm species). Barsoumian informed that IUCN has the ambition to complete the list for many groups of soil organisms (e.g., woodlice and mites). For doing that, support is needed in terms of resource mobilisation, data collection and policy demand.

Anders Dahlberg (Global Fungal Red List Initiative) presented the Global Fungal Red List Initiative that aims to get fungi and fungal conservation better known. The initiative is voluntary. So far it has worked on over 1,800 fungal species, of which 470 reached the final stage and publication in the IUCN's Red List. 137 species are from Europe. The list initiative is linked to fungal monitoring plans. Dahlberg highlighted the Fungal Monitoring of Swedish Forest soils. Fungal monitoring started in 2015 and it is based on DNA analyses. More than 12,000 species of fungi were found in over 1,800 forests. Few species are in common among sites. Data analysis offered interesting insights, such as the reduced amount of soil carbon in presence of a common webcap fungus. This shows how soil biodiversity monitoring can also help in better understanding the whole functioning of ecosystems.

Antonio Bispo (INRAe-France) presented the French National Soil Quality Network (RMQS) coordinated by INRAe's GIS Sol group. This soil monitoring programme includes over 2,000 sites visited every 15 years since 2000. Over the years some tests on soil biodiversity were carried out (e.g., earthworm and collembolan abundance). GIS Sol group is currently testing (30 sites) the possibility to include a full soil biodiversity assessment in RMQS. Five protocols were selected to monitor both taxa and functions. Lessons learnt from the testing phase show that complete soil biodiversity monitoring and its inclusion in existing network is feasible, however it requires time (and money) and, the adaptation of the overall monitoring process.

Carlos Guerra (iDIV) gave an overview of the Soil BON initiative, an example of international cooperation as a basis for the conservation of soil biodiversity worldwide. Soil biodiversity is overlooked when we look at conservation initiatives (e.g., Red List). Nonetheless, data show that protecting aboveground diversity does not always mean protecting life belowground. In this contest, iDIV and many other institutions (more than 200) have moved to action and put in place the Soil BON project. It aims to monitor soil biodiversity and functions on a global scale. It is a voluntary initiative, so far identifying sampling locations in 81 countries worldwide. Collected and analysed data will allow to propose actions for a better inclusion of soil organisms into conservation policy agendas.

Technical Working Group on Soil Biodiversity

Over the last years, knowledge on soil biodiversity distribution has skyrocketed. Nonetheless, evidence of the status of soil biodiversity and, thus, the inclusion of soil organisms into lists of endangered species are limited. There is a strong need to fill in this gap to ensure a better integration of soil biodiversity into conservation policies.

Finally, the available and future knowledge on soil biodiversity should be converted into handy indicators that could be easily applied for policy development and implementation. Compared to other compartments, soil still suffers lack of agreements among scientists and other stakeholders on which is/are the most appropriate soil biodiversity indicator(s).

A Technical Working Group on Soil Biodiversity was established at the workshop. It aims to become a reference point for openly discussing these issues and proposing concrete actions to move forward and promote soil biodiversity conservation at EU (and global) scale.

Questions that the Technical Working Group will address:

1. What are policy needs on soil biodiversity?
2. How do we integrate local and regional monitoring schemes for soil biodiversity?
3. How is soil biodiversity doing? Is soil biodiversity declining? Do we have evidence of that?
4. How do we convert the available knowledge on soil biodiversity into indicators that can be easily applied to policy development and implementation?

Declarations of intent by interested stakeholders are collected till the end of 2021. In the first trimester of 2022, the final members of the group will be selected. The first meeting of the group will be organised by summer 2022.

2.5.7 Summary of the workshop on Soil Erosion

Moderators and chairs: Panos Panagos and Diana Vieira of the European Commission Joint Research Centre

Objectives

A key objective of this workshop meeting was to establish a Technical Working Group on soil erosion.

Summary of the presentations and the discussion

A welcome was given by Panos Panagos (JRC/EUSO) who introduced the speakers and he underlined that this is not scientific event but it covers a large spectra of interested stakeholders: policy makers at EU level, academia, research, regional authorities, IUSS, farmers, NGOS and the private sector.

Some background information given by Panos Panagos. Over the past years, informal working groups on soil erosion, led by JRC, convened during three workshops (Ispra – Seoul – Rio) and addressed different activities. The first soil erosion-modelling workshop took place in Ispra in March 2017 followed by second one in Seoul (December 2017) and the third one in the World Soil Congress in Rio (August 2018). The working group on gully erosion notably developed the current status in measuring, modelling and managing gullies. This was published in Earth Science Reviews including datasets from Member States. In addition, another informal WG of 67 scientists have developed the first Global Applications of Soil Erosion Model Tracker (GASEMT) – a database of studies with erosion modelling. The GASEMT is publicly available and is accompanying two research publications. Since 2017, other erosion processes have been studied and published in EU: Wind erosion, harvest erosion and gully erosion with LUCAS monitoring. One key objective of the present session is to establish a formal Technical Working Group on soil erosion – this would benefit from the activities that have been ongoing already for a number of years, and a strong soil erosion community built in the process.

Mike Mackenzie (DG AGRI, European Commission) presented the post 2020 CAP requirements in relation to soil. The future CAP has a great potential to contribute to care for soil. Next months are crucial in this direction. One of the impact indicators in the future CAP is the soil erosion (% of agricultural area under severe erosion). GAEC 2 (protection of wetlands), GAEC 5 (tillage management), GAEC 6 (minimum soil cover) and GAEC 7 (crop rotation) are relevant to soil conservation and present the future conditionality in the new CAP.

Julia Pongratz (University of Munich) presented the land use change and carbon fluxes. Land use changes (deforestation, conversion of grassland to forests) or other soil processes are responsible for CO2 emissions in the atmosphere. Not all of the Earth Science models to estimate carbon budget include soil erosion processes. Measures aimed at reducing the risk of erosion may play a role in carbon mitigation, for example, avoid deforestation, application of biochar, conservation agriculture, protect grassland. To better account for carbon losses, we need accurate estimates of erosion and sediment fluxes for the last century at global scale.

Christine Alewell (University of Basel) presented the food security threat due to phosphorus reduction. Phosphorus is mainly lost in agro-ecosystems due to soil erosion and this output is neglected in global P budgets and cycling. Combining the P concentration (INRA) with Global soil erosion, a group of scientists estimated the P losses due to erosion. The big challenge is how we can feed the world without P and how to reduce the erosion in Africa and south America and Asia.

Edoardo Costantini (president of the International Union of Soil Sciences - IUSS) presented the importance of soil conservation. IUSS has two commissions relevant to land

degradation in the IUSS. 76% of land degradation globally is due to water and wind erosion. Mr. Constantini presented the anthropogenic pressures to increase soil erosion: Tillage translocation, ploughed erosion, mechanical mass movements (bulldozer erosion) and soil fluxes on compacted subsoil. The mechanical movement may affect around 500,000 ha in Italy, in particular in vineyards. He also presented solutions for soil care against soil erosion: conservative agriculture, organic farming, agroforestry, crop diversification, etc.

Pasquale Borrelli (University of Pavia) presented the future challenges for the soil erosion community. Soil erosion is more a problem for areas that suffered more in the past as well. Global models give little understanding on what is happening at the field. We need to target the fields as we have enough modelling capacity to face the complexity of processes. Modelling approaches at field scale is the solution and we explore with changes in cover (crop and management driven). The EUSO may give the opportunity to predict erosive events, improve our capacity to monitor the effectiveness of land management and provide ex-ante and ex-post policy support through a scientific monitoring network.

Petra Deproost (Region of Flanders) presented the monitoring scheme on soil erosion in Flanders. They noticed an increase in rain erosivity since early 2000 using detailed rainfall depth time-series in Flanders at 10 min temporal resolution. All agricultural parcels get one general C-factor value when calculating the potential soil erosion. The soil erosion risk is calculated based on the specific crop and crop management (main crops, cover crops, CAP conditionality, AECM) per parcel using look up tables and reduction factors. Based on the potential erosion class, in Flanders there is an application of specific measures (obligatory GAECs) for soil conservation. The C-factor for calculating the soil erosion risk is based on the crop choices and various (obligatory or voluntary) management practices. Considering the evolution of the soil erosion risk from 2008-2019, Flanders estimates a decline of severe erosion in this period (obvious influence of GAECs in reducing soil erosion). Keeping constant the rain erosivity factor allows to estimate the impact of CAP measures.

Claudio Screpanti (Syngenta) presented innovation for sustainable agriculture with investments in soil health. Soil health is a long-term, large-scale phenomenon that requires system-level management. The R&D at Syngenta has the following specific priorities for soil health: promote soil biodiversity, preserve soil resources and mitigate climate change. The 3 priorities include 8 targets such as protect soil microfauna, increase water storage, improve nutrients bio-availability, reduce N2O emissions, etc. A more resilient and sustainable agriculture is needed through the promotion of soil health. Public and private collaborations would unlock new solutions.

Elizabeth Lunik (Rabobank) presented the Carbon bank. The Rabo Carbon bank project focusses on carbon farming, supply chain decarbonisation and carbon reduction retail. It is important to have long-term carbon gaining agricultural systems. Managing carbon is a key issue in soil health: reduce tillage, increase cover crops and crop rotation and the managed grazing. Most of those solutions are "win-win" for soil erosion mitigation as well. It is important to develop agricultural management that helps soil capacity to store carbon and reduce GHG emissions. The rural clients have co-benefits such as improved soil fertility, increased yield, better water holding capacity and biodiversity.

Sebastian Vogler (Farmer in south Germany) presented his experience in applying conservation agriculture on his 85 ha farm. He tries to protect his farm against erosion by having a plant coverage 365 days per year in the field, feed soil with compost and adjust nutrients. Some practices in detail: after maize silage to apply compost, seeding triticale or winter crops without any tillage. After harvesting grain around 20th June, the rye grass/red clover regrows in 10 days and the field is green again (protect against erosion, feed soil with nutrients).

Rigas Tsiakiris (NGO Green Institute) presented productive reforestations for creating jobs, tackling erosion/desertification and mitigating the effects of climate change. Ancient rural

agro-forestry landscapes are being lost at large scale in the Mediterranean due to fires, land abandonment and land use change. Productive reforestation can protect against erosion, increase biodiversity, provide income to less favoured areas. The Green Institute is very active in raising awareness in social media, TV and magazines. He proposed a proposal for a climate-smart Mediterranean forestry and a climate smart innovative product policy involving local farmers to achieve economic viability.

A discussion took place on the following points:

- The CAP management plans and their importance in soil conservation.
- Models uncertainty and application on local/regional and larger scale.
- It was also important to involve also geomorphologists in discussions on this WG as they have deep knowledge on the process.
- Reduced tillage and no tillage conservation practices are linked to glyphosate application. Alternatives are the cover crops or even expensive products to replace glyphosate. There is a huge interest to substitute it or looking for biological/electrical alternatives. However, the proposed alternatives to glyphosate cost a lot and their uptake from farmers is low.
- As farmers do not have such a high knowledge for applying conservation measures, how we can convince them?
- Discussion about the application of models to test the extreme weather events such as the ones in summer 2021.
- How we can better monitor also other erosion processes than water erosion (tillage erosion, gully, wind).
- Importance to integrate not only with other processes but include also socio-economic data (age of farmers, income, etc).

Technical Working Group on Soil Erosion

The Technical Working Group **"Soil erosion in relation to land degradation, climate change & food security"** will develop linkages between soil erosion and emerging issues such as climate change, food security and land degradation. The WG will propose modelling approaches that can respond to new developments in the European policies: Post-2020 Common Agricultural Policy (CAP), New Soil Strategy for soils, Biodiversity Strategy, Farm to Fork and Zero Pollution Action Plan.

The Soil Erosion Working Group will have the following objectives for a first 12-24 month period:

1. develop an **object oriented (bottom-up) approach** for estimating soil erosion and health indicators at farm scale – The development of a bottom-up soil erosion monitoring modelling framework;
2. **integrate** soil erosion with emerging issues such as soil contamination, carbon loss and food security;
3. improve **large scale assessments;**
4. have **different sub-groups** based on research question or policy request.

The first priority will be to develop a modelling approach that it modular/adaptive and would target applications at regional and local scale. This requests the involvement of all potential stakeholders: farmers, advising services, regional authorities, Member States, EU policy makers and scientists. This new approach would use as a basis the information/data at a **farm level**. Therefore, new datasets at high spatial resolution (e.g. **Land Parcel Identification System LPIS**) and new Remote sensing inputs (e.g. Phenological indexes) would be important inputs. This modelling tool could be applied at farm and local scale taking also into account the farmers' management practices to reduce erosion and improve soil health. Our biggest challenge is to take the feedback from farmers and local

stakeholders and include it in assessments, proposed management practices and policy inputs. This requires a scientific monitoring network and at least a region, which will serve as case study. Synergies with lighthouses network and mission on soil can be also an option.

Flexible sub-groups will address new research challenges such as food security, climate change and sediment distribution. EUSO already put in place a network for an extensive data collection of Sediment distribution data in 2021 with the objective to populate all the findings at EU level by 2022. The sediment assessments could support policy options in the new EU Green Deal.

The global studies will focus on how to better integrate soil erosion data in Earth Systems models and include them in IPCC or IPBES assessments. In addition, we should look forward to improve the current UNCCD Land Degradation indicator definition 15.3.1 by including soil erosion.

Working group structure: in a first stage informal and voluntary; in consecutive stages, a more formal approach could be envisaged. It is proposed that persons/organizations that want to contribute actively send a mail to panos.panagos@ec.europa.eu, with their intentions by 29.11.2021.

EUSO (JRC) will chair the WG (Panos Panagos) with two vice chairs: one from academia (vacant for the moment – Diana Vieira from JRC will cover this role in the beginning) and one from regional/policy (Petra Deproost – Region of Flanders).

2.5.8 Summary of the workshop on Citizen Engagement

Moderators: Arwyn Jones, European Commission Joint Research Centre; Arianna Pasa, EC DG AGRI/Soil Mission Secretariat

Objectives

The scope of this Workshop was to highlight good practices and effective examples of citizen engagement and awareness raising relating to soil. It also aimed to establish a Community of Practice on Citizen Engagement to support the implementation of the EU Soil Strategy and Soil Mission These items are flagged as high priorities in both the Soil Strategy and the Mission "A Soil Deal for Europe".

Summary of the presentations

The following presentations took place:

- Introduction and Scope: Arwyn Jones, EC JRC/EUSO
- Citizen engagement and the new EU Soil Strategy: Mirco Barbero EC ENV
- Introduction to the Citizen Engagement/Education/Communication elements in the Soil Mission: Arianna Pasa, EC AGRI
- Citizen Engagement: how to do it properly? Ângela Guimarães Pereira, EC JRC
- EU Education and youth programmes: Dalibor Mladenka & Marlene Bartes, DG EAC
- The role of soil science in raising awareness - Anna Krzywoszynska (Soil Care Network), Bridget Emmett (CEH, UK), Christine Berrill (IUSS World Soil Congress), Gabrielle Broll (ENSA/University of Osnabruck, Germany)
- Save the Landscape Forum - Soil Europe Group: Francesca Tescari & Mario Catizzone
- Youth awareness: Šarlote Abatniece, Raivo Kleijsen Laas, Darina Alexandrova (European School Students); Rebecca Lardeur, Youth4Climate Ambassador
- Global Soil Partnership & World Soil Day: Isabelle Verbeke, FAO

Unfortunately, pressures of time prevented us from hearing the contributions of experiences with local authorities: Christian Steiner (Lower Austria/ELSA), Francesco Malucelli (Regione Emilia Romagna, Italy); Alfred Grand's view of citizen engagement as a farmer and the JRC's Soil Biodiversity Massive Online Course by Nelson Ribeiro Jorge. Presentations are available.

2.5.9 Summary of the Young Soil Researchers Forum

The Young Soil Researchers Forum included 4 sessions as presented below.

2.5.9.1 Soil Organic Carbon

Moderators: Calogero Schillaci, European Commission Joint Research Centre; Anna Muntwyler Collaborative Doctoral Partnership PhD student JRC-ETH.

This workshop was about soil organic carbon, its main components, and their effect on European soils. The session had 16 contributions selected based on the relevance of the study area and the relation with SOC, greenhouse gasses emissions, and nutrient cycling. The moderators gave a brief introduction, highlighting the innovative topics presented by the participants (young researchers), which presented state of the art methods and evidence synthesis. These findings are essential for the EUSO and European community of soil researchers.

The topics of the presentations were as follows:

- SOC modelling across the different land covers (5),
- SOC monitoring (4),
- GHGs emissions and modelling (4),
- Nutrient cycling (2),
- SOC Spectroscopy (2),
- SOC evidence synthesis (1).

The contributions came from 10 countries with the collaboration of academic and research institutes. Most of the research demonstrated the use of experimental, national soil data, LUCAS data, and other EU monitoring networks (ICOS), highlighting the potential of monitoring schemes, long term trials of agriculture and forestry in soil research. The priority will be to interlink soil data and experimental results from local to regional scales. This requests the involvement of all potential stakeholders: farmers, advising services, regional authorities, Member States, EU policymakers, and scientists.

2.5.9.2 Soil Monitoring and Contamination

Moderators: Diana Vieira and Anne Maréchal, European Commission Joint Research Centre; Julia Koeninger Collaborative Doctoral Partnership PhD student JRC-UVigo.

This session resulted from several contributions on soil monitoring and contamination, summing up 14 presentations on novel monitoring approaches, ad soil contamination remediation techniques, and soil processes modelling. Soil contaminants such as metals, hydrocarbons, antibiotics, and their remediation were addressed. Several approaches for the monitoring and assessment of soil properties and contamination were also discussed, such as spectroscopy, crono-sequencing and hydrological modelling. Finally, some reflections were made on soil management and sustainability.

The session covered at least 10 different nationalities between the EU and the USA, focused mostly on located field studies, but also revealed some upscaling at MS and EU level.

2.5.9.3 Soil biodiversity

Moderators: Alberto Orgiazzi, European Commission Joint Research Centre; Maëva Labouyrie Collaborative Doctoral Partnership PhD student JRC-Zurich University.

This session included 12 presentations on topics linked to soil biodiversity, from drivers and predicators of soil biodiversity, to risk factors, historical changes and evolution, to soil biodiversity genome comparison.

2.5.9.4 Soil erosion

Moderators: Panos Panagos, European Commission Joint Research Centre; Francis Matthews Collaborative Doctoral Partnership PhD student JRC-KU Leuven

This session included 16 presentations on soil erosion topics from PhDs and post-doctoral students of 12 different nationalities. The topics addressed in this interesting session were: Piping erosion, new models for sediment delivery, wind erosion modelling, tillage erosion models, gully erosion, upscaling cover management factor, resilience of soil erosion rates, calibration of models in permanent crops, event-based erosion assessment, use of novel photogrammetry techniques, runnoff and soil loss, post-fire management, impacts of wildfires in soil erosion.

All the Young Soil Researcher Forum presentations available have been allocated at the following address: https://esdac.jrc.ec.europa.eu/euso/young-soil-researchers-forum .

In addition, the JRC in collaboration with the European Journal of Soil Science launched a call for a special issue based on the Young Soil Researchers Forum. The Special issue will be competed and published in autumn 2022 (Figure 4).

Figure 4. Call for Papers following the 2021 European Young Soil Researchers Forum

Source: EUSO

3 Expected developments of the EU Soil Observatory in 2022

This section highlights the main activities planned for 2022 which should also aim to respond to the actions proposed by the EU Soil Strategy (COM (2021) 699). Outcomes will be reported in the 2022 EUSO Review report.

3.1 Soil monitoring

The following activities are planned in 2022 with respect to soil monitoring:

- Engagement with EJP SOIL, EEA, ESA and researchers involved in the monitoring of soil condition through meetings of the various EUSO Technical Working Groups. Draft position paper outlining concept and roadmap for integrated soil monitoring system (including indicators and critical thresholds) for discussion by MS (EC Expert Groups, EIONET-Soil), with possible implementation in time for LUCAS 2025/2026 (tbc)
- Support the implementation of the Soil Health Food Mission Work Programme 2021-2023, focusing on monitoring
- Coordination of soil element of LUCAS 2022
- Publication of reports on:
  - residues of plant protection products active ingredients in cropland soils
  - antimicrobial resistance genes in LUCAS soil samples
  - micro-plastics in LUCAS soil samples
  - soil biodiversity in LUCAS soil samples

3.2 Soil pollution

The first meeting of the TWG on Soil Pollution was scheduled and held in November 2021 during which a more detailed roadmap for 2022 was presented. Subsequent meetings have been scheduled to take place in February, April and June 2022. The final goal of this work is to substantially contribute to the Clean Soil Outlook Report.

The Clean Soil Outlook Report will analyse synergies and trade-offs between different EU policies in relation to soil pollution. It will help translate 'early warnings' into recommendations on pollutants of increasing concern based on the latest research findings (e.g. microplastics, PFAS, pharmaceuticals, ...) through its watch list, and by providing a list of substances as potential or emerging contaminants. The watch list concept will also indicate a methodology to reach a consensus on its elements, and to provide updates on the extent of such substances of concern, by means of monitoring and screening programs at European and National scales.

The Clean Soil Outlook report should be developed in synergy with the Soil Monitoring Report. It should also present a European landscape of soil pollution according to the R-DPSIR (current Response, Driver, Pressure, State, Impact, Response) Framework.

The development of a Clean Soil Outlook could complement the implementation of the Soil, Biodiversity and Farm to Fork Strategies. While it may be too early to have a comprehensive soil dimension by 2022, discussions are ongoing about how existing instruments and initiatives (e.g. the ongoing European Soil Condition Assessment, LUCAS Soil) can support an outlook assessment for soils.

3.3 Soil erosion

The kick off meeting of the Soil Erosion working group (WG) was held in December 2021. During this meeting, the 52 members of the WG decided on the structure of the WG assigning the chairs and vice-chairs. In addition, the WG has identified the main priorities and the topics to address.

A series of research activities are planned to take place in 2022 which will advance the state of knowledge on soil erosion. Various meetings of the Technical Working Group on Soil Erosion will also be scheduled, including a Soil Erosion Workshop planned to take place in June 2022. One of the priorities is to proceed with the development of the Sediments database in 2022.

The emerging challenges for soil erosion workshop will be: a) Sediments (including monitoring network) b) Farm/Field scale modelling c) Erosion mitigation & management practices d) Soil organic carbon and erosion integration e) Food security, nutrient losses with erosion f) Large scale modelling g) Early Career Research on Soil Erosion h) Landslides and soil erosion i) Climate change and soil erosion. The outputs of the workshop will be published as proceedings (technical report) and a journal Special issue.

3.4 Soil dashboard

Work towards the development of a functional Soil Health Dashboard will start in 2022. This will encompass the development of supporting indicators and thresholds associated with soil health, the prototype development of the interface, which ultimately will include a web mapping function.

3.5 R&I portal

Initial content will start to be published on the R&I portal as implemented by the Soil Mission Support CSA (a Horizon 2020 project). The R&I portal will ensure links to Horizon Europe and the Soil Mission Work Programme, with initial elements addressing Soil Mission Living Labs and Lighthouses, together with Horizon Europe Soil Research Portal.

3.6 Soil Awareness/Citizen Engagement portal

A portal aiming at raising soil awareness and engaging citizens on the importance of soil protection will be developed as part of EUSO. A dedicated Horizon Europe project, PREPSOIL (Preparing for the "Soil Deal for Europe" Mission), will kick off in July 2022 and will start developing this online platform, to which the JRC will also contribute.

3.7 2022 EUSO Stakeholder Forum

Discussions have started with organisers of 2022 IUSS World Soil Congress for a possible session at the 2022 edition of the EUSO Stakeholder Forum.

3.8 Policy related activities and developing EUSO knowledge base

Throughout 2022, the EUSO will undertake a range of activities to support the development of soil-related policies and research, as well as directly contributing to the development of the knowledge base on soils in the EU. For example, the following contributions are planned for 2022:

- Coordination of Zero Pollution Clean Soil Outlook Report and collaboration with EEA on Zero Pollution Clean Soil Monitoring Report.
- Concept paper on Soil Pollution Watch List and LUCAS Soil Pollution Module.

- Together with DG ENV and the Land Information System of the EEA, develop a regular reporting on land degradation and restoration in the EU in response to the recommendations of the report by the ECA.
- Support ESTAT in the reporting of the relevant indicators for the soil related SDGs, especially for target SDG 15.3 for achieving land degradation neutrality in the EU.
- Support DG AGRI in relation to the CAP Context indicators (soil erosion, soil organic carbon) including EJP Programme and EU-Africa FNSSA Partnership.
- EUSO will collaborate with EEA in relation to indicators on soil sealing and contaminated sites and with OECD in relation to soil erosion.

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List of acronyms

CAP: Common Agricultural Policy

CAPRI: Common Agricultural Policy Regionalised Impact model

DG AGRI: Directorate-General for Agriculture and Rural Development

DG CLIMA: Directorate-General for Climate Action

DG ENV: Directorate-General for the Environment

DG INTPA: Directorate-General for International Partnerships

DG RTD: Directorate-General for Research and Innovation

DG SANTE: Directorate-General for Health and Food Safety

EC: European Commission

ECA: European Court of Auditors

ECHA: European Chemicals Agency

EEA: European Environmental Agency

EFSA: European Food Safety Authority

EIONET: European Environment Information and Observation Network

EJP SOIL: European Joint Partnership on Soils

ELSA: European Land and Soil Alliance

ENSA: European Network on Soil Awareness

ESA: European Space Agency

ESDAC: European Soil Data Centre

ESP: European Soil Partnership

ESTAT: Eurostat

EU: European Union

EUROSOIL: European Conference of Soil Science

EUSO: EU Soil Observatory

FAO: Food and Agriculture Organisation

GAEC: Good Agricultural and Environmental Conditions

GASEMT: Global Applications of Soil Erosion Modelling Tracker

GLOSIS: Global Soil Information System

GSP: Global Soil Partnership

ICOS: Integrated Carbon Observation System

INSPIRE: Directive 2007/2/EC establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)

IPBES: Intergovernmental Science-Policy Platform for Biodiversity and Ecosystem Services

IPCC: International Panel on Climate Change

IPR: Intellectual Property Rights

IUSS: International Union of Soil Sciences

JRC: Joint Research Centre

LISE: Land Information System for Europe

LUCAS: Land Use/Cover Frame area Survey

LULUCF: Land Use, Land Use Change and Forestry

MAOM: Mineral-associated Organic Matter

MRV: Monitoring Reporting and Verification

MS: Member State

NGO: Non-Governmental Organisation

OECD: Organisation for the Economic and Cooperation Development

PFAS: Perfluoroalkyl chemicals

POM: Particulate Organic Matter

R&I: Research & Innovation

REA: Research Executive Agency

SDG: Sustainable Development Goal

SF: Stakeholder Forum

SHL: Soil Health Law

SOC: Soil Organic Carbon

SoilBON: Soil Biodiversity Observation Network

SOLACE project: Understanding the links between Soil pollution and CancEr

SOM: Soil Organic Matter

TWG: Technical Working Group

UNCCD SPI: Science-Policy Interface of the United Nations Convention to Combat Desertification

UNEP: United Nations Environmental Programme

WG: Working Group

YSRF: Young Soil Researcher Forum

ZPAP: Zero Pollution Action Plan

List of figures

Annex: Agenda 1st EUSO Stakeholder Forum

1st EUSO Stakeholder Forum

AGENDA

19-21 October 2021

All times are expressed in
Central European Summer Time

Please click below to register for the WEBEX sessions:
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Day 2b: https://webcast.ec.europa.eu/euso-stakeholder-forum-day-2-session-2
Day 3: https://webcast.ec.europa.eu/euso-stakeholder-forum-day-3

Questions can be submitted through SLIDO www.sli.do or Webex chat for those who are registered

Enter the SLIDO event code, which we will provide at the start of each session.

19.10.21 @10:00-12:30 CEST
Recent EU policy developments in soil

Moderator: Giovanni De Santi, European Commission JRC, Director Sustainable Resources

09:45: Opening of Webex Room, Streaming Service and Slido

10:00 – Arrangements for meeting

10:05– Welcome, scope and update on EUSO

Giovanni De Santi European Commission JRC

10:15 - EU Soil Strategy

Claudia Olazabal European Commission DG ENV

10:35 - EU Mission: A Soil Deal for Europe: 100 living labs and lighthouses to lead the transition towards healthy soils by 2030

Nathalie Sauze-Vandevyver European Commission DG AGRI

10:55 - Zero Pollution Action Plan

Joachin D'Eugenio European Commission DG ENV

11:10 - EP soil resolution

Martin Hojsík European Parliament

11:25 - Land Information System for Europe

Andrus Meiner, European Environment Agency

11:40 – Questions from audience & Discussion

12:25 – Closing remarks: Giovanni De Santi

12:30 – End of session and lunch break

Establishment of EUSO Technical Working Groups

To support the implementation and operation of the EU Soil Observatory, one of the objectives of the EUSO Stakeholder Forum is to establish a series of Technical Working Groups. These Technical Working Groups (TWG) are meant to mirror the specific needs of the EUSO by:

*** supporting the implementation and eventual operation of the Observatory
*** developing the EUSO knowledge base
*** serving specific policy driven needs.

Each working group will be chaired by the JRC together with (up to) two co-chairs, representing the respective policy drivers and/or a recognised expert in the field. Technical Working Groups will be composed of a limited group of Stakeholders with a recognised background in the specific domain.

The duration of Technical Working Groups should be nominally 12-24 months to reflect concrete actions. Meetings of the Working Groups are variable but at least two meetings per year are foreseen. It is possible that more regular meetings may be required during the implementation phase and in response to specific policy support requests.

Following the Technical Sessions of the EUSO Stakeholder Forum, the JRC will invite nominations to be members of Working Group, on the basis of proven experience and capacity to contribute.

The initial meetings will be online only. Future meetings will probably be hybrid in nature.

The outcomes of the Technical Working Groups will be reported to both the Stakeholder Forum and relevant EC Services and Agencies.

The following TWG will be established as a result of the 2021 Stakeholder Forum:

**Integrated soil monitoring

Scope: Contribute to development of an integrated monitoring system for the EU

**Soil pollution

Scope: Support to 2022 Clean Soil Monitoring and Outlook Report

**Data integration

Scope: Integration of relevant EU-wide data in EUSO/ESDAC?

**Soil biodiversity

Scope: What should the EU do to protect soil biodiversity?

**Soil erosion

Scope: Exploring the role of soil erosion in relation to land degradation, climate change, food security

A Community of Practice on Citizen Engagement will also be established.

19.10.21 @ 14:00-16:30 CEST

Core EUSO Objective: Integrated soil monitoring

Scope: Contribute to development of an integrated monitoring system for the EU

Moderators: Arwyn Jones/Anne Maréchal, EC JRC/EUSO

- Introduction and Scope: Arwyn Jones, EC JRC/EUSO
- Soil monitoring in the Soil Strategy: Mirco Barbero, EC ENV
- Soil monitoring in the Soil Mission: Annette Schnegaans, EC AGRI
- Preliminary outcomes of EJP Soil WP6: Antonio Bispo, INRAE
- Indicators and thresholds for soil indicator set: Rainer Baritz, EEA
- Reflections on the LUCASA project: Andreas Baumgarten, AGES, Austria
- Alpine Soil Information System: Christian Stenier, Alpine Convention Soil Protection WG
- Monitoring of Urban Soils: Przemysław Charzyński, SUITMA Project / Nicolaus Copernicus University, Poland
- Monitoring soils in semi-natural landscapes: Bridget Emmett, UKCEH
- Monitoring of forest soils: Nicole Wellbrock, ICP Forests/Thünen-Institut, Germany
- Worldsoils carbon mapping project: Zoltan Szantoi, European Space Agency
- Experiences in peatlands: Franziska Tanneberger, Greifswald Mire Centre, Germany

Other contributions from the audience

Questions and Discussion

- Indicators
- National and LUCAS sampling strategies/schemes
- Compare national and LUCAS datasets
- Methods to combine national and LUCAS datasets
- Methods to combine existing maps

Establishment of EUSO Monitoring Technical Working Group

Next steps & Conclusions

20.10.2021 @ 10:00-12:30 CEST

Developing the EUSO Knowledge Base (Part 1)

10:00 Parallel Session 1a: Soil pollution

Scope: Support to Clean Soil Monitoring & Outlook Report

Moderators: Piotr Wojda EC JRC/EUSO

- Introduction and Scope: Piotr Wojda, EC JRC
- Zero Pollution Action Plan: Joachim D'Eugenio, EC ENV
- Soil pollution in the EU Soil Strategy: Bavo Peeters, EC ENV
- Zero Pollution Monitoring: Ian Marnane, EEA
- Soil possibilities in the New European Bauhaus: Alessandro RANCATI, EC JRC
- Clean soil outlook, context, structure, inputs watchlist and roadmap: Piotr Wojda, EC JRC
- Diffuse pollution – *plastic & pesticides*: Nicolas Beriot, Wageningen University & Research, NL
- Diffuse pollution – *metals*: Panos Panagos, EC JRC
- Contaminated sites: Frank Swartjes, EIONET Soil Pollution Working Group/RIVM, NL
- Common Forum (MS) Dietmar Müller-Grabherr
- NICOLE: Johan de Fraye (Chair)

Contributions from the floor

Questions and Discussion

Establishment of EUSO Zero Pollution Technical Working Group

Next steps & Conclusions

10:00 Parallel Session 1b: Data integration

Scope: how can relevant EU-wide data be integrated in EUSO/ESDAC?

Moderators: Introduction and Scope: Marc Van Liedekerke, Calogero Schillaci, JRC/EUSO

- Introduction and Scope: Marc Van Liedekerke, EC JRC/EUSO
- The integration of EU-project results in EUSO: Maria Jose Amaral, REA
- EJP-SOIL as soil data provider to EUSO: Maria Fantappie', CREA Italy/Fenny Van Egmond, ISRIC Netherlands
- Is there a role for the European Soil Partnership in contributing to EUSO? : Maria Fantappie', CREA Italy
- EEA perspective on soil data integration and exchang: Rainer Baritz, EEA
- Is there a role for EU national soil data organizations in contributing to EUSO? : Antonio Bispo, INRAE France

Contributions from the floor

Questions and Discussion

Establishment of EUSO Data Integration Technical Working Group

Next steps & Conclusions

20.10.2021 @ 14:00-16:30 CEST

Developing the EUSO Knowledge Base (Part 2)

14:00 Parallel Session 2a: Soil biodiversity

Scope: What EU should do for protecting soil biodiversity?

Moderator: Alberto Orgiazzi, EC JRC/EUSO

- Introduction and scope: Alberto Orgiazzi
- Soil biodiversity and EU environmental policies: Mirco Barbero, DG ENV
- Soil biodiversity and CAP: Olivier Diana, DG AGRI
- Soil biodiversity and private sector: Matteo Piombino, Corteva Agriscience
- Soil biodiversity and farming: Alfred Grand, Farmer
- How to tell soil biodiversity: Rolf Sommer/Michael Berger, WWF
- Soil biodiversity and IUCN Red List: Sarine Barsoumian, IUCN
- Global Fungal Red List Initiative: Anders Dahlberg, Swedish University of Agricultural Sciences
- Soil biodiversity monitoring in France: Antonio Bispo, INRAE
- Global monitoring of soil biodiversity: Carlos Guerra, SoilBON

Contributions from the floor
Questions and Discussion
Establishment of EUSO Soil Biodiversity Technical Working Group
Next steps & Conclusions

14:00 Parallel Session 2b: Soil erosion in relation to land degradation, climate change & food security

Scope: What should the EU do to halt soil erosion?

Moderator: Panos Panagos, EC JRC/EUSO

- The post-2020 CAP and soil: Mike Mackenzie, EC AGRI
- Land use changes and Carbon fluxes: Julia Pongratz, Univ. Munich, Germany
- Food security and erosion: Christine Alewell, Univ. Basel, Switzerland
- Land degradation and the importance on Soil conservation: Edoardo Costantini, International Union of Soil Science Societies
- Gap of erosion models and Development of a network to validate models: Pasquale Borrelli, Univ. of Pavia, Italy
- An example of soil erosion monitoring in Flanders: Petra Deproost, Gov. of Flanders
- Chemical innovation to support sustainable agriculture and soil health: Claudio Screpanti, Syngenta
- Carbon sequestration in agricultural soils: Elizabeth Lunik, Rabobank
- Best practices followed by farmers: Sebastian Vogler, Farmer
- Afforestation to reduce land degradation: Rigas Tsakiris, NGO Green Institute

Contributions from the floor

Questions and Discussion

Establishment of EUSO Soil Erosion Technical Working Group

Next steps & Conclusions

21.10.2021 @ 10:00-12:30 CEST

Young Soil Researchers Forum

Scope: To provide a platform and voice for young soil researchers

10:00 Plenary Session

- Welcome: Alberto Orgiazzi
- JRC Doctoral Training Programme: Panos Panagos
- Housekeeping for Breakout Rooms: Arwyn Jones

10:10 Breakout Rooms (see Annex for programme of presentations)

- Soil erosion (Moderators: Panos Panagos & Francis Matthews)
- Soil organic carbon (Moderators: Calogero Schillaci & Anna Muntwyler)
- Soil biodiversity (Moderators: Alberto Orgiazzi & Maëva Labouyrie)
- Soil monitoring & contamination (Moderators: Diana Vieira, Anne Maréchal & Julia Koeninger)

11:00 Break

11:20 Breakout Rooms (continued)

12:20 Plenary - Conclusions and way forward

Please see the Annex after this Agenda for a complete listing of the individual presentations in the Young Soil Researchers Breakout Rooms

21.10.2021 @14:00-16:30 CEST

Core EUSO Objective: Citizen Engagement - Soil Literacy (with Soil Mission)

Scope: To establish a Community of Practice on Citizen Engagement to support the implementation of the EU Soil Strategy and Soil Mission

Moderators: Arwyn Jones, EC JRC/EUSO & Arianna Pasa, EC AGRI/Soil Mission Secretariat

- Introduction and Scope: Arwyn Jones, EC JRC/EUSO
- Citizen engagement and the new EU Soil Strategy: Mirco Barbero EC ENV
- Introduction to the Citizen Engagement/Education/Communication elements in the Soil Mission: Arianna Pasa, EC AGRI
- Citizen Engagement: how to do it properly? Ângela Guimarães Pereira, EC JRC
- EU Education and youth programmes: Dalibor Mladenka& Marlene Bartes, DG EAC
- The role of soil science in raising awareness - Anna Krzywoszynska (Soil Care Network), Bridget Emmett (CEH, UK), Christine Berrill (IUSS World Soil Congress), Gabrielle Broll (ENSA/University of Osnabruck, Germany)
- Save the Landscape Forum - Soil Europe Group: Francesca Tescari & Mario Catizzone
- Experiences with local authorities: Christian Steiner (Lower Austria/ELSA), Francesco Malucelli (Regione Emilia Romagna, Italy)
- Global Soil Partnership & World Soil Day: Isabelle Verbeke, FAO
- Youth awareness: Šarlote Abatniece, Raivo Kleijsen Laas, Darina Alexandrova (European School Students); Rebecca Lardeur, Youth4Climate Ambassador
- Farmers and citizen engagement: Alfred Grand, Benedikt Bose
- Soil Biodiversity Massive Online Course: Nelson Ribeiro Jorge, EC JRC
- Soil4Life Manifesto
- Other contributions from the floor

16:30 - 17:00 CEST Summary and Close of Forum

Key outcomes from each session

Reflections: Luca Montanarella, EC JRC/EUSO

1st Young Soil Researchers Forum (YSRF) Programme

Soil Erosion

Moderators: Panos Panagos & Francis Mathews

order	Start time	Presenting Author	Title
1	*10:10*	Francis Matthews *JRC, KU Leuven*	Dynamic modelling of soil erosion and sediment delivery in Europe
2	*10:17*	Anita Bernatek-Jakiel *Jagiellonian University, Kraków*	Susceptibility of soils to piping erosion in Europe
3	*10:24*	Simon Scheper *Natural Hazards, Vienna*	Risk Assessment vs Wind Erosion Modelling
4	*10:31*	Sema Kaplan *Erciyes University*	Assessing the Performance of Wind Erosion Prediction Models (RWEQ & SWEEP)
5	*10:38*	Lena Katharina Öttl *University of Augsburg*	Tillage erosion as a driver of in-field biomass patterns and soil organic carbon dynamics
6	*10:45*	Osumgborogwu Ikenna *Durham University*	A multi-method approach to analyze changes in gully characteristics
7	*10:52*	Pinar Melis *Ministry of Agriculture and Forestry*	Upscaling cover management factor for different land use types in semi-arid agro-ecosystems
8	*11:59*	Filippo Milazzo *University of Córdoba*	The resilience of soil erosion rate under LUC and the role of the Mediterranean grassland
9	*11:06*	Tobias Koch *Agricultural Landscape (ZALF)*	Calibration of soil erosion models for permanent bioenergy crops
10	*11:13*	Konstantinos Kaffas *University of Bozen-Bolzano*	Event-based soil erosion and sediment yield modeling for modelling reservoir sedimentation in the Alps
11	*11:20*	Somil Swarnkar *Indian Institute of Technology*	Quantifying hydrogeomorphic and climatic controls on sediment dynamics in large Himalayan basins
12	*11:27*	Simoni Alexiou *Agricultural University of Athens*	Assessing soil erosion and sedimentation through high accuracy tLiDAR and UAV-Photogrammetry technique
13	*11:34*	Sophia Bahddou *Cranfield University*	Effect of random and oriented soil surface roughness on water infiltration, runoff and soil loss
14	*11:41*	Marta Basso *University of Aveiro*	A modelling approach to evaluate different post-fire management scenarios
15	*11:48*	Marcos Francos *University of Salamanca*	Forest management to reduce wildfire severity and avoid soil degradation in Mediterranean forests
16	*11:55*	Joana Parente *Universidade de Lisboa*	Assessing the impact of wildfires on long-term erosion: LAPSUS and IC
	12:02	Discussion	
	12:20	Return to main Forum	

Soil Organic Carbon

Moderators: Calogero Schillaci & Anna Muntwyler

order	Start time	Presenting Author	Title
1	*10:10*	Anne Muntwyler *JRC and ETH Zurich*	**Modelling agricultural soil P dynamics in a long-term experiment of north-eastern Italy**
2	*10:17*	Simone Zepp *German Aerospace Center (DLR)*	**Estimation of Soil Organic Carbon Contents in Croplands from SCMaP Soil Reflectance Composites**
3	*10:24*	Julia Fohrafellner *BOS Science Austria, Vienna*	**Quality assessment of meta-analyses on Soil Organic Carbon research**
4	*10:31*	Laura Sofie Harbo *Department of Agroecology, Aarhus University*	**Changes in Danish agricultural soil SOC inventory between 2008 and 2018**
5	*10:38*	Konstantinos Karyotis *Laboratory of Remote Sensing, Spectroscopy and GIS, Aristotle University of Thessaloniki*	**A crowdsourcing spiked bottom-up approach for Soil Organic Carbon mapping through multispectral imagery analysis.**
6	*10:45*	Asma Jebari *Basque Centre for Climate Change, Bizkaia*	**Regional modelling of Soil Organic Carbon changes and greenhouse gas emissions in grasslands associated to cattle dairy production in Northern Spain**
7	*10:52*	Elisa Bruni *Laboratoire des Sciences du Climat et de l'Environnement, Saclay, Gifsur-Yvette*	**Assessing the feasibility of Soil Organic Carbon stock increase in Europe with a multi-modelling**
8	*11:59*	Zsófia Adrienn Kovács *Institute for Soil Sciences, Centre for Agricultural Research, Budapest*	**Soil organic carbon content predicting based on PRISMA hyperspectral satellite imagery and synthetized LUCAS SOIL spectral data**
	11:06		**Break**
9	*11:13*	Melani Cortijos-López *Instituto Pirenaico de Ecología, Zaragoza*	**Mediterranean mid-mountain adaptation to Global Change: land management as strategy for enhancing Soil Carbon stock**
10	*11:20*	Moritz Koza *Institute of Geosciences and Geography, Martin Luther University, Halle Wittenberg*	**Natural limitations influence the effect of tillage on aggregation in dry steppe soils**
11	*11:27*	Murphy Rachael *Trinity College Dublin, Dublin and Teagasc, Wexford*	**Nitrous oxide emissions determined by eddy covariance and SC methods from a grazed grassland**
12	*11:34*	O'Neill Rosie *Trinity College Dublin, Dublin and Teagasc, Wexford*	**The effect of carbon availability on N2O emissions is moderated by soil phosphorus**

13	*11:41*	Olha Khomenko *Teagasc, Wexford and Department of Chemical Sciences, University of Limerick*	**Phosphorus availability and dynamics in soils amended with recycled dairy processing sludge**
14	*11:48*	Dawid Kupka *Department of Forest Ecology and Silviculture, Krakow*	**How does climate change affect the soil organic matter of spruce stand soils?**
15	*11:55*	Maria Nolan *University of Plymouth*	**Multi-dimensional environmental factors drive Soil Organic Matter formation across vegetation communities in a freshwater wetland**
16	*12:02*	Łukasz Musielok *Institute of Geography and Spatial Management, Jagiellonian University, Kraków*	**Linkage between land cover change and Soil Organic Carbon sequestration in mountain ecosystems**
	12:09		**Discussion**
	12:20		**Return to main Forum**

Soil biodiversity

Moderators: Alberto Orgiazzi & Maëva Labouyrie

Start time	Presenting Author	Title
10:10	Maëva Labouyrie *Zurich University, JRC*	**Soil microbial diversity and ecosystem functioning assessment across Europe**
10:20	Linnea Smith *iDiv*	**Large-scale drivers of relationships between soil microbial properties and organic carbon across Europe**
10:30	Dajana Radujković *Antwerp University*	**Consistent predictors of microbial community composition across scales in grasslands reveal low context-dependency**
10:40	Sorcha R. Kelly *Teagasc, James Hutton Institute, National Uni of Ireland Galway*	**Soil nitrogen mineralisation, microbial community, and enzymatic activity are impacted by soil type and nutrient management**
10:50	Rémy Beugnon *iDiv, Leipzig University*	**Tree diversity effects on litter decomposition are mediated by litterfall and microbial processes**
11:00	Katy J. Faulkner *University of Warwick*	**High rainfall disturbs soil microbial structure and function in a temperate forest under elevated CO2**
11:10		**10 minutes break**
11:20	Carmen Vazquez *Wageningen University*	**The evolution of biological soil quality under long term agricultural management**
11:30	*Pilar Gavín-Centol* *EEZA – CSIC*	**Feeding activity of soil detritivores in wheat fields: relationship between depth, drought and farming systems**
11:40	Victoria J Burton *Natural History Museum*	**Historical changes of land use on local soil and leaf-litter biodiversity**
11:50	Michael Steinwandter *Eurac Research*	**High alpine soil macro-invertebrates communities – First results from three elevation gradients (1500–3000 m)**
12:00	Gemma Collins *Senckenberg Biodiversity and Climate Research Center*	**Comparing soil invertebrate genomes for functional trait differences**
12:10	Romy Zeiss *Leipzig University*	**Challenges and opportunities for protecting European soil biodiversity**
12:20		**Return to main Forum**

Soil monitoring and contamination

Moderators: Diana Vieira, Anne Maréchal & Julia Koeninger

Start time	Presenting Author	Title
10:10	Julia Köninger *U. Vigo, JRC*	**Manure management and soil biodiversity: Towards more sustainable food systems in the EU**
10:18	Diego Baragaño *U. Oviedo*	**Unravelling graphene oxide effects on arsenic and metals mobility, soil microbiology and plant physiology during polluted soil (nano)remediation**
10:26	Szimona Zarzsevszkij *CZU Prague*	**Effect of soil water content on metal(loid) stabilization by amendments in a contaminated mine technosol**
10:34	Miroshnychenko Inna *USRIEP Kharkiv*	**Dynamics of self-cleaning processes in the oil-contaminated Chernozem**
10:42	Paul Drenning *Chalmers UT, COWI AB*	**Phytomanagement of Contaminated Sites**
10:50	Inés Pereira-Rodríguez *U. León*	**Mining waste distribution in torrential wadis: analysis with sentinel-2 of Cartagena mining district**
10:58	Leonidas Liakos *JRC*	**Challenges in geo-processing of Large scale Soil datasets. A geographer's perspective.**
11:06		**Break**
11:15	Antonio Rodríguez Hernández *INIA-CISA/CSIC*	**Targeted monitoring of veterinary pharmaceuticals in the environment based on soil vulnerability to antibiotic contamination**
11:23	*Chris Feeney* *UKCEH, ECW*	**Ensemble soil map assessment highlights challenges for predicting topsoil organic carbon concentration at national scale.**
11:31	Olivia Azevedo *U. Stirling*	**Historical effects on aggregate stability and SOC storage during forest succession**
11:39	Florian Lauryssena *KU Leuven*	**Survey in old forests sediments to infer phosphorus reference conditions in Flanders**
11:47	Yakun Zhang *U. Wisconsin-Madison*	**Spectra-informed soil profile characterization and soil classification**
11:55	Giulio Genova *Free U. Bolzano*	**Land-use history and trace metal concentration to assess the impact of agricultural management on soil**
12:03	Daniel L. Evans *Cranfield U.*	**Sustainability rooted in soil science**
12:13		**Discussion**
12:20		**Return to main Forum**

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