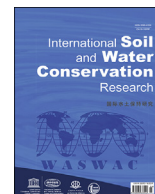




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## Original Research Article

## Soil conservation and sustainable development goals (SDGs) achievement in Europe and central Asia: Which role for the European soil partnership?



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## ABSTRACT

Voluntary soil protection measures are not sufficient to achieve sustainable soil management at a global scale. Additionally, binding soil protection legislation at national and international levels has also proved to be insufficient for the effective protection of this almost non-renewable natural resource. The European Soil Partnership (ESP) and its sub-regional partnerships (Eurasian Sub-Regional Soil Partnership, Alpine Soil Partnership) were established in the context of FAO's Global Soil Partnership (GSP) with the mission to facilitate and contribute to the exchange of knowledge and technologies related to soils, to develop dialogue and to raise awareness for the need to establish a binding global agreement for sustainable soil management. The ESP has taken a role of an umbrella network covering countries in Europe and Central Asia. It aims to improve the dialogue in the whole region and has encouraged establishing goals that would promote sustainable soil management, taking into account various national and local approaches and priorities, as well as cultural specificities. The ESP first regional implementation plan for the 2017–2020 period was adopted and implemented along the five GSP pillars of action. Building on the experience of the last four years, this study demonstrates that establishing sub-regional and national partnerships is an additional step in a concrete sustainable soil management implementation process. It also suggests that a complementary approach between legal instruments and voluntary initiatives linked to the development of efficient communication and strong commitment is the key to success.

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## 1. Introduction

The history of humankind has always been linked to the use of natural resources, they are currently linked and continue to be in the future. The successes or rise and failures of civilisations depend

on people's awareness of how to sustainably manage natural resources such as air, water, and soil (Montgomery, 2012), and ultimately, how to avoid their loss or degradation. Like water and air, soils need to be protected against degradation from indiscriminate human activities. Chemical pollution is one of the most notable threats affecting the three natural resources through direct or indirect inputs. However, contrary to the use of air and water, the use of soil (as a source of food, fibre, and fodder) since the inception of agriculture, inevitably entails a transformation of its basic

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properties and functioning and can lead to its intrinsic degradation. Hence, soil conservation involves both, protection against threats and sustainable management of multifunctional soils.

The complex nature of soils, that is, their high number of components and the interactions and feedbacks between these components (Havlicek & Mitchell, 2014) requires also a complex and a multidisciplinary sustainable soil management approach. Land use in general depends on soil properties and their potential functions (e.g. food or fibre production, water purification or climate regulation, and habitat); however, land use modifies soil properties and, therefore, affect provision of soil ecosystem services (Fig. 1).

The multiple and often unsustainable use of soils can lead to specific soil degradation, such as erosion, compaction, contamination, decline in soil organic matter, loss of soil biodiversity and others, which have been identified at national, regional, and global levels since the beginning of the Anthropocene. The matter has gained attention in the global environmental and development agenda, and many articles concerning soils were published in recent times stressing the importance of soil as a vital natural resource that performs many functions and provides ecosystem services (Drobnik et al., 2018). The capacity of soil for food production and the potential of climate change mitigation attract particular attention in the context of current environmental problems (Vermeulen et al., 2019).

In today's world, the sustainable use of soil depends not only on the management preferences and capabilities of local users—such as farmers, foresters, and land-use planners—but also on the development and implementation of widely adopted environment protection and climate mitigation policies at global or regional levels (Davies, 2017; Juerges & Hansjürgens, 2018; Montanarella, 2015). However, an approach and a legal framework based on the protection against soil threats alone are not sufficient to maintain multiple soil functions. Soil degradation with its associated social, economic and environmental impacts, costs, and problems require long-term regional and global funding, resource mobilisation, and expertise far beyond the solutions that are available to local users.

In response to the need of a global approach, the FAO established the Global Soil Partnership (GSP) in 2012 to develop synergies among national and international organisations for global action to stimulate a sustainable use of soil resources. The mission of the GSP is to “develop awareness and contribute to the development of capacities, build on best available science, and facilitate/contribute to the exchange of knowledge and technologies among stakeholders for the sustainable management and use of soil

resources”. The GSP encompasses nine regional soil partnerships (RSPs), covering the entire globe. The fundamental principle of the GSP and its RSPs is a country-driven, bottom-up approach. In this regard, regional partnerships play an important role to develop and steer dialogue between RSP's member countries. In Europe and Central Asia, this is performed by the European Soil Partnership (ESP), which was established in 2013. Given the vast geographic extent of the ESP, covering all Europe and Eurasia, the Eurasian Soil Partnership (EASP) was established in 2013 to account for sub-regional specificities and issues. The ESP, covering 40 member countries in Europe and Eurasia (Fig. 2), has identified the soil protection and sustainable soil management priorities with considering the major Europe-relevant soil threats, whereas the EASP has elaborated specific priorities for Eurasia.

The current study outlines the ESP and the EASP actions during the 2017–2020 period. Its objective is to present activities performed during the first implementation plan and to outline the challenges that had to be met. Moreover, further global reflections on the aspects of the concrete implementation of soil protection and management will be addressed.

## 2. Prioritised main UN SDG challenges and solutions at the European/Eurasian level

Maintenance and restoration of healthy soils along with its proper functioning is an underlying principle of several targets of the Sustainable Development Goals (SDGs). Since its inception, the GSP has been successfully raising awareness about soil at the global level, specifically on the UN SDGs and the 2030 Agenda. Soil, a cross-cutting theme, is not the subject of a specific multilateral environmental agreement (MEA), while it remains a relevant aspect in relation to climate change (UNFCCC), biodiversity (CBD) and desertification (UNCCD). However, many SDGs refer to targets that directly consider soil resources. For instance, poverty (SDG 1), food security (SDG 2), food safety (SDG 3), clean water (SDG 6), urban development (SDG 11), consumption and production pattern (SDG 12), climate regulation (SDG 13), land-based nutrient pollution of the seas (SDG 14), terrestrial ecosystem service sustainability (SDG 15), and partnership building for the Goals (SDG 17) all are dependent directly or indirectly, on the provision of ecosystem services where soils play a key role (<https://sustainablesoils.org/soil-and-the-sdgs>; Keesstra et al., 2016; Bouma et al., 2019) (Fig. 3).

Achieving soil-related SDGs in Europe and Central Asia requires an improved sharing of data and knowledge, incentives for research and monitoring, the analysis and design of adequate sustainable soil management options, and political and financial support. Regional implementation plans are the main tool for defining joint targets and priority actions; therefore, priorities and needs should be accurately defined and agreed on by the RSP's member countries. The implementation plans are organised along the GSP action framework, which is based on five pillars (Global Soil Partnership | Food and Agriculture Organization of the United Nations (fao.org)) (Fig. 4).

The main soil threats in Europe and Central Asia have been identified as soil sealing, salinization, and contamination (FAO, 2017 and FAO and ITPS, 2015). Additional threats include soil organic carbon changes, nutrient imbalance, soil compaction, soil erosion by wind and water, soil biodiversity loss, desertification, and landslides. Additionally, the EASP has recognised soil salinity as a main regional threat.

## 3. ESP and EASP policies and the 2017–2020 implementation plan

The 2017–2020 implementation plans of the ESP and the EASP have been developed according to regional soil threats and

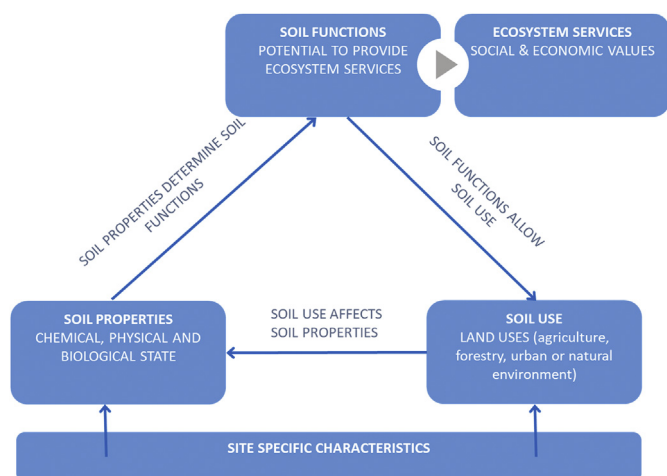


Fig. 1. Interrelations between soil properties, soil functions and soil use (adapted from FOEN, 2020).



**European Soil Partnership (ESP) Members:** Albania, Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Israel, Italy, Latvia, Montenegro, Netherlands, North Macedonia, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Kingdom, Turkey, European Commission

**Eurasian Sub-Regional Soil Partnership (EASP) Members:** Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russian Federation, Tajikistan, Turkmenistan, Ukraine and Uzbekistan

Fig. 2. Geographic extent of regional soil partnerships in Europe and Central Asia.

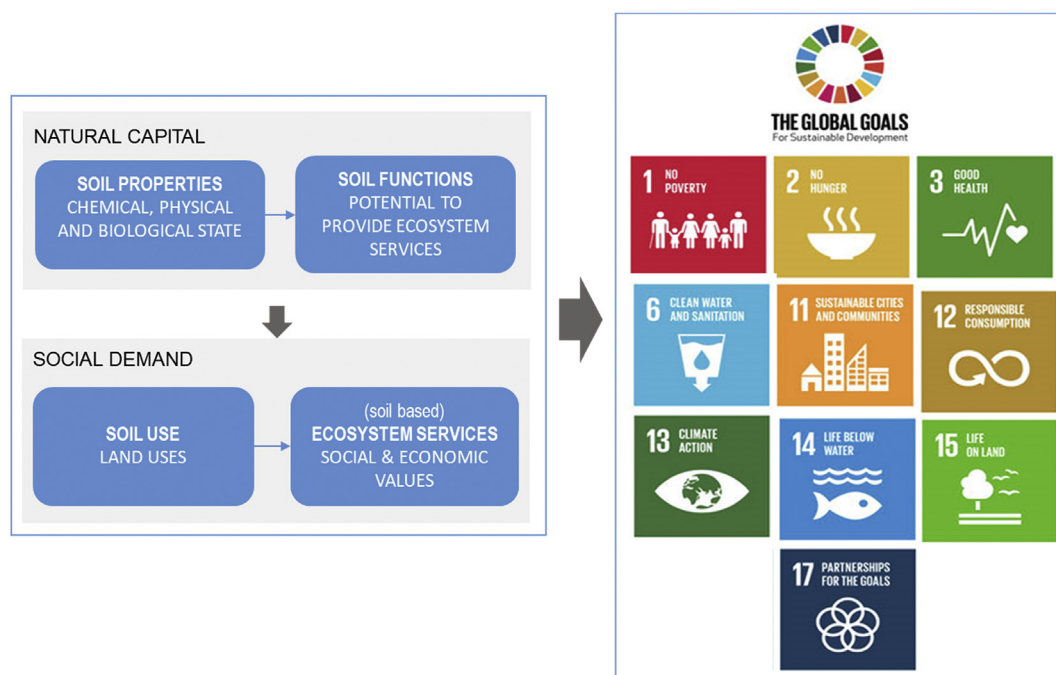


Fig. 3. Soils and cross-cutting themes.

considering their contribution to the achievement of the SDGs. They also prioritise an understanding of cross-border soil-related and land-based demands referring to soils by implementing SDGs 1, 2, 3, 6, 11, 12, 13, 14, 15, and 17 (FAO, 2017). In the

following sub-chapters, the planned activities with their contribution to the SDGs will be described for each ESP pillar, and the key actors and the main challenges and opportunities will be outlined.



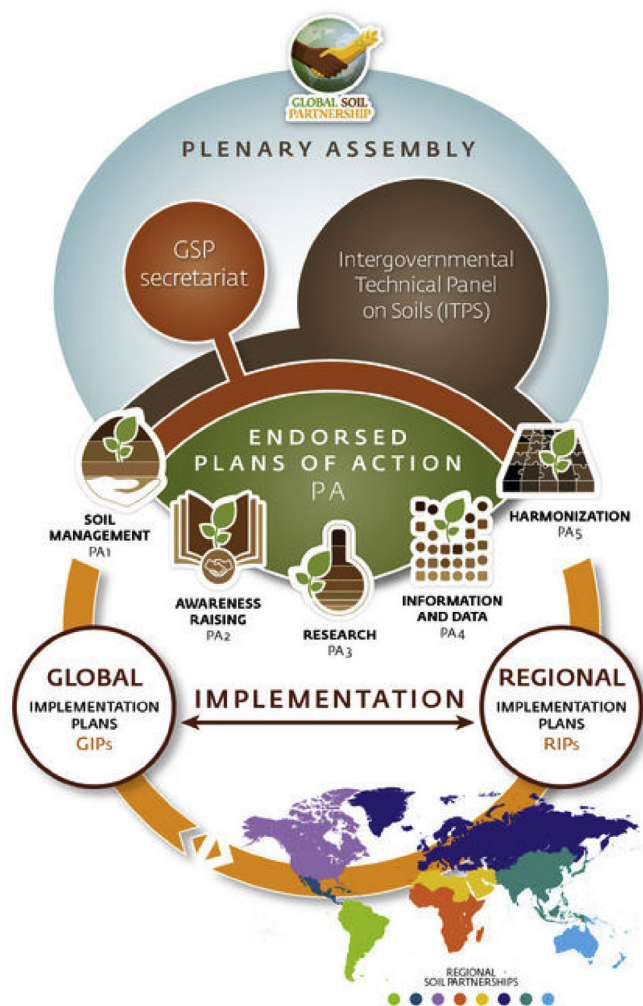


Fig. 4. The Global Soil Partnership action framework.

### 3.1. Promote sustainable management of soil resources for soil protection, conservation, and sustainable productivity (Pillar 1)

The European region is characterised by a large number and variety of institutions and organisations, and numerous regional-wide projects<sup>1</sup> whose objective is to study and implement sustainable soil management. Consequently, the main activities for Pillar 1 (Table 1) were set out to identify the key projects, institutions, and stakeholders and to bring together existing networks. The development of concrete solutions to soil-related problems, such as soil salinity in Central Asia, is essential to achieve land degradation neutrality (SDG 15.3).

The challenges associated with SSM implementation must be

<sup>1</sup> Examples of such projects are:- EJP Soil – a large H2020 programme that embeds internal projects related to main topics (e.g. carbon sequestration, erosion, soil ecosystem services, etc.); <https://projects.europa.eu/ejpsoil/>; iSQAPER (Interactive Soil Quality assessment in Europe and China for Agricultural productivity and Environmental Resilience; <http://www.isqaper-project.eu/>); SOILCARE (Soil Care for profitable and sustainable crop production in Europe, <https://www.soilcare-project.eu/>); LANDMARK (Land Management Assessment Research Knowledge Base; <http://landmark2020.eu/>); CACILM-II (Central Asian Countries Initiative for Land Management; <http://www.cacilm.org/>); SPRINT (Sustainable Plant Protection Transition: A Global Health Approach; <https://sprint-h2020.eu/>); MINAGRIS (Micro- and Nano-Plastics in Agricultural Soils: sources, environmental fate and impacts on ecosystem services and overall sustainability).

assessed including economic, technical, social-political, investment and partnership challenges. The ESP and EASP bring together partners and existing initiatives to improve global and regional solutions and practices towards improving and increase SSM for soil protection, conservation, and sustainable productivity (FAO, 2017).

The EASP has carried out activities in the context of awareness raising and dialogue for an integrative system approach and SSM technologies. Regarding this, several flagship reports have been published to support decision-making and policy development (EFCS 2018; FAO, 2016). In addition, guidance for the management of salty lands was published, which contributes to resolving the main threat in the region (FAO & ECFS, 2018). Most notably, between 2019 and 2020, 10 small projects on salinity mitigation and adaptation and 4 projects on soil organic carbon management were granted by the GSP Secretariat to the research groups in Armenia, Belarus, Moldova, Ukraine and Uzbekistan. A major part of the financial support for the EASP activities was provided in the frame of grant funded by the Russian Federation to the GSP Secretariat.

During the implementation period, having a guidance document such as the Voluntary Guidelines on Sustainable Soil Management (FAO, 2017), adopted by GSP member countries, was an important achievement but at the same time, the lack of policies to translate it into the action was challenging. Even if the EU Soil Thematic Strategy and EU Common Agricultural Policy are addressing soils in the 27 EU member countries, there is the need to develop a coherent sustainable soil management approach for the entire European region. A major role can be played in this sense by the European Environment Agency (EEA), that includes in its membership most of the countries in the region (EC, 2020; 2020a).

### 3.2. Encourage investment, technical cooperation, policy, education awareness, and extension in soils (Pillar 2)

Many of the actions under the other pillars addressed the general lack of societal awareness about the importance of soil in people's lives and for the well-being of the planet. In many cases, education deficiency in education of the environmental, societal and economic importance of soil is one of the underlying causes of unsustainable soil management practices, of the general lack of investment (both in education and in technical measures to protect soil), and of the widespread political reluctance to adopt short- and long-term measures to preserve and enhance soil conditions. Therefore, Pillar 2 activities of the ESP (Table 2) aimed to express the importance of soil to achieve SDGs 2, 11, 13 and 15. The promotion of outreach materials on best soil management practices, improving the dialogue between the scientific community, stakeholders, policy makers and the soil end users, and conducting integrated research programs were the main regional actions to enhance international support for implementing effective and targeted capacity-building for sustainable development (see Table 3).

A specific action has also been taken to increase soil awareness and research at the EU level. Such action concerns a request to revise and to update the panels of the European Research Council (ERC) whose mission is “to encourage the highest quality research in Europe through competitive funding and to support investigator-driven frontier research across all fields, on the basis of scientific excellence”. However, the topic “soil science”, does not appear with the importance that it deserves, and that has been acknowledged at a global level. Starting from this consideration, the ESP together with the European Society for Soil Conservation (ESSC) and the European Confederation of Soil Science Societies (ECSSS) prepared and signed a “petition” (also signed by the President of all the soil science societies of Europe) that has been sent to the ERC President.

**Table 1**

The ESP Pillar 1 2017–2020 implementation plan to promote sustainable management of soil resource in the Europe and Central Asia region.

Main activities	Partners/Key Stakeholders	Links with SDGs
Promoting an overview on the European soil threats and existing sustainable soil management (SSM) practices and stakeholder networks	In partnership with existing SSM-related projects and networks, and/or engaging farmer associations; ESP national focal points provide contacts to national projects	SDG 1.4 - equal access to ownership and control over land and other forms of property SDG 3.9 - substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water, and soil pollution and contamination
Improve the multi-disciplinary dialogue	In partnership with existing networks from projects such as iSQAPER, Soil Care, Landmark, and CACILM-II	SDG 14.1 - prevent and significantly reduce marine pollution of all kinds, from land-based activities
Support the mitigation and adaptation to soil pollution in Europe	EC-Joint Research Centre (JRC) on behalf of ESP secretariat, national focal points, national research organisations	SDG 15.3 - combat desertification, restoration of degraded land and soil
Support the mitigation and adaptation to soil salinity in Eurasia	Eurasian Center for Food Security (ECFS) on behalf of EASP secretariat, national focal points, national research organisations	SDG 17.16 - enhance the global partnership for sustainable development
Facilitate the development of a capacity-building strategy amongst stakeholders	EC- JRC on behalf of ESP secretariat, ECFS on behalf of EASP secretariat and FAO GSP, ESP and EASP national focal points	
Report on the barriers preventing SSM implementation	provide information from national projects and extension services and farmer associations	

**Table 2**

ESP 2017–2020 implementation plan for Pillar 2.

Main activities	Partners/Key Stakeholders	Links with SDGs
Promote key messages to inform politicians and decision makers on the importance of soil	EC- JRC on behalf of ESP secretariat, ECFS on behalf of EASP secretariat and FAO GSP, ESP national focal points	SDG 2.4 - sustainable food production systems and resilient agricultural practices
Promote educational resources (multilingual), public outreach material and events, the definition of best practices, engagement with other scientific disciplines	Regional Soil Science Communities, NGOs	SDG 11.3 - inclusive and sustainable urbanisation
Establish an inclusive dialogue to address soil fertility management at the European level	European Commission and all other partners	SDG 13.1 - strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries
Conduct research calls (targeting of EU and national funding programme)		SDG 15.1 - conservation, restoration and sustainable use of terrestrial ecosystems and their services
Improving engagement between the soil science community and agricultural extension services to enhance the soil component in sustainable land use advisory activities	EC- JRC on behalf of ESP secretariat, ECFS on behalf of EASP secretariat and FAO GSP, ESP national focal points	SDG 15.2 - sustainable forest management, halt deforestation, restore degraded forests
For Central Asia, the establishment of a consultation service on soil management, for knowledge sharing and transfer	ECFS on behalf of EASP secretariat, with other possible partners such as the International Centre for Agricultural Research in the Dry Areas (ICARDA), and the International Centre for Biosaline Agriculture (ICBA)	SDG 17.9 - enhance international support for implementing effective and targeted capacity-building

**Table 3**

ESP Pillar 3 implementation plan 2017–2020 to improve regional soil research area.

Main activities	Partners/Key Stakeholders	Links with SDGs
Initiate a web-based platform for a structured inventory of soil research, and metadata on available soil information	EC- JRC on behalf of ESP secretariat, and FAO GSP, ESP national focal points, ESP Working Group members (or other voluntary contributors) of ESP and EASP	SDG 17.6 - enhance international cooperation and access to science, technology and innovation, and enhance knowledge sharing
Evaluate the impact/cost–benefit of soil research, stressing the cross-cutting role of soils in grand environmental and societal challenges		SDG 17.7 - promote the development, transfer, dissemination of environmentally sound technologies
Review the needs of inter- and transdisciplinary research for coherent action		SDG 17.14 - enhance policy coherence for sustainable development

The petition requested that the ERC establish a unique and specific ERC panel devoted to the field of “Soil Science” under the Life Sciences domain. A “Soil Science” panel will allow raising soil awareness and for a direct route to early-career soil scientists to apply for ERC grants.

During the first implementation period, the Eurasian Soil Portal was launched, and the EASP secretariat established cooperation on soil, with organisations such as the Dokuchaev Central Soil Museum, St. Petersburg (Russia). Additionally, a Pillar 2 workshop, “Giving soils more voice” was co-organised by the EC-JRC and the European Network of Soil Awareness (ENSA), supported by the European Land and Soil Alliance (ELSA). Although many well-developed local initiatives have been acknowledged, efforts to

reach a wide audience and to make a societal impact remain a major challenge. In the EU, the communication aspects of the forthcoming Soil Health Mission of the new Horizon Europe research programme (2021–2027) has a high potential to provide opportunities to facilitate such outreach.

### 3.3. Promote targeted soil research and development focusing on identified gaps and priorities and synergies with related productive, environmental, and social development actions (Pillar 3)

Pillar 3 activities focus on needed improvement of soil knowledge, effective sharing of research results, evaluating their impact with cost-benefit analysis, and reviewing the needs of linkages

with cross-cutting issues, to ensure the access to science (SDGs 17.6), the development and transfer of environmentally sound technologies (SDG 17.7), and to enhance policy coherence for sustainable development (SDG 17.14).

In Europe, many research and innovation projects have been funded under the EU Seventh Framework Programme for Research and Innovation (2007–2013) and the EU's funding instrument for the environment and climate action (LIFE programme) to address soil issues and to improve the knowledge base for action. LIFE has funded 147 soil-related projects covering different aspects of soil protection (soil sealing, soil biodiversity, soil carbon sequestration, soil monitoring, water and soil, sustainable agriculture and forestry, and land contamination). This effort continues under Horizon 2020 and LIFE+. The European Innovation Partnership (EIP) on agriculture also plays a role.

At the EU level, the INSPIRATION project released the bottom-up demand-driven research need, including 14 integrated and 19 thematic areas. Additionally, the ESP became a member of the advisory board of the European Joint Program on Soil (EJP SOIL), which was established to identify soil research needs and propose research activities on priority topics for Europe. Recently, the Sino-EU Soil Observatory for Intelligent Land Use Management (SIEU-SOIL) consortium has been established to promote a research platform consisting of advanced crop and soil sensing tools, modelling and data fusion, digital soil mapping, and farm management information systems that will be developed to maximise land productivity and socio-economic benefits while minimising the environmental impacts.

In the EASP, the FAO and ECFS initiated a small grant facility for soil research projects to support targeted research and partnerships between scientists and local/national beneficiaries that would form a stable basis for long-term collaborative engagement to scale up the implementation of SSM practices to adapt or mitigate soil salinity and climate change.

Combining basic and applied research is pivotal in generating knowledge on adaptation of existing/traditional and integration of new, more environmental friendly soil management practices to adequately support SDGs. In soil research, the future development of the ESP would depend on the format of interaction with the new regional initiatives on soil research and knowledge exchange, which can support to the ambition of the EU Green Deal in relation to soil (Montanarella & Panagos, 2021) in the region.

#### 3.4. Enhance the quantity, quality, and availability of soil data and information: data collection (generation), analysis, validation, modelling, reporting, monitoring and integration with other disciplines (Pillar 4)

In Europe, the building of information systems has a long history in terms of data exchange and networking. There are many soil data available, however gaps still exist and currently available data do not satisfy increasing user requirements (e.g. soil monitoring for agricultural, soil contamination, or soil biodiversity monitoring purposes). Current assessments of the status of the European soil resources are mainly based on rough estimates using largely nowadays considered legacy soil data that were compiled almost twenty years ago and cross-border harmonised to produce the Soil Geographical Database (SGDB) of Europe 1:1,000,000 (SGDB) in 2004, later published in the Soil Atlas of Europe in 2005. Yet, the relatively rough 1:1M scale of the SGDB and the needs on information of key soil properties calls for a spatial (resolution) and content improvement of uniform soil information at the European level.

The current situation in the Eurasian region is characterised by disaggregated, coarse and missing soil data. Even when soil data

exist, they are often not shared or have limited availability. In this regard, there is need to develop a joint action and the ECFS as Secretariat of EASP can facilitate the dialogue among countries for establishing a regional soil information system.

At the same time, data demands are high in the context of climate change (e.g. greenhouse gas inventories), SDGs, soil monitoring and soil research on soil pollution, and lack of data hinders advances in policy development and implementation, as well as research and innovation.

In the implementation plan, the investments in soil data collection were prioritised, and the activities were planned (Table 4) to support the establishment of regional soil information systems. Within this scope, ESP and EASP member countries agreed to prioritise the soil data collection investments to assess and monitor soil health in terms of soil quality (soil organic carbon, soil productivity, biodiversity, etc.), degradation (pollution, erosion, salinization, etc.), and ex-post/ex-ante impact assessment of human activities such as deforestation, restoration, and conservation. The SIS would allow the development of coherent policies and monitoring of policy implementations related to SDGs 3, 14, and 15.

In this direction, the ESP and EASP activities focus on contributing to the mapping exercise of the Global Soil Organic Carbon Map (GSOCmap), Global Soil Salinity Map (GSSmap), and planned Global Soil Erosion Map (GSEmap) as part of the development of the regional and global soil information system (GLOSIS). Globally, the International Soil Reference and Information Centre (ISRIC) in the Netherlands has taken role as a soil information facility centre and the EC-JRC facilitates the dialogue among EU member countries to establish a regional soil information system.

In Eurasia, national soil data centres have been established in Russia, Moldova, Belarus and Azerbaijan. The ECFS as an EASP secretariat provided support for establishing the Eurasian Soil Information System (EASIS) and for capacity-building at the regional level.

During this exercise, the ESP and EASP both experienced that developing a regional soil information system is challenging due to the need for a country-specific approach to map regional results in artefacts across geo-political borders, diversity of soil analytical methods and classification systems, and a lack of publicly available country-specific data that ultimately influence the assessment of country-specific situations. Therefore, ESP and EASP facilitated data sharing, model validation, and calibration experiments between countries.

#### 3.5. Harmonisation of methods, measurements and indicators for the sustainable management and protection of soil resources (Pillar 5)

The main objective of the ESP's Pillar 5 was to develop an overarching mechanism for globally consistent and comparable harmonised soil monitoring for soil-related policies. The ESP implementation plan contained activities (Table 5) that contribute the Global Soil Laboratory Network (GLOSOLAN), the Universal Soil Classification and to the creation of global soil information exchange standards, to be called SoilML, that would allow access and use of data across a broad range of international initiatives (such as GEOSS and INSPIRE).

To support a European soil monitoring system, the EIONET-NRC Soil has initiated a task force to share details about national soil monitoring and associated information, and suggestions how this can be used to improve the current heterogeneous landscape in Europe for soil indicators, methods, and interpretation.

Moreover, the Regional Soil Laboratory Network for Eurasia and Europe (EUROSOLAN) was established in October 2019. Currently, 117 soil laboratories from Europe and Central Asia are registered.

**Table 4**

ESP Pillar 4 implementation plan to enhance quantity, quality, and availability of soil data and information between 2017 and 2020.

Main activities	Partners/Key Stakeholders	Links with SDGs
Joint technical meeting of European members of The International Network of Soil Information Institutions (INSII) and other soil information institutions to discuss ESP tasks related to soil information	ESP members of INSII, national soil research centres, European Soil Data Centre (ESDAC), EEA's European Topic Centre (ETC) on Urban/Land/Soil systems, European Soil Bureau Network (ESBN),	SDG 15.1 - conservation, restoration and sustainable use of terrestrial ecosystems and their services
Establish the Eurasian Soil information system and integrate with unified methodology and software (SOTER-type); specify data needs and identify gaps at different scales are assessed	EC- JRC on behalf of ESP secretariat, ECFS on behalf of EASP secretariat and FAO GSP, ESP national focal points	SDG 15.2 - sustainable forest management, halt deforestation, restore degraded forests and substantially increase afforestation and reforestation
Mobilise resources to implement new soil data collection and mapping and ensure comparable/harmonise soil data		
The global Pillar-4 Working Group data specifications: review and expansion to European conditions (e.g., representatively);	ESP members of International Network of Soil Information Institutions and ESP + EASP Pillar 4 Working Group Members	SDG 3.9 - substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination
Conduct a design study (integrating national and Europe-wide approaches—JRC, EUROSTAT) to establish a soil monitoring system		

The EUROSOLAN aims to strengthen the performance of laboratories using standardised methods/protocols and harmonising soil analysis results so that soil information would be comparable and interpretable across laboratories, countries, and regions. In this regard, the first EUROSOLAN meetings concluded that improvements in the following areas are required in the future: 1) the unification process of national and international measurement methodologies; 2) investments in new equipment; 3) investment in human and financial resources; 4) getting funding; 5) high engagement of staff in research projects and teaching; 6) sufficient coverage of lab services by national projects; and 7) inclusion of methods (e.g. organic contaminants).

#### 4. First ESP implementation plan 2017–2020: achievements, limitations and lessons

The period for the first implementation plan ended in 2020. During the last four years, the ESP partners together with the ESP Steering Committee and the 5 established Pillar Working Groups, held regular meetings and working sessions to improve dialogue on soil-related policies across the region. To what extent do they effectively contribute to the achievement of the ESP's objectives and to the promotion of SSM at global, regional, and national levels?

**Table 5**

The implementation plan to provide the opportunity on the harmonisation of the use of existing national/regional standards on the intergovernmental level.

Main activities	Partners/Key Stakeholders	Links with SDGs
Revision of the European soil mapping guidelines	ESP representation of International Network of Soil Information Institutions (INSII), ESP representation of	SDG 15.1 - conservation, restoration and sustainable use of terrestrial ecosystems and their services
Support the development of a global soil profile description standard	European Soil Laboratory Network (EUROSOLAN), National Research Centres, European Topic Centre on Urban, Land and Soil Systems, (ETC-ULS), European Soil Data Centre (ESDAC),	SDG 15.2 - sustainable forest management, halt deforestation, restore degraded forests, and substantially increase afforestation and reforestation
Support to the development of a universal soil classification system	ESP + EASP Pillar 5 Working Group, European Soil Bureau Network (ESBN),	
Interaction with global activities for developing best practice recommendations and procedures for soil sampling, storage, and soil laboratory analytics		SDG 14.1 - prevent and significantly reduce marine pollution of all kinds, from land-use based activities.
Analyse the implementation status for interoperable soil data according to INSPIRE, and the degree of soil data and data processing harmonisation		SDG 3.9 - substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution, and contamination
Establish an ESP-wide network of soil laboratories building on existing initiatives	EC- JRC, on behalf of ESP secretariat, (ECFS) on behalf of the EASP secretariat and FAO GSP, ESP and EASP national focal points	
Develop a soil indicator concept about the state and response of soils expressing the effect of (soil) policies, management, and climate change	Pillar 5 Working Group	
Development and approval of new standards for saline and sodic soils for Central Asia	ECFS on behalf of the EASP secretariat and FAO GSP, ESP national focal points, Working Group Members	

#### 4.1. Facilitation of cooperation between the global, regional, and local level

The ESP National Focal Points and the ESP secretariat participated in all surveys launched by the GSP secretariat (Global Assessment of Soil Pollution report, Protocol for the Assessment of SSM, Assessment of the Global Status of Soil Biodiversity, SoilLEX platform). The ESP secretariat functioned as a channel for the transmission of information and the continuous efforts of the GSP secretariat to support the RSPs allowed for enhanced cooperation. Therefore, one of the core tasks of the regional partnership - to bring the region-specific aspect to the implementation of global actions - has been achieved.

During this first period, several bottom-up initiatives have led to the establishment of national or sub-regional partnerships. Several countries have set up national soil partnerships (e.g. Italy, Latvia, Portugal, Slovenia) that enable the transfer of the pillar tasks and activities from the global/regional to the national level. In the framework of the Interreg Alpine Space project Links4Soils, a sub-regional initiative led to the establishment of the Alpine sub-regional Soil Partnership (AlpSP) that considers the soil-related priorities and specificities of the Alpine Region. This is a region featuring specific ecological, economic and social conditions and is facing specific threats, such as soil sealing, erosion, landslides or permafrost thawing. The AlpSP efforts to address the soil resource

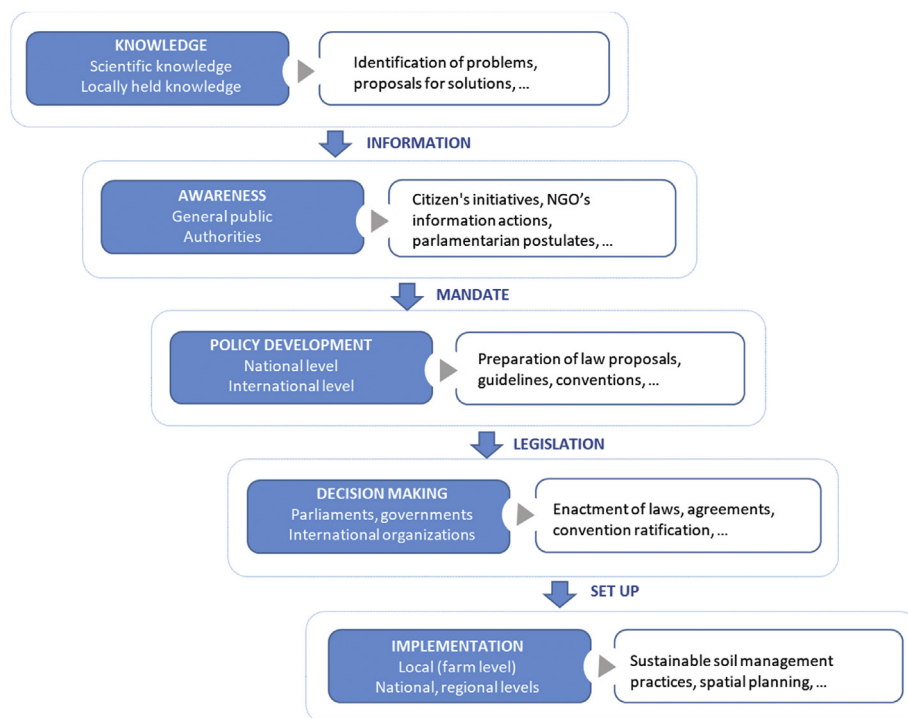


Fig. 5. Adoption of SSM practices: from problem and/or solution identification to the implementation, a multilevel process.

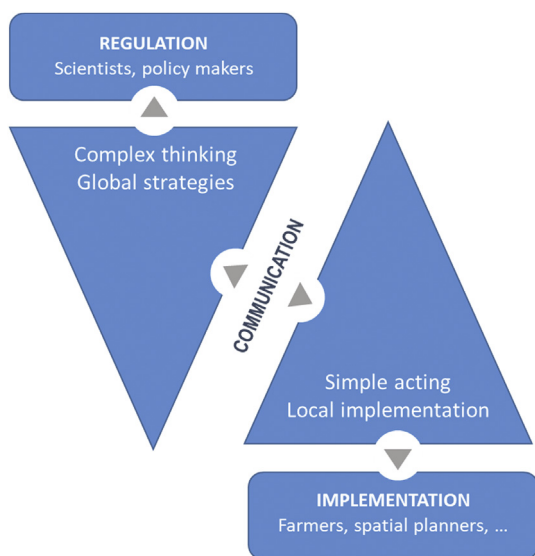


Fig. 6. Soils are complex systems and their comprehension requires complex thinking, however implementation of soil protection policy must be based on understandable and simple tools.

in line with the ESP implementation plan are a transnational contribution to fostering the implementation of the Alpine Convention's Soil Conservation Protocol (a binding international treaty ratified by virtually all parliaments of the Alpine countries) through the review of existing regional and national soil data, transferring knowledge and best management practices to local level policy-makers, decision makers, and other stakeholders in national languages.

Given that Europe encompasses a large array of ecological conditions, as well as many countries or regions with various local

approaches and cultural specificities, national partnerships and sub-regional partnerships, such as the EASP, the Alpine Soil Partnership and the newly emerging Pyrenean Soil Partnership are essential and valuable initiatives linking local initiatives and activities to a larger/global – the GSP scale.

#### 4.2. Exchange of data, knowledge, and technologies

Developing awareness and contributing to the development of capacities is a major part of the ESP mandate. During the last four years, the ESP succeeded in raising awareness on soil to support the prioritisation of sustainable soil management in various policies, as the European Commission presented in an ambitious package of measures within the Biodiversity Strategy 2030, the Farm to Fork and the European Climate Law. For instance, the Farm to Fork strategy addresses soil pollution with a 50% reduction in the use of chemical pesticides by 2030 and aims at a 20% reduction in fertiliser use plus a decrease in nutrient losses by at least 50%.

The necessity to set up an effective monitoring, reporting, and verification (MRV) system for soil in Europe and Central Asia is not a matter of doubt. A harmonised monitoring for evaluating the progress made in reversing the current negative trend is needed to support and adapt soil policies. Europe has an extensive history of harmonisation activities, mainly due to activities by the JRC and the EEA in cooperation with Europe-wide experts, groups, and networks (e.g. the European Soil Bureau Network, EIONET National reference Centre for Soil). However, given the challenges ahead and the stagnation of data harmonisation since the late 1990s, data harmonisation is a difficult and challenging area that still needs to be addressed. The newly launched EU Soil Observatory (EUSO) provides a great opportunity to streamline soil monitoring and indicator development harmonised into a single coherent system for monitoring, reporting, and verifying of policy-relevant soil data and indicators. In the new implementation period, the ESP should be in close collaboration with EUSO to develop a European soil information system.



In EASP, soil information systems are poorly harmonised, and there is a need for the integration of universal harmonised approaches rather than the development of regional systems. Currently, automated data exchange is a main challenge, and it is needed as a core element of the GLOSIS, while in Europe, detailed specifications for such data exchange exist (INSPIRE Directive). It is of high interest that global developments are consistent with the existing European experience. The EEA and EC-JRC are interested to conduct a study comparing the GLOSIS data exchange language with EU INSPIRE Directive data specifications for soil. The objective is to clarify the interoperability between data sets exchanged by INSPIRE and GLOSIS. Accordingly, in the new ESP implementation period, the activities related to soil data exchange should be conducted in connection with Pillar 3 (Research), and more importantly, successful implementation requires tight coordination or even combination with Pillar 4 (Soil information). Ultimately, the question of standardisation of methods and harmonisation of data, as defined in the Pillars 4 and 5, extends well beyond the regional dimension and should be spearheaded and coordinated at the global level. Conversely, awareness raising should be initiated at the local level as awareness depends on a person's intimate connection with his/her environment and personal experience with the "soil" (Michailova & Hutchings, 2006). That is why messages addressed to urban residents or farmers require a different approach, focus and emphasis and, more importantly, should be co-designed with practitioners and communication experts (Bouma, 2019). In this sense, the ESP in general, the ENSA in particular and the GSP play a role as a formal or informal platform to facilitate the exchange of awareness raising experiences and compelling messages (e.g. World Soil Day website World Soil Day | Food and Agriculture Organization of the United Nations (fao.org)).

#### 4.3. Communication, regulations, and implementation

The experience acquired during the first period of ESP's activities between 2017 and 2020 has highlighted that the adoption of concrete SSM practices is based on a process involving different steps and numerous stakeholders (Fig. 5).

The transfer of appropriate and comprehensible information between different levels and stakeholders constitutes a major challenge and a critical phase. Each stakeholder, whether farmer, citizen, scientist, policymaker, or parliamentarian, has its own language and its own understanding of the problem, priorities and needs. Therefore, promoting and supporting sustainable soil management at the heart of the GSP and ESP activities requires a solid soil literacy and "translation" skills. The VGSSM can be successfully implemented in Europe and Central Asia if end-users participate in the identification, dissemination, and implementation of best practices, and if evidence of economic and social benefits from SSM are adequately presented to the decision makers (politicians). Two levels are particularly relevant for the effective and concrete implementation of soil management measures: the end-users from different sectors (farmers, spatial/urban planners, environmentalists, etc.) and the regulators (policymakers, local and regional level decision makers) (Fig. 6). The former need social and economic conditions that allow for informed decisions and simple concrete actions; the latter require sufficient knowledge and information to adopt a transdisciplinary approach and a holistic view (Havlicek, 2012; Rodrigo-Comino et al., 2020). Moreover, scientists with ability to translate often complex science-based data and facts to commonly understandable information, messages and indicators are another essential link in the transfer of information.

By bringing together policymakers, scientists, and farmers' representatives, the ESP is creating a complementary way of protecting and managing soil resources.

## 5. Conclusion: mandatory versus voluntary approach

The fulfilment of the ESP fundamental function as an overarching mechanism for the many European organisations involved in the sustainable management of soils is currently based on a strong commitment and voluntary participation from ESP member countries, an active role of the GSP Secretariat, the substantial support of the European Commission and individual EU countries, participating national focal-points of EU countries and the voluntary based involvement of the members of the ESP steering committee and working groups. The design and successful implementation of the above-mentioned activities (Chapter 3) highly depend on a better institutionalisation and the availability of funding, continuous support from EU and international donors, and the commitment of regional and national institutions, including the updating of policies and laws. The successes of the sub-regional partnerships (EASP, AlpSP) achieved so far have also been made possible thanks to financial support from the European Commission, national governments, or research funding, respectively.

The willingness of partners and commitments of governments is the key to successful regional implementation of the VGSSM. Such effort can be realised if different ministries work together to integrate soil issues within their related activities at the national or local level, particularly in the environment, water, climate-change, and agriculture-related departments. Soil protection activities and best management practices need to find a way to specific geographic areas such as the Alps and Mediterranean, regional actors, and, when applicable, even to municipal actors where many soil-affecting decisions are made. On the one hand, binding legal instruments at national (Ronchi et al., 2019) and regional and sub-regional levels will be needed to fully protect available soil resources for future generations. Some instruments are already available, such as the Alpine Convention and its Soil Conservation Protocol (Schmid, 2018), but additional instruments are needed and should be the final aim of the ESP and EASP.

In contrast, capacity-building, awareness raising, and public-private partnerships can help build regional and local cooperation, develop, and implement good national and regional governance in soil management and protection. Complementarity between voluntary and mandatory approaches is a prerequisite to design smart regulation tools that include different instrument categories such as legal or economic instruments, self-regulation, or information strategies (Gunningham & Sinclair, 2017). The voluntary character of the RSPs cannot create any legally binding rights or obligations for its partners. However, the ESP and its sub-regional partnerships, with its voluntary and Europe-wide actions, complements the effectiveness and efficiency of soil conservation in Europe.

## Declaration of competing interest

The authors confirm that there is no conflict of interest with the networks, organisations, and data centres referred to in the paper.

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