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# The relevance of sustainable soil management within the European Green Deal

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ABSTRACT

The new European Green Deal has the ambition to make the European Union the first climate-neutral continent by 2050. The European Commission presented an ambitious package of measures within the Biodiversity Strategy 2030, the Farm to Fork and the European Climate Law including actions to protect our soils. The Farm to Fork strategy addresses soil pollution with 50 % reduction in use of chemical pesticides by 2030 and aims 20 % reduction in fertilizer use plus a decrease of nutrient losses by at least 50%. The Biodiversity Strategy has the ambition to set a minimum of 30 % of the EU's land area as protected areas, limit urban sprawl, reduce the pesticides risk, bring back at least 10 % of agricultural area under high-diversity landscape features, put forward the 25 % of the EU's agricultural land as organically farmed, progress in the remediation of contaminated sites, reduce land degradation and plant more than three billion new trees. The maintenance of wetlands and the enhancement of soil organic carbon are also addressed in the European Climate Law. The new EU Soil Observatory will be collecting policy relevant data and developing indicators for the regular assessment and progress towards the ambitious targets of the Green Deal.

## 1. Introduction

The new President of the European Commission, Mrs. Ursula von der Leyen, has outlined her priorities 2019–2024, including her vision for a greener Europe: *"Climate change, biodiversity, food security, deforestation and land degradation go together. We need to change the way we produce, consume and trade. Preserving and restoring our ecosystem needs to guide all of our work"* (Von der Leyen, 2019). This vision underpins the proposal for a European Green Deal (EGD), striving to be the first climate-neutral continent. Becoming the world's first climate-neutral continent by 2050 is the greatest challenge and opportunity of our times. To achieve this, the European Commission presented the European Green Deal, the most ambitious package of measures that should enable European citizens and businesses to benefit from sustainable green transition. Measures accompanied with an initial roadmap of key policies range from ambitiously cutting emissions, to investing in cutting-edge research and innovation, to preserving Europe's natural environment. The European Commission proposed ambitious objective in the Biodiversity Strategy 2030, the Farm to Fork and the European Climate Law which include actions for sustainable soil management.

Achieving sustainable soil management in the EU will be crucial for several of the planned actions within the EGD. Sustainable soil management was well defined in 2016 by FAO (FAO, 2017) adopting the Voluntary Guidelines for Sustainable Soil Management. All FAO Members, including EU Member States and the European Commission, endorsed these guidelines. The challenge in front of us is how to translate these guidelines into actions within the EGD. This opinion paper addresses the importance of soils within the Green Deal and identifies the significance of soils in Biodiversity Strategy, Farm to Fork and Climate Law. In all three policies, soil health will benefit from ambitious objectives to be reached by 2030: 50 % reduction of pesticides, 50 % decrease of nutrients excess, 20 % fertiliser reduction, organic farming at 25 % of agricultural lands, 10 % increase of landscape features, increase of land-protected areas at 30 %, wetlands restoration and halting land degradation.

## 2. Main elements of the European Green Deal relevant to soils

The proposed EGD has several elements (Fig. 1) that will lead towards the final goal of a climate-neutral continent. Soils are explicitly mentioned in the Farm to Fork strategy and in the Zero Pollution action plan (European Commission, 2019) but are indirectly relevant for achieving climate neutrality in 2050, preserving, and restoring ecosystems and biodiversity. The important role that land degradation and restoration play in preserving terrestrial ecosystems has been well documented in the recent Intergovernmental Science Policy Platform

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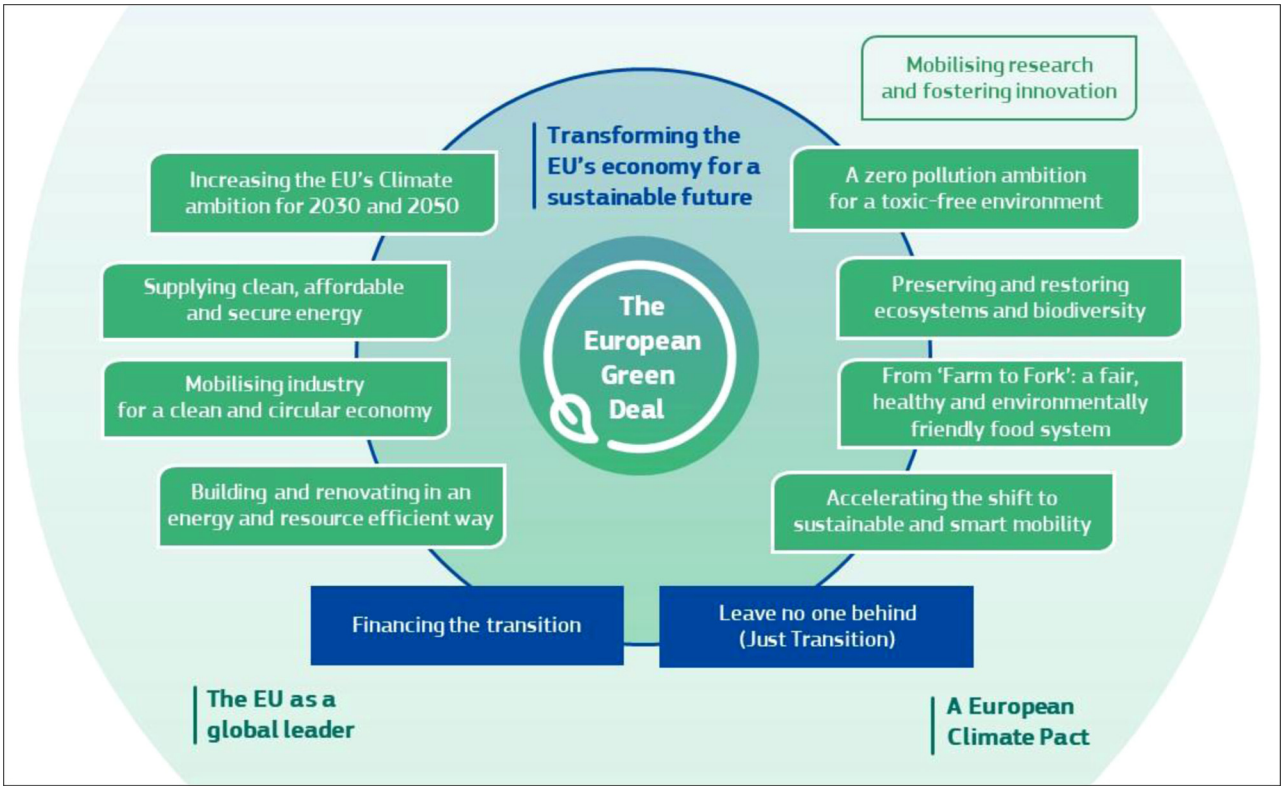


**Fig. 1.** The various elements of the European Green Deal (COM(2019) 640 final). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article).

on Biodiversity and Ecosystem Services' (IPBES) Land Degradation and Restoration Assessment (IPBES, 2018). Achieving the SDG target 15.3 of a land degradation neutral world by 2030 will substantially contribute to the perseveration of terrestrial biodiversity (Akhtar-Schuster et al., 2017).

Soils will therefore play an important role in the future agricultural policy (Farm to Fork strategy), environmental protection (Biodiversity strategy) and climate change (Climate Law).

In May 2020, the European Commission proposed the Farm to Fork Strategy aiming to make food systems fair, healthy and environmentally-friendly (F2F, 2020). The strategy highlights the soil pollution because of high use of pesticides in agriculture (Arias-Estévez et al., 2008) and proposes the 50 % reduction in use of chemical pesticides plus the 50 % reduction of more hazardous pesticides by 2030 (Fig. 2). The excess of nutrients is a major source of soil pollution as well (Vitousek et al., 2009). The Farm to Fork strategy targets the 20 % fertiliser reduction use and the decrease of nutrient losses by at least 50 % without deteriorate soil fertility (Fig. 2).

In May 2020, the European Commission has also adopted the new EU Biodiversity Strategy for 2030 (BDS, 2030) and an action plan for a comprehensive, ambitious, long-term strategy for protecting nature (including soils) and reversing the degradation of ecosystems. Among the ambitious soil-related objectives of the strategy is to legally protect a minimum of 30 % of the EU's land area, limit urban sprawl, reduce the pesticides risk, bring back at least 10 % of agricultural area under high-diversity landscape features, put forward the 25 % of the EU's agricultural land as organically farmed, progress in the remediation of contaminated soil sites, reduce land degradation and plant more than three billion new trees (Fig. 2).

In March 2020, the European Commission proposed also the first European Climate Law (EU Climate Law, 2020) targeting a climate neutral EU by 2050. In relation to soils, this ambitious plan includes the maintenance of wetlands as an important carbon sink and the further reductions of $CO_2$ emissions including the agricultural sector (Fig. 2). In addition to this, the Commission will adopt the Zero Pollution Action Plan for Air, Water and Soil in 2021.

## 3. Soils and agriculture

European food must remain safe, nutritious and of high quality. It must be produced with minimum impact on nature. To achieve this important goal of the European Green Deal (EGD), there is the need to implement measures to preserve soil quality and limit soil contamination. Healthy food from healthy soils is one of the objectives of the Farm to Fork strategy and should be one of the slogans of the EGD. Introducing innovative agricultural practices together with new technology can be the way forward, as envisaged by the mission on soil health and food within the Horizon Europe framework program for research beginning in 2021. A mission in the area of soil health and food will provide a powerful tool to raise awareness on the importance of soils, engage with citizens, create knowledge and develop solutions for restoring soil health and soil functions. New tools and methodologies (e.g. genomics, DNA and RNA sequencing) will further help to enhance our scientific knowledge of soil health (Karlen et al., 2019).

In addition, It will be important to address the main soil degradation processes that affect the agricultural soils of the EU (EEA, 2020): soil erosion, soil contamination, soil compaction, soil sealing and the loss of soil organic matter and biodiversity continue to be major threats to soil health in Europe (Fig. 2). Soil erosion by water is about 1.6 times higher than soil formation rates in all land and 2-times higher in agricultural lands of the EU (Panagos et al., 2016). Soil sealing is an intense form of land degradation and 2.43 % of EU lands are sealed (EEA, 2020). About 23 % of soils in EU have critical high densities in their subsoils indicating soil compaction (Schjønning et al., 2015). Soil organic carbon stocks in European peatlands might be reduced by 13–36 % by end of the century (Gobin et al., 2011). In all regions of Europe, the species richness of earthworms has negatively affected by increased land use intensity (Tsiafouli et al., 2015). Different forms of land degradation

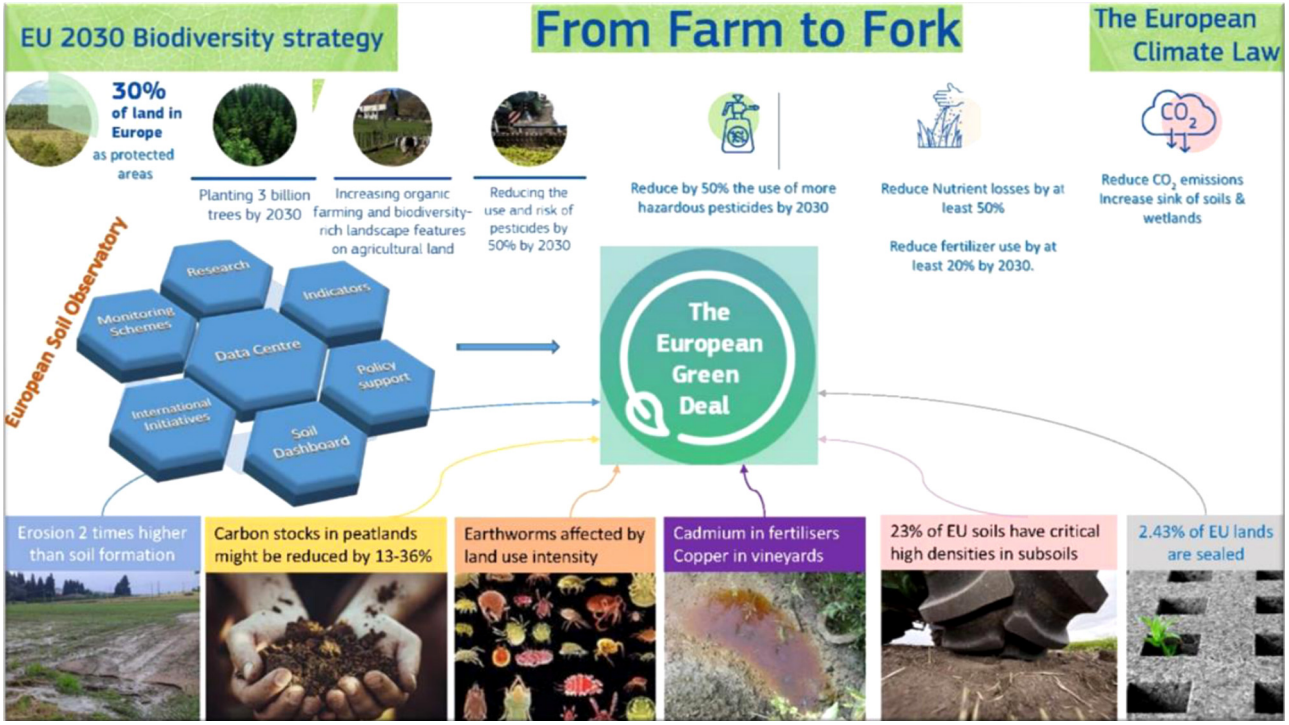


**Fig. 2.** Soils in the European Green Deal and their contribution in the 2030 Biodiversity Strategy, Farm to Fork and European Climate Law. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article).

(tillage practices, soil pollution, compaction, soil sealing, organic carbon decline), climate change and intensive human exploration are serious threats for microorganisms, fauna and soil functions (Orgiazzi et al., 2016). Agricultural topsoil have shown relevant high concentrations of cadmium mainly originated from mineral fertilisers (De Vries et al., 2007) and copper has been widely used in vineyards and orchards (Ballabio et al., 2018).

The EU Farm to Fork Strategy will have to consistently address these issues and implement an efficient monitoring system in order to measure progress made in reversing the current negative trend. An effective monitoring, reporting and verification (MRV) system for soil organic carbon (SOC) in agricultural soils will be necessary for accounting of soil organic carbon stocks for climate change mitigation purposes. The proposed components of a suitable MRV system for SOC in agricultural soils (Smith et al., 2019) need to be translated into the elements of an operational MRV system for the EU. Such an integrated monitoring system will include five components: a) benchmark sites based on long-term experiments (e.g. Rothamstead (UK), Cordoba (ES), Foggia (IT), Lucavec (CZ), Gembloux (BE) among others) for model calibration (Sandén et al., 2018); b) remote sensing tools based on the most recent satellite platforms (EU Copernicus program); c) ground observations and measurements, like in the LUCAS soil monitoring system (Orgiazzi et al., 2018); d) national and regional SOC soil surveys (Kaczynski et al., 2017; Morvan et al., 2008) and e) advanced modeling and scenario analysis including spatial data for future predictions and assessments (Lugato et al., 2018). This integrated monitoring system will advance the knowledge to better deliver the necessary indicators for the new Common Agricultural Policy (CAP) implementation (Panagos and Katsoyiannis, 2019). Soil erosion and soil organic carbon indicators contribute to the assessment of CAP environmental performance. The necessary innovation and research to fully develop such an integrated monitoring system should rely on the establishment of an International Research Consortium (IRC) on soil organic carbon in agricultural soils. Such an IRC should be open to all interested global players and stakeholders in order to achieve full consensus on the MRV system to be adopted at global scale.

## 4. Soils and biodiversity

Soils host one fourth of the world's biodiversity and provide ecosystem services such as nutritious food, clean drinking water, raw materials and carbon sequestration that are essential to overcome societal challenges like climate change, guaranteeing food security, biodiversity loss, safeguarding human health (Montanarella et al., 2016). Unfortunately, soil degradation is a pervasive, systemic phenomenon that occurs in all parts of the terrestrial world and which can take many forms in the EU and globally (Gilbey et al., 2019). Combating land degradation and restoring degraded land is an urgent priority to protect the biodiversity and ecosystem services vital to all life on Earth and to ensure human well-being. Land cover change and management intensity significantly affect soil condition and soil biodiversity in the EU (Tsiafouli et al., 2015). Progress in the remediation of polluted soils is relatively slow (Pérez and Eugenio, 2018). Despite recent reductions in soil sealing, fertile soils and soil biodiversity continue to be lost by land take (Gardi et al., 2015). On intensively managed land, soil biodiversity is endangered and soil carbon depleted. Soil loss because of water erosion is still significant and results in relevant economic costs to the European citizens (Panagos et al., 2018). Recent research findings recommend to bring landscape features (hedges, grass margins, trees, ponds, terraces) and non-productive areas back to farms, in order to increase biodiversity (including pollinators, pest antagonists) which can contribute to agricultural productivity (Cole et al., 2020), enhance carbon sequestration (Kay et al., 2019) and prevent soil erosion (Panagos et al., 2020).

In order to revert this negative trend in land degradation there is the need to device a comprehensive land restoration program as recommended by IPBES (IPBES, 2018). This should include a commitment by the European Union to:

- *Protect soil functions, particularly fertility, and achieve land degradation neutrality in the EU, addressing specific drivers that reduce soil biodiversity, carbon storage and fertility and implementing extensively sustainable soil management practices;*

- *Increase efforts to reduce soil erosion and increase soil organic matter, and to enhance the integration of land use aspects into decision-making at all levels of government, supported by the adoption of targets on soil and on land;*
- *Take into account the direct and indirect impact of EU policies on land use in the EU and globally; the rate of land take should be on track with an aim to achieve no net land take by 2050;*
- *Progress considerably in identification and remediation of polluted sites; reduce the soil pollution in agricultural lands at minimum level (toxic free);*
- *Reduce the agricultural areas having severe soil erosion rates (> 10 t/ha annually) by 2030*

Parts of those positive actions were already clearly outlined in the EU Soil Thematic Strategy adopted by the European Commission in 2006 (European Commission, 2006). However, 14 years after the adoption of the strategy there is the need for a clear and objective assessment of the reasons for the failure of the proposed strategy in achieving full soil protection in the EU. A new strategy is needed based on the new scientific evidence and including few, measurable targets with a clear timeline. A new EU Soil Observatory that will be collecting the policy relevant data and developing indicators for the regular assessment of the progress made should closely monitor the new strategy.

The EU Soil Observatory (ESO) will streamline soil monitoring and indicator development in the European Commission (e.g. LUCAS SOIL) with the national activities of Member States (including the Integrated Administration and Control System (IACS) and European Joint Programme Initiative on Agricultural Soil Management) and ongoing activities of the European Environmental Agency (EEA) and UN agencies (e.g. FAO Global and European Soil Partnership) into a single coherent system for monitoring, reporting and verification of policy relevant soil data and indicators. The eventual system will extend the operation of the current European Soil Data Centre (ESDAC) through the development and population of a soil dashboard indicating the state and trends of a broad range of existing and new soil indicators reflecting diverse policy drivers and concerns (compaction, salinization, pollution, bodiversity) relevant to the various Commission services related to soils, like DG ENV, DG CLIMA, DG AGRI, DG SANTE and others.

The ESO will be providing regular reports on the status and trends of EU soil resources and will cover the main threats to soil health as listed in the EU Soil Thematic Strategy: Soil erosion, Soil organic matter decline, Soil contamination, Soil sealing, Soil compaction, Soil acidification, Soil salinization, Soil biodiversity loss, Landslides and mass movements. Prioritization of activities will follow after the adoption of the revised EU Soil Thematic Strategy in 2021 as anticipated by the EU Biodiversity Strategy for 2030. Among the priorities of the ESO will be to provide regular reporting on land degradation and restoration in the EU following the recommendation of the recent report by the European Court of Auditors and will 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.

The ESO will be developing the indicators related to soils in the framework of the new Common Agricultural Policy (DG AGRI) and the Farm to Fork Strategy (DG SANTE), especially in relation to soil erosion, soil nutrients, soil organic carbon and soil contamination by agrochemicals and pesticides (Fig. 2). The ESO will be supporting with the necessary data the European Green Deal, especially for the Biodiversity Strategy 2030 for soil biodiversity and for the European Climate Law by providing the regular monitoring of soil organic carbon and peatland areas for achieving the target of net zero greenhouse gas emissions by 2050. In this context, the ESO will provide the EU contribution to international initiatives like the Global Soil Biodiversity Initiative (Cameron et al., 2018), the Global Peatland Initiative (Joosten and Clarke, 2002), the 4per1000 initiative (Minasny et al., 2017) and the FAO RECSOIL: Recarbonization of global soils initiative (Lal, 2016).

## 5. Soils and climate change

In order to achieve climate neutrality by 2050 there will be the need to use the full potential of European soils for mitigation and adaptation strategies. Increasing the soil organic carbon pool in agricultural soils by implementing sustainable soil management practices will contribute to the final achievement of this ambitious goal. Halting land degradation and restoring degraded lands, as recommended by IPBES (IPBES, 2018) and IPCC (IPCC, 2019), should be at the core of such a strategy. Achieving land degradation neutrality by 2030 (SDG target 15.3) should be a pre-condition for the later achievement of a climate neutral continent in 2050. Plenty of land restoration initiatives and programs are possible in the EU. There will be the need for a coherent action plan on how to achieve land degradation neutrality, including the financial mechanisms that will allow the massive investments in land restoration that are needed. As already pointed out by the recent evaluation by the European Court of Auditors (ECA, 2018), the EU is still lacking a coherent approach for combating land degradation and desertification, with only one EU member state (Italy) that has presented a land degradation neutrality target setting program as recommended by the United Nations Convention to Combat Desertification (UNCCD).

Land restoration results in a measurable increase of soil organic carbon. Healthy soils store large quantities of carbon (C) in the form of soil organic carbon (SOC). For this reason, SOC is included as a metrics for the regular assessment of land degradation in reporting for SDG target 15.3. Soils constitute the largest terrestrial carbon pool: an estimated total of 2344 Gt C, more than the sum of carbon contained in the atmosphere and vegetation (Stockmann et al., 2013).

Soils perform crucial functions in the global carbon balance and recognition of the importance of soils and their sustainable management for addressing climate change adaptation and mitigation is increasing. Recent discussions under the Koronivia Joint Work on Agriculture (KJWA) particularly highlighted the positive role of soils for climate change adaptation and mitigation, agriculture and food security (Bombelli et al., 2019). There exists substantial scientific and practical evidence of how sustainable soil management (SSM) can provide multiple benefits for the environment, people and livelihoods. Recent scientific developments recommend management practices (arable land conversion to grassland, straw incorporation, reduced tillage, ley cropping and cover crops) to in increase carbon sequestration in agricultural soils (Lugato et al., 2014).

SSM preserves and increases SOM, a key element of soil health, which regulates many soil functions, including carbon storage in the form of SOC. In this way, SSM supports the retention and enhancement of carbon stocks in soils and thus climate change mitigation, while generating benefits for agriculture, food security and nutrition, provision of ecosystem services, climate change adaptation, and advancing multiple sustainable development goals (SDGs). Investing in SSM constitutes a cost-effective and feasible climate change mitigation option, which, at the same time, enhances soil health and climate resilience (Sapkota et al., 2019; Lal et al., 2015). 128 countries include the Agriculture, Forestry and Land Use sector in their pledges for the Paris Agreement (Den Elzen et al., 2016). Limiting warming to 1.5 °C will require the use of 'negative emissions technologies' – methods that remove $CO_2$ from the atmosphere such as soil organic carbon sequestration (Soussana et al., 2019). Soil organic carbon sequestration (SCS) is a major mitigation option. Up to 1.4 Gt C could be stored annually in agricultural soils (after IPCC, 2007, 2014). About 20 % of the mitigation from SCS is achieved at negative cost and 80 % below US$100/$tCO_2$eq making SCS a low-cost mitigation option. It requires conserving carbon stocks, storing carbon in agricultural landscapes both in soil organic matter and in biomass through agroforestry, reducing $CO_2$ emissions from drained peatlands and wetlands and better recycling organic carbon through improved circularity and lifecycle of urban and agri-food industries organic wastes, thereby contributing to the bioeconomy.

SOC conservation and sequestration also have multiple co-benefits for food security, climate change adaptation, land degradation neutrality (an objective agreed by the UNCCD), desertification, biodiversity and water resources as shown by the latest IPCC Special Report on Climate Change and Land. Further, SOC content is a target (15.3) of the life on land Sustainable Development Goal 15. Both for UNCCD and for UNFCCC, countries are requested to report on SOC status. However, only a few countries have the capabilities and methods to monitor agricultural soil carbon with country specific methods.

While there is considerable private and public interest in soil carbon and health, adoption of soil enhancing agricultural practices appears to be slow. Farmers from several world regions see the main barriers to adoption as socio-economics (e.g. additional costs are too high; lack of funds to access technology or machinery; farm extension services do not have knowledge and capacity). Overcoming these barriers requires a strengthened knowledge base and advisory services, improved awareness in the public, increased availability of indicators and tools, as well as financial support for agricultural transition and payments for soil carbon and other ecosystem services.

Although barriers may vary with national circumstances, stakeholders and farmers from different world regions have similar views on the major barriers preventing an increased adoption of soil carbon sequestration and soil health enhancing practices. The EU legislative proposal for the future CAP (COM(2018) 392) shifts the focus from compliance to performance. In the post-2020 CAP, measures under the green architecture should focus on climate performance, including managing and storing carbon in the soil, and improved nutrient management to improve water quality and reduce emissions. In relation to soil organic carbon, the Member States will establish management plans to enhance carbon stocks in agricultural soils and to maintain wetlands (CAP Impact indicator 11). In addition to this the EU Biodiversity Strategy 2030 sets ambitious targets for having 30 % of land as protected areas and to plant more than 3 billion trees by 2030 (Fig. 2).

## 6. Conclusions

The European Green Deal sets out a comprehensive strategy for tackling climate and environmental-related challenges. Soils play a central role in achieving the Sustainable Development Goals (SDGs) by 2030 (Bouma et al., 2019). For Europe, this means that soils have to be included as a key element of the proposed European Green Deal (EGD). Especially soils play a key role in achieving the ambitious European target of a climate neutral EU by 2050. As a major carbon sink, soils play an important role in mitigating greenhouse gas emissions and therefore should be an important element of the new EU Climate Law. In addition, soils hold a large biodiversity pool (Jeffrey et al., 2010) and therefore are included in the new EU Biodiversity Strategy 2030. As the Biodiversity Strategy has the ambitious objectives to enhance of landscape features, increase of organic farming, commit with plantation of 3 billion trees, reduce of pesticides and halt land degradation, the sustainable soil management is fully addressed. Finally, soils are the foundation of agriculture, and therefore will have to play an important role in the EU Farm to Fork Strategy. Incorporating a coherent sustainable soil management framework within all three strategies will be challenging, given the necessary trade-offs between sometimes contradicting goals and targets. A coherent framework could be a revised EU Soil Thematic Strategy taking into account the goals and ambitions of the European Green Deal.

## Declaration of Competing Interest

Authors declare no conflict of interest. All authors have read and agreed to the published version of the manuscript.

## CRediT authorship contribution statement

**Luca Montanarella:** Conceptualization, Investigation, Methodology, Project administration, Supervision, Writing - original draft, Writing - review & editing. **Panos Panagos:** Data curation, Formal analysis, Methodology, Resources, Visualization, Writing - original draft, Writing - review & editing.

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## Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.landusepol.2020.104950.

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