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IMPACT ASSESSMENT REPORT

Accompanying the proposal for a

Directive of the European Parliament and of the Council

on Soil Monitoring and Resilience (Soil Monitoring Law)

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Glossary

Term	Meaning or definition
Agroecology	The concept of a holistic approach to sustainable agriculture by considering the entire agro-ecosystem on both local and global level, choosing farming practices that seek to boost the resilience and the ecological, socio-economic, and cultural sustainability of farming systems and to provide multiple ecosystem services.
Agro-forestry	Concept of agricultural land use through a combination of trees with crops and/or livestock to best utilise spatial and temporal complementarities in resource use. The aim is to provide multiple benefits besides food, fodder and biomass production, including biodiversity, water flow regulation and water use efficiency, soil conservation and soil fertility improvement, as well as diversification of (marketable) products.
Biodiversity	The variability among living organisms from all sources including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part and includes diversity within species, between species and of ecosystems.
Carbon farming	Business model that rewards land managers for improving management practices, that result in the increase of carbon sequestration in living biomass, decaying organic matter and soils.
Contaminated site	A delineated area with confirmed presence of high levels of contaminants in the soil caused by point-source anthropogenic activities .
Ecosystem	A dynamic complex of plant, animal, and microorganism communities and their non-living environment, interacting as a functional unit, and includes habitat types, habitats of species and species populations.
Eutrophication	A process that is usually caused by anthropogenic activities whereby water bodies accumulate nutrients, mostly nitrogen and phosphorus, resulting in high concentrations of algae, water blooms or microorganisms that prevent light penetration and oxygen absorption for underwater life.
Groundwater	Water as defined in article 2(2) of Directive 2000/60/EC, i.e. all water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil.
Land	The surface of the Earth that is not covered by water.
Land take	The conversion of natural and semi-natural land into artificial land development, using soil as a platform for settlements and infrastructure, as a source of raw material or as archive for historic and geological patrimony, at the expense of the capacity of soils to provide ecosystem services (provision of biomass, water and nutrients cycling, basis for biodiversity and carbon storage).
Land Use/Cover Area frame Survey (LUCAS)	Periodical survey funded by the Commission that provides harmonised and comparable statistics on land use and land cover based on in-situ observations across the EU. It contains a soil module where 41 000 topsoil samples are collected by surveyors in all Member States and analysed for several parameters in a harmonised way, which is unique.
Minimal tillage	Soil conservation practice where soil cultivation is kept to a minimum necessary for crop establishment and growth.
Organic farming	An agricultural production system aimed at maintaining the health of soils, ecosystems and people, and based on ecological processes, biodiversity and

	cycles adapted to local conditions, rather than the use of inputs with adverse effects. In the EU, organic farming is governed by a legal framework that provides a clear structure for the production and marketing of organic products throughout the EU.
Passport for excavated soil	A document issued by the competent authority or certified body describing the quantity and/or quality of the excavated soil.
Programme of measures	A programme elaborated by a Member State containing the elements required by the Soil Health Law.
Risk	Chance of harmful effects to human health or the environment resulting from exposure to soil contamination.
Risk reduction measure	Risk-based action that ensures that contaminated sites no longer pose an unacceptable risk. Risk reduction measures include remediation or any other action for risk reduction that break the source-pathway-receptor chain, e.g. land use restrictions or safety measures.
Soil	The top layer of the Earth's crust situated between the bedrock and the surface. Soil is composed of mineral particles, organic matter, water, air and living organisms.
Soil district	Part of the territory of a Member State, as delimited by that Member State for the purposes of soil health assessment and management.
Soil health	Physical, chemical and biological condition of the soil measured in terms of its characteristics describing soil's capacity to provide ecosystem services.
Soil health assessment	Evaluation of the health of the soil based on the measurement or estimation of soil health descriptors.
Soil health certificate	A document issued by the competent authority designated by the Member State containing information on the key characteristics and health of the soil.
Soil remediation	Regeneration action that reduces contaminant concentrations in the soil with the aim to re-establish its good chemical condition.
Soil restoration or soil regeneration[1]	Intentional activity aimed at reversing or re-establishing soil from a degraded state to a healthy condition. Remediation is considered as a restoration activity.
Sustainable soil management	Management practices that maintain or enhance the ecosystem services provided by the soil without impairing the functions enabling those services, or being detrimental to other properties of the environment . Sustainable soil management is an act of good stewardship or a duty of care to prevent that a healthy soil degrades.

[1] The terms 'soil restoration' and 'soil regeneration' have the same meaning for the purpose of this Impact Assessment

Abbreviations

CAP	Common Agricultural Policy
CBD	Convention on Biological Diversity
COM	European Commission
COR	European Committee of the Regions
CS	Contaminated site
EAFRD	European Agricultural Fund for Rural Development
EEA	European Environment Agency
EAGF	European Agricultural Guarantee Fund
ECA	European Court of Auditors
EESC	European Economic and Social Committee
EJP	European Joint Research Programme
ENVI	Environment, Public Health and Food Safety Committee
EP	European Parliament
GAEC	Good agricultural and environmental conditions
IED	Industrial Emissions Directive
INSPIRE	Infrastructure for Spatial Information in Europe
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPPC	Integrated Pollution Prevention and Control
LUCAS	Land Use/Cover Area frame Survey
LULUCF	Land Use, Land Use Change and Forestry
NNLT	No Net Land Take
NRL	Nature Restoration Law
OPC	Open Public Consultation
PCS	Potentially contaminated site
REFIT	Regulatory Fitness and Performance Programme
RSB	Regulatory Scrutiny Board
SAC	Special Areas of Conservation
SCIP Database	Database for Information on Substances of Concern
SDGs	Sustainable Development Goals
SHL	Soil Health Law
SME	Small and Medium Enterprises
SOC	soil organic carbon
SSM	sustainable soil management
STS	Soil Thematic Strategy
SWD	Staff Working Document
TFEU	Treaty on the Functioning of the European Union
UNCCD	United Nations Convention to Combat Desertification
UNFCCC	United Nations Framework Convention on Climate Change
UWWTD	Urban Wastewater Treatment Directive
WFD	Water Framework Directive

1 INTRODUCTION

1.1 Political context

Soil and the organisms that live in it provide us with food, biomass and fibres, raw materials, and regulate the water, carbon and nutrient cycles. Soils make life on Earth possible but human pressures are exceeding planetary boundaries.[2] Ensuring soil health is key to address some of our most important **societal challenges**, such as climate change, biodiversity loss, zero pollution and desertification. The Russian war in Ukraine has destabilised global **food systems**, intensified food insecurity risks and vulnerabilities across the world, and amplified the EU's need to be able to feed itself in a sustainable manner for centuries to come. Healthy soils are key to secure our **access to sufficient, nutritious and affordable food** in the long-term. Without sustainable management and restoration, our soils will lie at the heart of future food security crises.

The soil file has a **long history** at EU level (see annex 5), but regained momentum with the **European Green Deal** that underlined the importance to protect, conserve and enhance the EU's natural capital. As part of the Green Deal, the **Biodiversity Strategy for 2030**[3] announced the update of the 2006 Soil Thematic Strategy (STS)[4] to address soil degradation and fulfil EU and international commitments on land-degradation neutrality. The **EU Soil Strategy for 2030**[5] set the vision to have all soils in healthy condition by 2050, to make protection, sustainable use and restoration of soils the norm and proposes a combination of voluntary and legislative actions. Addressing soil degradation and ensuring the protection and sustainable use of soil, including by a Soil Health Law (SHL), is also included in the **8th Environment Action Programme**.[6]

Regarding **the position of the EU institutions,** the **European Parliament** (EP) called on the Commission to develop an EU legal framework for soil including definitions and criteria for good soil status and sustainable use, objectives, harmonised indicators, a methodology for monitoring and reporting, targets, measures, and financial resources.[7,8] The **Council of the EU** supported the Commission in stepping up efforts to better protect soils and reaffirmed its commitment to land degradation neutrality. The Council wants to address desertification, land degradation and make progress towards no net land take by 2050.[9] Furthermore, the **European Committee of the Regions** (CoR), the **European and Economic Social Committee** (EESC) and the **European Court of Auditors** (ECA) have all called on the Commission to develop a legal framework for the sustainable use of soil.[10,11,12,13]

The importance of soil health has been recognised **globally** and the EU has made commitments in the international context of the three **Rio Conventions** since soils are affected by desertification (**UN Convention to Combat Desertification**), contribute to climate change mitigation (**UN Framework Convention on Climate Change**) and constitute an important habitat for biodiversity (**Convention on Biological Diversity**). Restoring, maintaining and enhancing soil health is included as a target in the new

[2] EEA (2020), Is Europe living within the limits of our planet?
[3] COM/2020/380 final
[4] COM/2006/231 final
[5] COM/2021/699 final
[6] Decision (EU) 2022/591 of the European Parliament and of the Council of 6 April 2022 on a General Union Environment Action Programme to 2030
[7] European Parliament resolution of 28 April 2021 on soil protection (2021/2548(RSP))
[8] European Parliament resolution of 9 June 2021 on the EU Biodiversity Strategy for 2030: Bringing nature back into our lives (2020/2273(INI))
[9] Council Conclusions of 16 October 2020 on Biodiversity – the need for urgent action
[10] Opinion NAT-VII/010 of the CoR in the plenary session of 3, 4 and 5 February 2021 on Agro-ecology
[11] Opinion ENVE-VII/019 of the CoR in the plenary session of 26-27 January 2022 on the EU Action Plan: 'Towards zero pollution for air, water and soil'
[12] Opinion NAT/838 of the EESC on the new EU Soil Strategy of 23 March 2022
[13] European Court of Auditors (2018), Combating desertification in the EU: a growing threat in need of more action

Kunming-Montreal **Global Biodiversity** Framework, which was accompanied by a 2020-2030 action plan for the International Initiative for the Conservation and Sustainable Use of Soil Biodiversity. Soil health also directly contributes to the achievement of several of the **Sustainable Development Goals** and is high on the global policy agenda thanks to international initiatives like the **Global Soil Partnership, 4 per 1000, the International Resource Panel, the UN Environment Assembly or the UN Decade on Ecosystem Restoration**. Annex 5 sets out more details on the political context.

1.2 Legal context

The EU has comprehensive environmental measures covering sectors such as air, water, nature, circular economy, industrial emissions and chemicals. There is no dedicated EU soil legislation, but instead a patchwork of provisions impinging on soil health across existing EU legislation. For example, the Landfill Directive[14] sets operational and technical requirements to prevent leachate infiltration into the soil. Amongst horizontal EU environmental legislation, the Environmental Impact Assessment Directive[15] and the Strategic Environmental Assessment (SEA) Directive[16] require the assessment of the likely effects on soil of certain projects, plans and programmes. Provisions in other policy fields such as the Common Agriculture Policy or Climate Policy are also of relevance for soils.

Annex 6 sets out the details on the legal context by describing the existing EU environmental legislation and its relevance for soils. Annex 6 also lists existing EU instruments in other policy fields than environment that are of relevance for soils, such as the new CAP which has enhanced its contribution to environmental and climate objectives.

Overall, soil health profits from the existing sectorial and horizontal environmental EU legislation in a tangential manner, supporting the specific objectives pursued by these acts, such as improving water or air quality, protecting habitats and biodiversity, managing waste properly, etc.

However, and as it appears notably from the table in annex 6 (and further explained in chapters 2 and 5 and detailed in annex 6), there is also a clear legislative gap regarding soil protection.

1.3 Coherence with other related initiatives

The objectives of this initiative will contribute to the EU **climate change adaptation objectives** by making the EU more resilient at reducing its vulnerability to climate change. Regarding climate change mitigation, the EU aims to achieve a **climate-neutral and climate-resilient Europe by 2050.** Achieving these objectives relies inter alia on carbon removals through the restoration and better management of soils to absorb the emissions that will remain at the end of an ambitious decarbonisation pathway, and on enhancing the capacity of soils to retain water.

The **Land Use, Land Use Change and Forestry (LULUCF) Regulation** was recently revised to make it fit for the 55% net emission reduction target for 2030. It includes a target that the LULUCF sector should remove 310M tonnes of CO_2 from the atmosphere to be stored in soils, biomass or harvested wood products. The LULUCF Regulation does not lay down rules on the definition of the sustainable management or restoration of soils and their health. The Soil Health Law and LULUCF Regulation will be mutually reinforcing, because healthy soils sequester more carbon and because the LULUCF targets incentivise sustainable management and restoration of soils. Enhanced and more representative soil monitoring can also contribute to the improvement of LULUCF accounting. In addition, the Soil Health

[14] Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste

[15] Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment

[16] Directive 2001/42/EC of the European Parliament and the Council on the assessment of the effects of certain plans and programmes on the environment, OJ L 197, 21.7.2001, p. 30–37.

Law would direct sustainable soil management to SOC-depleted soils where carbon management will be most effective, benefiting the terrestrial greenhouse gas balance as well es ecosystem health.

The **Nature Restoration Law (NRL)**[17] aims at restoring ecosystems (including significant areas of degraded and carbon-rich ecosystems, including forest ecosystems and cropland mineral soils[18]) to good condition by 2050. The SHL will provide a more tailored approach to restoring degraded soils that complements the targets and actions of the NRL proposal. This will include provisions on the definition of the health, monitoring, sustainable management and restoration for soils in all terrestrial ecosystem types, as anticipated in the NRL proposal.[19]

The future **new legislative initiative on forest monitoring and long-term planning** will propose a framework to monitor the state and functions of the forests across the EU. The forest proposal will not include requirements relating to forest or soil management, or restoration. Duplications will be avoided e.g. by harmonizing data collection and shared indicators.

The **EU Mission 'A Soil Deal for Europe'**,[20] and other Horizon Europe instruments,[21] together with the **European Soil Observatory (EUSO)[22]** will support the monitoring and soil assessment capacities. While they cannot replace the rolling out of an EU-wide soil monitoring network and do not deal with soil management as such, they can spearhead research and development in this area providing for example substantial insight on soil degradation and how to effectively deal with this. across the EU via various case studies. Together, these initiatives will work in synergy with all building blocks of the SHL and form a robust framework to address soil and land stewardship at the necessary scale for all types of land use and sectors.

2 PROBLEM DEFINITION

2.1 What are the problems?

The **main problem that this initiative addresses is that soils in the EU are unhealthy and continue to degrade**. Scientific evidence indicates that soil degradation in the EU is continuing and worsening (see Annex 7 for details and sources). Based on the data available, it has been estimated that about 60 to 70% of soils in the EU are currently not in a healthy state[23] i.e. showing one or more forms of soil degradation. The overall outlook indicates that degradation will accelerate without specific measures.

The main types of soil degradation include:

- **Loss of soil organic carbon**: soil organic carbon (SOC) is a fundamental element of the soil and an indicator for soil health. It results from the decomposition of plant material and the remains of soil organisms. The loss of SOC in mineral[24] soils leads to reduced fertility, reduced capacity to cycle

[17] Proposal for a Regulation of the European Parliament and of the Council on nature restoration COM/2022/304 final

[18] The NRL requires action to improve the level of organic carbon in cropland mineral soils and rewet organic soils in agricultural use constituting drained peatlands.

[19] The NRL proposal indicates that it "*has clear links with the EU soil strategy because many terrestrial ecosystems depend on and interact with the underlying soils. Any other soil-related targets will be integrated into future legislation governing soils*".

[20] https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/soil-health-and-food_en

[21] The Horizon Europe framework programme for research and innovation facilitates knowledge creation and collaboration and will thereby accelerate the transition to healthy soils. In this context, in addition to the Soil Mission, there are relevant instruments available also through Cluster 6, Food2030 priorities and the (forthcoming) Horizon Europe Partnerships (Food System, Biodiversity, Agroecology, Agriculture of Data, etc.).

[22] https://joint-research-centre.ec.europa.eu/eu-soil-observatory-euso_en

[23] European Commission, Directorate-General for Research and Innovation, Veerman, C., Pinto Correia, T., Bastioli, C., et al., *Caring for soil is caring for life : ensure 75% of soils are healthy by 2030 for food, people, nature and climate : report of the Mission board for Soil health and food*, Publications Office, 2020, https://data.europa.eu/doi/10.2777/821504

[24] Mineral soils have a carbon content below 20%.

water and nutrients and reduced soil biodiversity. Drained peatlands[25] are losing depth by 0.5 to 1 cm per year, leading to subsidence of the soil surface. Carbon losses from such soils dominate the negative carbon balance of non-forest terrestrial ecosystems in the EU.

- **Nitrogen** and **phosphorus** are essential elements for plants and organisms, but **nutrient excesses** are hazardous. An accumulation leads to the saturation of the soil and leaching or run-off to ground- and surface-waters causing eutrophication and acidification. Excessive application of nutrients can contaminate the air and contribute to climate change. The planetary boundaries for N and P flows have been exceeded strongly, which is causing changes to ecosystems and biodiversity.
- **Soil acidification** is caused by the accumulation of soluble inorganic and organic acids, at a faster rate than they can be neutralized. It decreases soil pH over time and may result in reduced soil fertility and loss of soil biodiversity.
- **Soil erosion** is the removal of soil by wind, water and other processes. Erosion is unsustainable when the soil loss rate is higher than the rate at which soil regenerates (approximately 1.4 tonne per hectare per year or 1.4 t/ha/y).
- **Soil compaction** is the reduction of the micro-cavities or pores in the soil. Soil compaction is generally irreversible or requires long time to reverse,[26] in particular for the deeper part of the soil that cannot be reached by machinery (subsoil compaction). Compaction is particularly severe when the pressure is applied under wet conditions, when the soil is softer (e.g. sandy soils) and thus loses more volume for a given pressure.
- **Soil contamination** is the occurrence of contaminants in soil above a certain level causing deterioration or loss of one or more soil functions. **Point-source or local soil contamination** is caused by specific events or contaminating activities (e.g. industrial production) within a specific area or site, where the source of the contamination is usually clear**. Diffuse soil contamination** is a more widespread form of contamination caused by diffuse sources and multiple activities that sometimes interact and have no specific point of discharge (e.g. atmospheric deposition). It is therefore more difficult to assess and control than point-source contamination. Contaminated soils can also leach to surface, ground, coastal and marine waters.
- **Salinization** is the accumulation of water-soluble salts in the soil that affects hotspots in the EU, often along the coastlines. High concentrations of salt adversely affect plant growth and degrade soil structure, resulting in less fertile soils, less yields, less soil organic carbon, and soil erosion.
- **Desertification** is defined by the UNCCD as land degradation in arid, semi-arid, and dry sub-humid areas.
- **Water provision**: **the capacity of soils to retain water** is steadily diminishing. The sponge function of the soil is key to mitigate the effects of climate change, drought and floods.
- **Loss of soil biodiversity:** Soil biodiversity is the variability of living organisms in soil (e.g. earthworms, springtails, mites and wild pollinators that nest in soil) and includes diversity within species, between species and of ecosystems. Soil biodiversity determines the multi-functionality of soils, including soil fertility, underpins the delivery of ecosystem services, and is closely linked to above ground biodiversity.
- **Land take** is the increase in artificial or settlement areas over time.[27] **Soil sealing** is the extreme form of land take through the covering of soils by buildings, construction and layers of completely or partly impermeable material. Sealing causes the complete and irreversible loss of all soil functions and ecosystem services.

[25] Organic soils have a carbon content above 20%.
[26] https://www.sciencedirect.com/science/article/pii/S037811271500540X
[27] Land take is defined as the conversion of natural and semi-natural land into artificial land development, using soil as a platform for urban settlements and infrastructure, as a source of raw materials or as archive for historic and geological patrimony, at the expense of the capacity of soils to provide ecosystem services (provision of biomass, water and nutrients cycling, basis for biodiversity and carbon storage).

2.1.1 Root causes

The main root causes for soil degradation are:

- **Loss of soil organic carbon in mineral soils**: overgrazing, loss of vegetation and vegetative soil cover, physical soil disturbance, poor crop rotation and crop management, intensive input farming, deforestation, biomass burning, land use change, contamination, climate change;
- **Loss of soil organic carbon in organic soils**: drainage, unsustainable water management, land use change and conversion to more intensive uses (e.g. for agriculture and forestry), physical soil disturbance, overgrazing, climate change, peat extraction;
- **Excess nutrient content**: excessive / unbalanced application of fertilisers, high livestock density, atmospheric deposition, poor crop rotation, land use change, compaction, loss of soil organic matter and soil biodiversity;
- **Acidification**: excessive application of (acidifying) fertilisers, poor crop rotation and diversification, insufficient vegetative soil cover, run off, loss of soil organic matter, atmospheric deposition;
- **Erosion**: insufficient vegetative soil cover and landscape features, large homogeneity in field size and structure, physical soil disturbance (tillage and ploughing), soil loss through harvesting of root crops, compaction, poor crop management, overgrazing, deforestation, combined with topography, rainfall intensity, wind, climate change, loss of soil organic matter;
- **Compaction**: increased mechanisation, traffic of heavy machinery, high wheel pressure, high livestock density, poor crop rotation, physical pressure on the soil especially in wet conditions, large and dense crowds.
- **Contamination**: industrial activities, mining, services (petrol stations, dry cleaners, car repair, etc.), improper waste management (landfills, littering, illegal dumping, etc.), storage of substances (e.g. heating oil tanks, etc.), transport and combustion, military activities, spills, fires, accidents, atmospheric deposition, geology (e.g. volcanos), fertilizers, pesticides, contaminated sewage sludge, agricultural plastics, irrigation, floods, improper water management, backfilling with contaminated excavated soil;
- **Salinization:** poor or unsuitable irrigation (e.g. use of brackish or saline water), improper drainage, overexploitation and extraction of groundwater, de-icing of road infrastructure, climate change, saline water injection by industry, waste disposal, salt-rich wastewater;
- **Desertification**: climate change, poor irrigation and water management, monocropping, overapplication of fertilizers and pesticides, deforestation, insufficient vegetative soil cover and vegetation, wildfires, land abandonment, overgrazing, erosion;
- **Reduced water retention**: combination of loss of soil organic carbon, soil compaction, soil sealing and its root causes;
- **Loss of soil biodiversity**: physical soil disturbance, monoculture and poor crop rotation, insufficient soil cover, over fertilisation, use of pesticides, climate change, land use change, invasive alien species, ecosystem decline and habitat disruption, soil contamination, loss of soil organic carbon, erosion, sealing, compaction;
- **Sealing and land take:** development of infrastructure, roads, housing, commercial and industrial property, land use change, urban sprawl, spatial planning, demographic and economic growth.

Climate change is an important root cause of soil degradation. Factors such as temperature, precipitation, wind patterns or sea levels influence to a high degree soil degradation processes like erosion, decline in soil organic matter, desertification, salinization and loss of soil biodiversity. For compaction, contamination, sealing and land take, the influence of climate is less dominant. Climate change and drought influences soil health and vice versa: both processes intensify each other which can lead to a mutually reinforcing downward spiral. Anthropogenic activities and soil management also have a detrimental impact on soil health and alter soil properties, that can further amplify the effects of climate change.

2.1.2 *Scale of the problem at EU and Member States level*

The EEA concluded in its SOER 2020[28] that "soil degradation is not well monitored, and often hidden, but it is widespread and diverse". The following table presents the distribution of the aspects of soil degradation in the EU detailing the 60-70% estimation, the existing trends and the outlook.

Table 2-1: Scale of the problem, trends and outlook by aspect of soil degradation

Aspect of soil degradation	Share of EU land surface with "unhealthy soils"[29]	Trends[30]	Outlook
Loss of soil organic carbon in mineral soils	23% of agricultural mineral soils have low (<1%) and declining soil carbon stocks.	Decreasing soil organic carbon in EU agricultural mineral soils, at low rates.	The NRL proposal aims at halting loss in SOC stocks in croplands (about 23% of EU) and forests (about 40% of EU). However, it does not target a minimum SOC level for soil health. Climate change is expected to increase soil organic carbon losses, especially in colder and more humid climates.
Loss of soil organic carbon in organic soils	4.8% of peatlands (organic soils) are degraded, the majority of which (4.3%) is found in agricultural areas.	Northern European peatlands have undergone the earliest and highest losses globally since 1700. Drained peatlands will continue to lose soil organic carbon.	The NRL proposal is expected to restore as much as possible of drained peatlands.
Excess nutrients content in soils	27% – 31.5% of the EU (corresponding to 65%-75% of agricultural soils) displays excess nutrient levels due to unbalanced fertilizer or manure application and air pollution. 62% of semi-natural ecosystems are subject to nitrogen deposition leading to eutrophication.	Between 2000 and 2010, nitrogen surplus decreased in the EU, followed by stagnation (2010-2014). Use of mineral phosphorus increased by around 6% between period 2008-2011 and 2012-2015 in the EU27+UK. Use of manure phosphate decreased by around 3% between both periods. Gross phosphate balance decreased in the EU27+UK	The Farm to Fork and Biodiversity Strategies and the Zero Pollution Action Plan have defined an EU objective to reduce nutrient losses by 50% by 2030 while ensuring no deterioration in soil fertility. The outlook will depend to a large extent on the degree to which this political objective will be achieved.

[28] EEA, 2019, The European environment — state and outlook 2020, European Environment Agency (https://www.eea.europa.eu/ publications/soer-2020)
[29] Based on the assessment done in the report of the Soil Mission: "Caring for soil is caring for life - Publications Office of the EU (europa.eu)"
[30] An overview of the assessments on soil degradation by the European Environment Agency in the State and Outlook of the Environment Reports since 1995 can be found in Annex 7.

		from 1.7 kg/ha of utilised agricultural area in the period 2008-2011 to 1.6 kg/ha in the period 2012-2015.	
Soil acidification	- From air deposition: 4% of EU soils is expected to exceed acidification critical loads. - From excess nutrient inputs: unknown.	- Air deposition: critical loads for acidification have reduced from 43% in 1980 to 7 % in 2010, 4% in 2020. - Excess nutrient inputs: unknown trend.	Further reduction of air-borne deposition and subsequent acidification.
Unsustainable soil erosion	24% of the EU suffers from unsustainable water erosion (>2 t/ha/y) mainly in cropland (54 % of cropland is affected by unsustainable soil erosion or 14 % of all EU area). 9.7% of arable land has problems with wind erosion.	Soil erosion by water decreased by 9% in the period 2000-2010, and by 0.4 % in 2010-2016. No data on trends for wind erosion	Soil erosion (by water) is projected to increase by 13–22.5 % in EU (and UK) by 2050 due to climate change.
Soil compaction	23-33% of the EU is susceptible to compaction, of which 7% lie outside agricultural area (e.g. in organic-rich forest soils).	Problem has likely increased due to increased machine use and weight. Between 1960 and 2010, the average wheel load of field machinery increased by approximately 600%.	No outlook available.
Soil contamination	1-2.5% of non-agricultural is contaminated. Surface area with contaminated sites not accurately quantified. It was estimated in 2016 that 14% of an estimated total of 2.8 million potentially contaminated sites in the EU would require remediation or 390 000 sites; 21% of agricultural soils have cadmium concentrations in the topsoil which exceed groundwater limits used for drinking waters; 10 million tons of sewage sludge production for EU-27, 37% of which is applied on agricultural land and increasingly seen as a pathway for terrestrial micro-plastic pollution; 21% of land with use of pesticides (conventional arable); Agriculture produced 5% of plastic waste of EU, including plastic mulches and greenhouses;	**Diffuse Pollution** Data on trends are lacking. **Contaminated sites** Progress in the management of contaminated sites varies considerably, from 20 sites/year to 3 000 sites/year per Member State.	**Diffuse Pollution** Reduction in releases of contaminants to soil is expected if EU legislation is effectively implemented. **Contaminated sites** At the current rate of remediation, it would take some 47 years to remediate all estimated existing contaminated sites.

Secondary salinisation	1.5% of EU territory at risk of salinisation, largely driven by irrigation. The area at risk of saline intrusions in coastal areas due to sea-level rise is unknown.	No data on past trends.	Salt intrusion is expected to increase due to climate change and increasing irrigation.
Desertification	25% of Southern, Central and Eastern Europe (part of this value corresponds to areas already flagged by other degradational aspects). The risk of desertification is significant in particular in Spain, southern Italy, Portugal, and areas of south-eastern Europe including Bulgaria, Greece, Cyprus and the Danube Delta in Romania.	Trend data are largely lacking although indications that problem is increasing in Southern, Central and Eastern Europe.	Expected to increase due to climate change, combined with poor irrigation and water management practices. Hot semi-deserts already exist in southern Europe, where the climate is transforming from temperate to arid. This phenomenon is extending northwards.
Reduced water retention	Not assessed in Soil Mission report.	Likely decreasing capacity, because of decreasing soil organic carbon content, increasing compaction and increasing soil sealing. Between 2012-2018, sealing caused a potential loss of water retention capacity of 668 million m^3. Since beginning of measurements in 1979, Europe has generally experienced a downward trend in soil moisture.	Climate change may reduce soil water retention due to higher evaporation and decreased carbon content. Flood risk likely to increase for the Alps, northern, central and eastern regions; Projections for southern Europe are mixed.
Loss of soil biodiversity	37% of EU territory is at high risk for soil biodiversity loss. The state of soil biodiversity in the EU is still largely unknown. Only 1% of soil micro-organisms has been identified yet.	No direct data available to assess past trends in soil biodiversity. Based on land use and land use change the trend is deteriorating.	Most threats for soil biodiversity are expected to increase in the future (*i.e.* climate change, soil erosion).
Soil sealing and land take	Land take affects 4.2% of EU territory; 1.0 – 2.5% of land taken is sealed but with high local concentrations; consequently, 1.7-3.2% of EU soils (mostly in urban setting) are exposed to pressures (e.g. compaction, pollution).	Land take (2000-2018) and soil sealing (2006-2015) rates have decreased and vary by MS. Land take and soil sealing continue predominantly at the expense of agricultural and natural land at an estimated annual net rate of 440 km^2/year in the period 2012-2018.	Despite slowing trends in the expansion of urban and transport infrastructure, land take and soil sealing is expected to continue in coming decades. The political objective of no net land take by 2050 will not be met unless annual rates of land take are reduced and land recycling increased.
Total soil degradation	**60-70% of EU soils is unhealthy.**	**Deteriorating trends dominate for the past 10-15 years.**	**Most of the underlying drivers of soil degradation are not projected to change favourably, so deteriorating developments dominate for the outlook. The EU is not on track to meet policy objectives and targets.**

The estimated range of 60-70% of soil degradation expresses the uncertainty of the problem at EU level: this is due to a partial lack of representative data, for example on soil compaction and on soil contamination, lack of thorough monitoring and harmonized definitions, as well as the different situation of soil conditions across the EU. On the other hand, the uncertainty level is mitigated by modelling and case studies, decades of soil science and confirmation from different sources. In this context, the situation of soil degradation at EU level can be seen in graphic detail in the EU Soil Health Dashboard published by the JRC under the EU Soil Observatory. The map shows where scientific evidence converges to indicate areas that are likely to be affected by soil degradation processes and is updated as scientific evidence becomes available. The sources of the data as well as the limitations are described therein.[31]

The following table provides the best available information on soil health issues at Member States level. The data available, however, identify only the aspects that could be quantified per Member State based on the information available.[32] Quantification is available only for some land uses (namely cropland or agricultural land) or for limited elements of soil degradation (e.g. only copper and mercury concentration for soil contamination; concerning salinization, only areas equipped for irrigation). The table provides therefore only an order of magnitude of the distribution of soil health issues in Member States. It is therefore possible to anticipate a provisional distributional impact among Member State, showing which Member States would be likely to have to make more of an effort than others to achieve objectives of healthy soils for each type of soil degradation for which quantification at Member State level are available. The summary values of the table are represented in maps for each country in the country fiches in Annex 12.

[31] https://esdac.jrc.ec.europa.eu/esdacviewer/euso-dashboard/

[32] Details and sources of these data can be found in Annex 7

Table 2-2: share of quantified soil health issues by Member State[33] for each available indicator (see annex 7 section 1.3 for details)

Share of quantified soil health issues by MS for each indicator																
	Unsustainable soil erosion (water, wind, tillage, harvest)		**Low SOC compared to permanent grasslands (mineral soils only)**		**High or Very High susceptibility for topsoil compaction**	**High Copper concentrations**	**High Mercury concentrations**	**N excess**		**P excess**		**Peatland under hotspot of agriculture**		**Areas at risk of secondary salinization**		**Sealing**
Member State	% of cropland area	% of MS area	% of Cropland and Grassland area (except for land above 1000 m a.s.l.)	% of MS area	% of MS area	% of MS area	% of MS area	% of Agricultural land (CORINE)	% of MS area	% of Agricultural land (CORINE)	% of MS area	Peatland	% of MS area	Mediterranean biogeographical region	% of MS area	% of MS area
AT	68%	10%	47%	9%	4%	0%	8%	4%	1%	2%	1%	5%	0%	0%	0%	1%
BE	63%	17%	46%	15%	11%	0%	2%	69%	35%	58%	36%	0%	0%	0%	0%	6%
BG	71%	26%	84%	31%	7%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%
DK	65%	45%	16%	10%	6%	0%	0%	73%	50%	31%	25%	84%	4%	0%	0%	2%
ES	72%	18%	86%	20%	7%	0%	1%	11%	3%	1%	0%	0%	0%	8%	7%	1%
EE	22%	3%	2%	0%	45%	0%	0%	0%	0%	0%	0%	72%	18%	0%	0%	0%
EL	60%	10%	83%	13%	11%	1%	0%	5%	1%	0%	0%	28%	0%	11%	10%	1%
CY	46%	14%	21%	6%	9%	0%	0%	6%	2%	-	-	0%	0%	2%	3%	2%
CZ	64%	26%	52%	22%	10%	0%	0%	0%	0%	4%	3%	0%	0%	0%	0%	2%
DE	47%	19%	43%	20%	11%	0%	1%	50%	28%	33%	20%	91%	6%	0%	0%	4%
FR	53%	16%	41%	18%	8%	3%	0%	28%	16%	16%	10%	0%	0%	5%	1%	2%
FI	17%	1%	0%	0%	6%	0%	0%	0%	0%	2%	0%	19%	7%	0%	0%	0%
HR	31%	2%	76%	7%	1%	0%	0%	2%	0%	0%	0%	0%	0%	0%	0%	1%
HU	41%	24%	70%	41%	14%	0%	0%	0%	0%	0%	0%	80%	2%	0%	0%	1%
IE	42%	3%	0%	0%	8%	0%	1%	79%	46%	11%	8%	62%	12%	0%	0%	0%
IT	80%	23%	68%	19%	8%	14%	1%	23%	8%	3%	2%	1%	0%	7%	4%	3%
LT	26%	9%	29%	11%	8%	0%	0%	0%	0%	0%	0%	98%	9%	0%	0%	0%
LU	87%	12%	2%	0%	7%	0%	0%	86%	31%	1%	1%	0%	0%	0%	0%	4%
LV	25%	4%	10%	2%	13%	0%	0%	0%	0%	0%	0%	62%	6%	0%	0%	0%
MT	97%	0%	-	-	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	18%
NL	63%	16%	19%	10%	7%	0%	0%	87%	63%	90%	69%	97%	8%	0%	0%	7%
RO	59%	22%	71%	31%	8%	1%	0%	0%	0%	0%	0%	50%	2%	0%	0%	0%
PL	36%	17%	58%	29%	8%	0%	0%	15%	8%	6%	3%	87%	4%	0%	0%	1%
PT	60%	9%	29%	3%	4%	0%	0%	9%	2%	0%	0%	0%	0%	3%	3%	2%
SE	37%	3%	7%	0%	0%	0%	1%	6%	0%	5%	0%	6%	1%	0%	0%	0%
SI	64%	4%	41%	3%	8%	0%	19%	18%	4%	0%	0%	0%	0%	0%	0%	1%
SK	62%	22%	68%	23%	5%	0%	3%	0%	0%	0%	0%	0%	0%	0%	0%	1%

[33] The uncertainty for Malta and Cyprus is higher due to the small surface of these countries and the data availability.

2.1.3 Impacts of the problem

Healthy soils have the capacity to provide ecosystem services that are vital to humans and the environment. In particular, they:

1. provide safe and nutritious food, and biomass, including in agriculture and forestry;
2. absorb, store and filter water;
3. transform nutrients and substances, including dead biomass and excreta;
4. provide the basis for life and biodiversity, including habitats, species and genes;
5. act as a carbon reservoir;
6. provide cultural, recreational and health services for people.

Soil degradation has therefore **significant negative impacts,** affecting the provision of ecosystem services and leading to risks for human health, the environment, economy and society, including:

- **Reduced soil fertility**. Soil degradation impacts fertility, yields and nutritional food quality. Studies show that over the last 70 years, the level of many minerals and nutritious elements in almost every kind of food has fallen between 10 and 100 percent,[34] which may have serious effects on our health and well-being. Soil degradation undermines the resilience and profitability of agriculture in the EU, the production of biomass for the bioeconomy as well as the growth and resilience of forests. It is estimated that between 61% and 73% of agricultural soils are affected by erosion, the loss of organic carbon, nutrient (nitrogen) exceedances, compaction or secondary salinisation (or a combination of these threats).[35] Soil compaction for instance may lower crop yields by 2.5-15 %.[36] These degradations and their impacts on crop yields are discussed in Annex 7 – 4.1.2.
- **Climate change.** Soil degradation amplifies the effects of climate change on the land surface, while sustainable soil management and restoration helps to mitigate climate change. Europe’s resilience to climate change depends on the level of soil organic matter and fertility, water retention and filtering capacity, and resistance to erosion. Carbon farming practices could help to store up to 260 $MtCO_2$ in soils per year and contribute to mitigate climate change.
- **Risks to human health.** Several soil degradations harm human health:
    - **Erosion** by wind can lead to greater amounts of airborne particulate matter, causing respiratory and cardiovascular diseases, and indirectly harm human health through the deterioration of water quality.
    - **Sealing** prolongs the duration of high temperatures during heat waves and reduces the capacity of soils to act as a sink for pollutants.
    - **Contamination** of soils can affect food safety. Ingestion of chemicals can occur via ingestion of contaminated soil or plant uptake. Approximately 21% of agricultural soils in the EU[37] contain cadmium concentrations in the topsoil that exceed the limit for groundwater. While some metals are essential for plant growth (e.g., copper, iron, zinc and other macro- and micro-nutrients), high metal concentrations can induce toxicity for plants and expose the human population to diseases. Children are at greatest risk because they play close to the ground.
- **Loss of above-ground biodiversity.** Soil degradation causes not only the loss of below ground biodiversity, but also a reduction of above ground plant, animal, fungal and microbial diversity. Most biodiversity is bound to the soil ensuring the decomposition and mineralisation of organic material

[34] Thomas D. A Study on the Mineral Depletion of the Foods Available to us as a Nation over the Period 1940 to 1991. Nutrition and Health. 2003;17(2):85-115. doi:10.1177/026010600301700201, updated in 2007. One sobering conclusion is that today one would need to consume 2-5 times as much food to obtain the same amount of minerals and trace elements available in those same foods in 1940.

[35] Milder (2022) Environmental degradation: impacts on agricultural production.

[36] Brus and van den Akker, 2018, https://www.semanticscholar.org/paper/How-serious-a-problem-is-subsoil-compaction-in-the-Brus-Akker/9d20c231fc64b465db8e480e854a52f5dffc04fa

[37] EEA SOER 2020

(e.g. plant residues, manure, carcasses), influencing the carbon, nutrient and water cycles, providing natural pest regulation, and building the foundation of the food web.

Table 2-3: Soil health and its impact on services and societal needs (source: EEA (2023), Soil monitoring in Europe)

	Societal needs				
	Biomass	Water	Climate	Biodiversity	Infrastructure
Soil services	Wood and fibre production	Filtering of contaminants	Carbon stage	Habitat for plants, insects, microbes, fungi	Plataform for infrastructure
Soil services	Growth of crops	Water storage			Storage of geological material
Soil threat indicators					
Soil organic carbon	+	+	+	+	indiff. **(i)**
Soil nutrient statuts	+	- **(ii)**	indiff.	+	indiff.
Soil acidification	-	-	indiff. **(iii)**	-	indiff.
Soil pollution	-	-	-	-	indiff. **(iv)**
Soil biodiversity	+	+	+	+	indiff.
Soil erosion	-	-	-	-	indiff.
Soil compaction	-	-	-	-	indiff.
Soil sealing	-	-	-	-	+

Legend

+	Positive impact
-	Negative impact on soil service
indiff.	Neutral or unknown impact

(i) Soil organic carbon/infrastructure: organic soils are unstable as platform for infastructure.

(ii) The filtering capacity of soils prevents of buffers eutrophication and acidification.

(iii) Soil organic /carbon storage: fulvic acid (from acidified forest floors) enganges bleaching and nutrient loss, as well as loss of dissolved organic carbon; acidic soils slow down decomposition. From a climate point of view, soil acidification could favour carbon storage, as it leads to a lower biological activity and hence accumulation of dead biomass.

(iv) Land prices are lower if the soil is polluted, as remediation costs are incurred.

2.1.4 Costs of soil degradation

The table below presents the summary of the best quantifications available for the cost of soil degradation by aspect of degradation. This represents the cost of taking no action to address soil degradation. At the same time this would represent the benefit of addressing soil degradation and achieving soil health.

The range of costs of soil degradation is inherently uncertain, so lower and upper figures are presented for quantified costs only. Estimates are provided on an impact-by-impact basis using figures taken from a literature review, and where these are not available updating on the basis of the quantification of costs of soil degradations in the Impact Assessment for the Soil Framework Directive from 2006.[38]

As shown in the summary Table 2-4, the sum of quantifiable costs of no-action gives the broad range of EUR 16.5 to 68.8 billion per annum, excluding the costs of soil contamination. Soil contamination is more uncertain and increases the range by EUR 3.4 to 292.4 billion per annum (see Annex 9, section 4.2.2 for details). However, it is important to note that these values represent only the quantifiable costs: the table also lists the costs that could not be quantified for each of the soil degradations.[39] These costs of

[38] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52006SC0620&from=EN

[39] Furthermore the 2006 quantification was done for EU25. The updated figures from 2006 do not extrapolate to EU-27.

no action are split between on-site components (typically those experienced by soil managers) and off-site components (typically those experienced by other actors and society at large). Off-site costs of no action represent the cross-boundary nature of soil degradation and are often not possible to quantify.

Table 2-4: cost of soil degradation (cost of no action); as well potential benefits of addressing soil degradation

Soil degradation	**Quantified costs (billion EUR per year, 2023 prices)**		**Quantified costs – details**	**Other costs not quantified/not included**
	(min)	**(max)**		
Loss of soil organic carbon	9.8	25	Long-term prices for carbon also used (additional 2.5-10.2b€) On-site: • Yield losses due to reduced soil fertility Off-site: • Costs related to an increased release of greenhouse gases from soil	Off-site: • Costs due to loss of biodiversity and biological activity in soil (affecting fertility, nutrient cycles and genetic resources)
Erosion	2.4	23.1	Long term effects of erosion included (additional 3.8b€ to the max) On-site: • Yield losses due to eroded fertile land • Replacement application to compensate for P-loss Off-site: • Costs of sediment removal, treatment and disposal • Costs due to infrastructure (roads, dams and water supply) and property damage caused by sediments run off and flooding • Costs due to necessary treatment of water (surface, groundwater) • Costs due to damage to recreational functions	On-site: • Costs due to impact on tourism Off-site: • Economic effects due to erosion-induced income losses • Costs due to increased sediment load for surface waters (e.g. negative effects on aquatic species, difficulties for navigation) • Costs of healthcare caused by higher exposure to dust and soil particles in the air
Compaction	1.5	9.2	On-site: • Yield losses due to compacted soils	Off-site • Costs due to reduced water infiltration into the soil • Costs due to increased leaching of soil nitrogen • Costs linked to increased emissions of greenhouse gases due to poor aeration of soil
Salinisation	0.92	0.983	On-site: • Yield losses due to reduced soil fertility Off-site: • Costs due to damage to transport infrastructure (roads and bridges) from shallow saline groundwater • Costs due to damage to water supply infrastructure • Environmental costs, including impacts on native vegetation, riparian ecosystems and wetlands	On-site: costs due to negative effects on tourism
Contamination	3.4	292.4	On-site: • Costs of monitoring measures and impact assessment studies that must be carried out in order to assess the extent of contamination and the risk of further contamination of other environmental media (water, air) Off-site: • Costs of increased health care needs for people affected by contamination, which include the treatment of patients and the monitoring of their health during long periods to detect the effects of exposure to soil contamination	On-site • Costs of exposure protection measures for workers operating on a contaminated industrial site • Costs due to land property depreciation if land use restrictions are applied thus representing a loss of economic value of the industrial asset Off-site • Costs for insurance companies • Costs of dredging and disposing of contaminated sediments downstream borne by water supply companies or public administrations • Costs for increased food safety controls borne

			• Costs of treatment of surface water, groundwater or drinking water contaminated through the soil	by public administrations to detect contaminated food
Sealing and land take	1.9	6.6	On-site: • Loss of ecosystem services (only sealed area is used in the minimum, while land take area is used in the maximum)	Future costs of new sealed soils; On-site • Opportunity costs due to restrictions on land use Off-site • Cost linked to runoff water from housing and traffic areas, which is normally unfiltered and potentially contaminated with harmful chemicals • Costs due to fragmentation of habitats and disruption of migration corridors for wildlife • Costs due to impacts on landscape and amenity values • Costs on biodiversity
Biodiversity	No available quantification	No available quantification	N/A	On-site • Yield losses due to reduce soil fertility Off-site • Costs linked to the loss of ecosystem functions and reduced capacity to sequester carbon • Costs related to impacts on landscape and amenity values • Costs related to changes in genetic resources
Loss of soil capacity of water retention	0	3.9	On-site: • economic losses in agricultural sector due to drought not alleviated by the capacity of water retention by soil	Off-site • Costs of flooding related to reduced capacity of soil for water retention
Total quantified costs	**19.8**	**361.3 (of which 292.4 from contamination and 68.88 from the rest)**	**Sum of all above quantified costs**	Costs do not include non-linear effects.

Given the wide range of estimation, the study which assessed the contamination related costs[40] has used also a more prudent intermediate value that was updated at EUR 24.4 billion.[41] This is the one used in the overview of costs and benefits in chapter 7.3 to avoid overestimation.

2.1.5 Sub-problems

The reason for the persistence and the negative outlook of the main problem are described by the two key sub-problems:

A. Data, information, knowledge and common governance on soil health and management are insufficient.

- The minimum number of soil samples in the EU needed to have a statistically reliable measurement of soil health, taking into account the variability of soil condition (soil type, land use and climatic conditions), has been estimated by geostatistical methods at 210 000 points. Currently there are 34 000 points from Member States and 41 000 from LUCAS Soil campaign of 2022, while they were about 20 000 in previous LUCAS Soil campaigns. This shows the large gap to sufficient data on soil health. Furthermore, soil data from Member States are in general not public and not shared at EU level, so they cannot be used as data for assessing soil health at EU level.

[40] https://link.springer.com/chapter/10.1007/978-3-540-72438-4_5

[41] Updating to 2023 prices the estimate for intermediate cost of contamination done in 2006 for the impact assessment of the Soil Framework Directive proposal.

- Some Member States have soil monitoring schemes in place, but they are fragmented, not representative and not harmonised. Member States apply different sampling methods, frequencies and densities, and use different metrics and analytical methods, resulting in a lack of consistency and comparability across the EU. Furthermore, soil data are not consistently stored in one accessible database. Monitoring soil health also requires access to land.
- Current density of on-field measurements is not sufficient to adequately assess soil in a representative way at more local level, given the large variability of soil types, climatic conditions and land uses, and thus to inform adequate soil restoration actions.
- Quality data on soil health is lacking, especially on soil organic carbon,[42] water retention capacity, contamination with organic compounds and biological parameters.
- The LUCAS soil survey is a very useful tool for a harmonised and comparable assessment of soil health at EU level, but it currently lacks a clear legal mandate, depends on temporary administrative arrangements and its continuation is not secured.
- The current low density of soil sampling locations is not sufficient to representatively assess soil health at local level.

B. Transition to sustainable soil management and restoration, as well as remediation is needed but not yet systematically happening, e.g. for the unsolved legacy of contaminated sites.

- Current data and research show a continuation of unsustainable soil management practices even if they are detrimental to soil health (e.g. utilisation of heavy machinery, broad pesticide application, poor crop rotation, lack of soil cover) due to the below described drivers.
- Concerning the contaminated sites, the current rate of identification, registration, investigation, assessment and remediation will prove insufficient by 2050 to avoid risks for human health and the environment, and to achieve the zero pollution ambition.

2.2 What are the problem drivers?

The problem drivers can be grouped into market failures, regulatory failures and behavioural biases. Together these drivers contribute to the two sub-problems, and through them to the overall problem. Throughout these categories, recurrent themes are lack of relevant and verifiable information and a failure to fully implement sustainable soil management practices.

2.2.1 Market failures

Insufficient internalisation of environmental costs. The costs caused by practices harmful to soils are often not borne by those who benefit from them, in a phenomenon known as ‘externalities’. Whereas the short-term benefits of harmful practices are generally concentrated with the current landowner or land manager, its costs are borne by people that can be distant in time (in the future, over several generations), social or economic condition, or in space, including in other Member States of the EU. The fear of being undercut on costs by competitors leads land managers to adopt or retain harmful practices. This occurs also when the landowner and the soil manager are aware that soil health is part of their asset. Insufficient internalisation also means that the financial gains from land take can be considerably larger than the financial value of ecosystem services for the landowner, even if the opposite can be true from the point of view of society. This is a typical case of market failure to preserve ecosystem services and nature, where the financial computation performed using the marginal cost and benefit, as evaluated at the small scale of each individual actor, leads to decisions that, when aggregated, are collectively unsustainable. Concerning

[42] https://www.nature.com/articles/s41558-022-01321-9

soil pollution, this market failure is closely linked with the non-application of the polluter-pays principle.[43]

Short time decisions. Soil is formed at very low rates, meaning that it should be considered as a non-renewable resource. Therefore, the time horizon of public policy, taking into account the public interest of all involved parties, does not normally include the needs of the future generations. The long-lead times of soil restoration mean that to achieve the EU's long-term goals, such as climate neutrality in 2050, action should start immediately. Economic operators, however, have to pay interests on their loans and are not incentivised to consider long time horizons when it comes to soil. Short- and time-limited land tenure contracts tend to discount (i.e. largely ignore) non-sustainable practices (short termism) albeit landowners or land users are becoming more aware, due to climate change (frequency and intensity of weather events that greatly affect a particular area).

Asymmetry of information on soil health. Connected to the lack of parameters to define the health of soils and with the lack of obligations in this respect, in transactions bearing on the sale of a piece of land, there is often an asymmetry between the knowledge held by the seller on the condition of the soil on that piece of land (which is relatively higher, based on past empirical experience) and the knowledge of the buyer (which is lower, in the absence of data and of a scientifically stable assessment method). This lack and asymmetry of information reduces the incentives for landowners to have good soil management practices, as the detrimental consequences of these will be difficult to detect by a buyer, and hence will have minimal consequences on the selling price.

2.2.2 Regulatory failures

There is no dedicated EU legislation which protects soils like the ones existing for other media such as air and water. The EEA pointed out in the SOER 2020 that "the lack of a comprehensive and coherent policy framework for protecting Europe's land and soil resources is a key gap that reduces the effectiveness of the existing incentives and measures and may limit Europe's ability to achieve future objectives related to development of green infrastructure and the bioeconomy".

There is a **clear gap** within the existing current EU legal framework (see Annex 6 for a detailed gap analysis for each of the soil degradations):

- There is a lack of definitions, indicators and criteria to define the notion of "healthy soils" and there is currently **no obligation to monitor all aspects of the health of soils**. The assessment of the quality and health of soils is a subject of active research and of long-lasting controversy among scientists, practitioners and Member State authorities. It is therefore difficult, without a commonly agreed soil health definition and of indicators to measure it, to conclude on the condition of a soil. In addition, there is a lack of binding policy objectives relating to soil as such, and this is not covered by the objectives put in place for other areas such as air and water.
- There is a gap regarding the need to manage soil sustainably, avoiding their deterioration, as well as to restore those that have lost capacity to deliver ecosystem services.

Overall, soil health profits from the existing sectorial and horizontal environmental EU legislation only in a tangential manner (e.g. as regards excess of nutrients and some pollution aspects), supporting the specific objectives pursued by these acts, such as improving water or air quality, protecting habitats and biodiversity, managing waste properly. However, the **existing EU legislation does not address soil properly** for the reasons explained in chapter 1 and Annex 6. Due to their different objectives and scopes,

[43] The European Court of Auditors has noted that this principle is not currently applied to emissions from the agricultural sector, including emissions related to unsustainable soil management.
https://www.eca.europa.eu/Lists/ECADocuments/SR21_12/SR_polluter_pays_principle_EN.pdf

and to the fact that they often aim to safeguard other environmental media, existing provisions, even if fully implemented, yield a fragmented and incomplete protection to soil, as they do not cover all soils and all soil threats identified. An analysis of existing environmental legislation for each of the soil degradations is presented visually in table 2.1 of Annex 6.

There is also **a gap regarding national legislation**. While some Member States have put in place soil protection legislation, others lack nationally coordinated actions on soil protection and soil threats. Soil benefits often indirectly from other pieces of national legislation such as legislation on water, urban planning or industrial or agricultural activities.

It appears from the analysis (see Annex 6), that on the one hand the approaches vary from one Member State to another and on the other hand that some degradation aspects are better covered than others:

- Differences amongst Member States: a few Member States have dedicated legislative acts on soils while in the other Member States soil may benefit indirectly from other legislation. As an example, the Soil Act in Bulgaria focuses on the prevention of soil degradation and damages, the lasting protection of soil functions and the restoration of damaged soil functions. In France on the contrary, provisions on soils are dispersed in various legislative acts such as laws concerning urban planning, biodiversity, or climate.
- Differences concerning the aspects of soil degradation: In many Member States, the national legislation contributes directly or indirectly to address loss of soil organic carbon, soil erosion, loss of soil biodiversity and sealing of soil. On the contrary, in a large majority of Member States there is no or little contribution from national legislation (beyond national legislation transposing EU legislation) to address soil salinization, excess of nutrients in soils, soil acidification and water retention capacity.

This gap is reflected by the deterioration of soils across the EU as explained in section 2.1.2 above.

One notable example of insufficient legislation on soil at national level are rules on contaminated soil. Although there are provisions in many Member States on soil contamination, it appears that only a very small fraction of all chemicals that can contaminate soils are regulated under national legislation via contaminant thresholds, and other important policies and instruments that could remedy to the issue, such as maintaining a register of contaminated sites or assessing risks and remediating sites in case of inacceptable risks are also lacking. National legislation has not been successful in tackling historical soil contamination since it is estimated that there are still around 2,8 million of potentially contaminated sites in Europe. A big challenge results from the extremely different implementation of national approaches to tackle contaminated sites, indicating high potential health risks for many citizens

This uneven and fragmented response by Member States to tackle soil degradation has led to an **uneven playing field for economic operators** who have to abide to different rules, while competing on the same market. It has also prevented the take up of (financial) incentives, training and advice to stimulate sustainable soil management.

2.2.3 Behavioural biases

Lack of awareness of the importance of soil health, its complexity and its multiple benefits. Soil health is often taken for granted because it is still capable of producing (albeit less intensively) even if degraded. The lack of knowledge by stakeholders of the functioning of soils, the provision of ecosystem services and its link with human health is significant and has been pointed out by all stakeholders as a major barrier to achieve healthy soils. Moreover, the variability of soil conditions and uses generates a complexity that represents a significant barrier to the adoption of sustainable practices. Insufficient awareness of the consequences of soil degradation aggravates the other drivers when food and biomass producers feel bound by market and industry dynamics, which often drive them to seek short-term solutions to arising problems, including financial difficulties.

Delayed detection of soil degradation. Unlike for other environmental media, soil degradation often is invisible to the naked eye. Land users are often unaware of the poor state of their soils. By the time the impacts of such degradation start being noticeable (in the crops, in the water, etc), it often means that the damage is already very severe and sometimes the remedy comes too late. It is this complex delayed detection of symptoms that often prevents land users from taking the necessary management measures in time.

Furthermore, specifically concerning farmers, a number of barriers have been identified that are hindering the implementation of sustainable soil management practices:[44]

- Perceived economic barriers such as operating costs and capital investment costs as well as the risks and uncertainties associated with the implementation of new practices;
- Technical barriers: many of the SSM practices needs to be adapted to local conditions in order to maximise their benefits;
- Lack of information: the knowledge produced does not always reach nor is it always useful for the farmer to apply on the field;
- Lack of advisers able to deliver credible and balanced advice at the farm level, with a good level of specialist soil knowledge, able to take into account of trade-offs and synergies between soil functions and the ability to accommodate different styles of farmer learning.

Structural barriers (such as technological lock-ins, data ownership and use, structure of the food chain) that lock farmers into a certain system of agriculture; these impact farmers' ability to change representing inertial factors that are beyond the capacity of the individual farmer to overcome.

2.3 How will the problem evolve?

As found by the European Environment Agency, without additional action, the problem will persist.[45] Trends and outlook for the different degradation processes are presented in section 2.1. The assessment of past trends in the last 10-15 years, the outlook for 2030, and prospects of meeting policy objectives and targets for soil health and land take are very worrying, since deteriorating trends dominate (see also

[44] Sustainable Agricultural Soil Management in the EU: What's stopping it? How can it be enabled? – Rise Foundation

[45] European Environment Agency (2019), The European Environment: State and Outlook 2020 (cfr. pages 12, 124, 130)

2.3.1 *Scale of the problem at EU and Member States level*

The EEA concluded in its SOER 2020 that "soil degradation is not well monitored, and often hidden, but it is widespread and diverse". The following table presents the distribution of the aspects of soil degradation in the EU detailing the 60-70% estimation, the existing trends and the outlook.

Table 2-1Table 2-1 on detailed trends and outlook by soil degradations as well as Annex 7 section 1.3.2). The underlying drivers of soil degradation are not projected to change favourably in the future, so the functionality of the remaining healthy soils will come even more under pressure. The EU is certainly not on track to achieve healthy soil resources based on the existing strategies and policies. More harmonised, representative soil monitoring is needed to develop early warnings of exceedances of critical thresholds and to guide sustainable soil management. There is a high risk that the EU will fail some of its own Green Deal and international commitments such as land degradation neutrality, despite the existing patchwork of legislation and the legislation being developed. Additional measures could contribute but only partially, see Section 5.1 on the baseline, with the NRL, LULUCF, the Common Agricultural Policy (CAP) National Strategic Plans and other ongoing initiatives leading potentially to some improvements on the aspects of soil health.

Some regions will be more affected by soil degradation also due to the impacts of climate change. Nevertheless, across the entire EU in the coming decades, the pressure on soil will increase with demands from food, water and energy likely to grow. Food security is particularly sensitive to soil health. Left to itself, in the light of the trends in the last decades, there is a risk that soil degradation may lead to additional societal and environmental problems that combine features such as low productivity soils that are vulnerable to degradation, climate change that amplifies extreme conditions, low availability of productive soils, or high population density or population growth. The increased demands for food, fibre, biofuels, water, infrastructure and settlements result in growing competing claims for land and soil, and as a consequence, more and more difficult trade-offs between ecosystem services.[46]

3 WHY SHOULD THE EU ACT?

3.1 Legal basis

The legal basis for the EU to act on soil health lies in Articles 191 and 192 of the Treaty on the Functioning of the European Union (TFEU). These articles empower the EU legislator to take measures aimed at:

- preserving, protecting and improving the quality of the environment,
- protecting human health,
- prudent and rational utilisation of natural resources,
- promoting measures at international level to deal with regional or worldwide environmental problems, and in particular combating climate change.

Given that this is an area of shared competence between the EU and the Member States, EU action must respect the subsidiarity principle.

[46] IPBES (2018), Assessment report on land degradation and restoration

3.2 Subsidiarity: necessity of EU action

Intervention at EU level is justified in view of the **scale** and **cross-border aspects** of the problem (cfr. more details below), the impact of soil degradation across the Union as well as the **risks for the environment, economy and society**. Coordinated measures by all Member States are necessary to achieve the vision to have all soils healthy by 2050 as set out in the Soil Strategy for 2030, and to secure the provision of ecosystem services across the EU by the soil in the **long-term**. Unless the current degradation of our soils is rapidly reversed, our **food system** will become **less productive** and increasingly **vulnerable** to the changing climate and reliant on resource intensive external inputs.[47] Actions of Member States by themselves have proven to be **insufficient** to reverse the situation, since the degradation trend is continuing and even deteriorating (cfr. trends and outlook in section 2.1.2). As stated by the European Environment Agency, the lack of a comprehensive and coherent policy framework for protecting Europe's land and soil resources is a key gap that reduces the effectiveness of the existing incentives and measures and limits Europe's ability to achieve its objectives. Europe is not well on track to protect its soils. Given that some aspects of soil health are only fractionally covered by EU legislation, additional EU action is needed to complement existing requirements and to fill policy gaps in a holistic and integrated manner. Indeed, the EU has taken in the past already legislative action with a fragmented impact on soil health (e.g. through policies on agriculture, water, climate, industry, etc.). The policy options will be developed in chapter 5 in full respect of the subsidiarity principle with different degrees of flexibility for Member States and different intensities of EU intervention. The subsidiarity principle is analysed below and more extensively in the subsidiarity grid in the separate Staff Working Document accompanying the proposal and this impact assessment. Whilst the scale of the problem is established in Section 2, the **cross-border aspects of the problem** are particularly relevant for subsidiarity and therefore further explained here.

Cross-border aspects and impacts of soil degradation

The drivers and impacts of the problem **exceed country borders** and reduce the **provision of ecosystem services** throughout the EU and its neighbours. Soil degradation is often wrongly considered as a purely local issue while transboundary impacts are underestimated.[48] Healthy soils are essential to tackle global societal challenges. Soils play a key role in the nutrient, carbon and water cycles, and these processes are clearly not constrained by physical and political borders.

Soil health influences whether a soil emits or sequesters carbon, and therefore, the absence of effective measures to adequately tackle degradation in one country, undermines **climate change mitigation and adaptation** actions in other Member States and EU efforts to achieve climate neutrality by 2050. Every year mineral soils under cropland are losing around 7.4 million tonnes of carbon. Peatland drainage in Europe alone emits around 5% of total EU greenhouse gas emissions. Soil degradation due to unsustainable management practises (e.g. sealing, intensive agricultural and forest management practices that cause loss of soil organic matter, compaction and erosion) in one country can significantly increase the **flooding risks** across borders and the vulnerability of a whole region to extreme weather events.

Off-site costs of erosion are estimated to be much higher than on-site effects. Soil particles **eroded by water** are transported downstream and across borders through the **soil-sediment-water** system and increase turbidity. This reduces water quality and increases sedimentation and costs for water treatment. For nautical reasons, the Port of Rotterdam dredges every year millions m^3 of excessive

[47] RISE Foundation (2022), Sustainable agricultural soil management

[48] IPBES (2018). Thematic assessment of land degradation and restoration

sediments, half of which are brought down by the Rhine as an effect of unsustainable soil erosion upstream. Soil loss to riverine systems is about 15% of the on-site erosion in the EU. The average cost of sediments removal is 15-20 euro per m^3. Removing sediments due to erosion costs about 1.5 – 2.3 billion euro per year. Of the approximately 100 transboundary river basins in the EU, 25% have identified soil erosion as an important issue (due to agricultural practices). Sediments washed away by soil erosion in one country can block dams or damage infrastructure such as harbours in other countries. Other off-site and thus potential cross-border effects of soil erosion by water include increased risk of landslides, loss of biodiversity, adverse effects on the generation of electricity, decreased food supply and increased prices. Tackling the problem in the country of origin by erosion prevention and sustainable soil management is always the most cost-efficient solution.

Excessive use and run-off of nutrients from soils can lead to cross-border **eutrophication** of water bodies and seas. Oversupply of nutrients in agricultural land around the Baltic Sea is a major environmental pressure on groundwater aquifers and the marine ecosystem. Harmful chemicals and heavy metals enter the Baltic Sea via multiple sources and pathways, including from wastewater treatment plants, leaching from landfills and filling material, inappropriate spreading of sewage sludge, atmospheric deposition of industrial emissions, and agricultural use of fertilisers and pesticides. More than 97% of the Baltic Sea suffers from eutrophication caused by multiple countries. Europe is a global nitrogen hotspot with high nitrogen export through rivers to coastal waters, and 10 % of the global nitrous oxide (N2O) emissions.[49]

Erosion by wind transports soil particles and the harmful chemical substances attached to them across long distances and borders, e.g. the wind-driven transport of glyphosate and aminomethylphosphonic acid (AMPA, the metabolite of glyphosate). Similarly, anthropogenic emissions of air pollutants and subsequent **deposition** of heavy metals are known to cause negative effects on chemical and biological processes in soils. Wind erosion affects the transboundary semi-arid areas of the Mediterranean region as well as the temperate climate areas of the northern and central European countries. Transport of **contaminated sediments** in transboundary river basins and coastal waters can have adverse effects on the environment, human health and the economy across borders. Action is needed not only on source control, but also to deal with 'legacy' contamination where contaminated sediment is likely to be remobilized during extreme events (e.g. floods) and because such events are likely to become more frequent.

Contaminants introduced to soil leach into ground, surface, marine and coastal waters, leading to contaminated drinking and bathing water, and finally ending in the sea. Transboundary aquifers can become polluted by soil contamination. It is therefore important to prevent and remediate at the source, otherwise costs to restore environmental quality have to be borne by another Member State. A known example of transboundary contamination is the Campine area in Flanders and the Netherlands, where heavy metals were emitted by the Belgian non-ferro industry and zinc ashes were used as filling material. **Atmospheric deposition** of heavy metals also causes negative cross-border effects on chemical and biological processes in soils. Even though emissions were drastically reduced thanks to strong EU air policy, the impact of historical deposition can last very long. Lead and cadmium concentrations from deposition decreased in soil upper layers but were transferred in deeper soil layers. Heavy metals continue to leach from soil to water long time after the depositions are reduced. Another example of cross-border effects is the large-scale PFAS contamination caused by a chemical producer in Antwerp, that is mobile and crossing the border with the Netherlands.

[49] Van Grinsven et al., 2013.

Soil contamination can immediately become a cross-border threat to **food safety** in Europe and globally. Contamination of agricultural soils can lead to transboundary risks when resulting in food contamination that subsequently circulates freely in the EU **internal market**. E.g. dietary exposure to cadmium exceeds the tolerable level more than twice for a significant number of Europeans, including children. Food from agricultural products is the main source of cadmium exposure for the general, non-smoking population in the EU, and fertilisation with phosphate fertilisers is by far the main cause of cadmium contamination of European agricultural soils.

As stated in the recent Staff Working Document on the drivers of **food security**, the food supply chain is internationally highly interconnected and disruptions have increasingly been of transboundary nature.[50] This is reinforced by the fact that the EU is an important global player on international food markets. Since 95% of our food is produced on soils,[51] soil degradation and health is a driver that has a direct impact on food security and the cross-border food markets. No country in the EU is fully self-sufficient in terms of food security. The Global Food Security index[52] shows that the situation varies between Member States, but even the best performing EU countries still depend on soils beyond their borders and import for the provision of food. Food production, in combination with trade determines the food supply.[53]

The loss of capacity for **food production** due to unhealthy soils has an obvious effect on the overall food security of the EU and globally, with a view to the growing global population and EU's strong agri-food export orientation. As the balance between food supply and food demand determines the price, soil health is also directly linked to food prices. In 2021, 66% of the cereals produced in the EU came from only five countries. Decreasing soil health in these countries affects the availability of these products within the entire internal market and beyond. Agriculture in the EU is losing around 0.43% of crop productivity annually (with an annual cost of 1.25 billion euro) from water erosion alone. Soil degradation causes losses of almost 3 million tonnes of wheat and 0.6 million tonnes of maize per year in the EU. Heavy agricultural equipment deployed in wet conditions can reduce, through soil compaction, long-term crop yields by 2.5-15%. Soil sealing caused a loss of 0.81% of agricultural production in 19 EU countries between 1990 and 2006, the equivalent of 6 million tons of wheat. Salinisation leads to decreased biomass production of a further 10 million hectares per year.

The cross-border aspects of soil degradation call for close cooperation with EU neighbours, but this cannot be done properly unless the matter is first addressed within the EU. European policy should protect citizens of a given country from the harmful consequences of natural resources management practices in another country for which they are not responsible.[54]

3.3 Subsidiarity: added value of EU action

Coordinated action is needed **to deliver on EU and global commitments that rely on soil health**, and this initiative would allow for increased certainty for meeting these objectives and for reduced costs of doing so. The European and international commitments (e.g. under UNCCD, UNFCCC, CBD, SDGs, UNEA, etc.), adopted by the EU and its Member States are currently not matched by a corresponding level of action.

[50] Commission Staff Working Document on drivers of food security SWD(2023) 4 final
[51] FAO (2022): Soils for nutrition: state of the art. https://doi.org/10.4060/cc0900en
[52] Global Food Security Index (GFSI) (economist.com)
[53] Commission Staff Working Document on drivers of food security SWD(2023) 4 final
[54] Opinion of the Committee of the Regions on 'Implementation of the Soil Thematic Strategy' (2013/C 17/08)

Working at European scale is essential**,** as currently **soil protection policies vary markedly from one Member State to another**. Lower environmental requirements in some Member States may lead to **distortions in the internal market and unfair competition** among businesses. Some Member States have sophisticated soil protection policies and rules, others do not have provisions beyond those derived from EU non-soil specific policies. Some Member States have put more general soil protection legislation in place (e.g. AT, BE, DE, NL, SK), more specific agricultural or cultivation acts (e.g. BG, HR, SI, CZ, PL, DK), specific legislation for contamination and remediation (e.g. AT, FI, BE) or the sub-soil (e.g. LV, NL). Member States having less soil-protecting policy instruments in place are often those suffering from high pressures on soil, in particular in southern countries where depletion of soil organic carbon, soil erosion and the risk of desertification are the highest. **Differences between national rules** can lead to very different obligations for economic operators, different cost bases from one Member State to another and an uneven playing field (e.g. due to higher investigation or remediation costs).

There are considerable differences between the efforts that Member States deploy to identify and remediate (potentially) contaminated sites, e.g. Bulgaria has only registered 26 potentially contaminated sites, compared to more than 350.000 in Germany. Some Member States have fairly effective soil investigation schemes and remediation rates, others only remediate few sites per year, resulting in little progress in the management of contaminated sites. Remediation costs are normally borne by the polluting company, so this means that businesses in certain Member States are disadvantaged compared to companies in countries with looser regulation.

Externalities from soil degradation are unequally internalized by landowners, managers, operators and users and this would be reflected in the prices of the products they source on these soils. However, soil degradation results in lower crop yields, higher food prices and decreases the availability of agricultural land. Reduced soil fertility increases the cost of inputs for farmers and reduces their competitiveness in the longer run. These can distort the competition in the internal market. The proper functioning of the single market requires addressing the cause of these imbalances, i.e. ensuring soil health.

The Soil Strategy aims to have all EU soil ecosystems in healthy condition by 2050 and already noted that this will require decisive changes in this decade. By 2050 protection, sustainable use, and restoration of soil should become the norm. This requires immediate legislative action to fill the gap on soil at EU level. A Soil Health Law would **increase legal certainty** for European companies and provide clarity on the joint principles and long-term targets for soil health across Member States. Soil health improvement requires continued action which means constant investment and policy stability. Less subject to short-term political perturbation, the EU can provide the long-term dimension in a different way to national governments. Unified environmental norms at EU level bring clarity and certainty for the single market. Such a common vision and legal framework would also stimulate the development of **innovative solutions** that could strengthen the **export** of European expertise and technologies to non-EU countries.

Furthermore, the cross-border impacts of the problem, including the pressures on soil, mean that addressing the issue at European scale will also allow for **synergies and more efficient action** than if at Member State level alone. The process of regulating soil health is complex and requires scientific expertise. This could partly explain why some Member States have not yet taken action. A significant advantage of legislative EU action is that it partly eliminates the need for Member States to carry out their own scientific analyses, stakeholder consultations and impact assessments, with likely substantial savings on administrative costs. Some Members States have not yet taken advanced action on soil health, because soil degradation is often perceived as a hidden threat and complex problem with many links to other policy domains. EU-level action is needed to ensure a consistent approach across the EU and beyond and would allow for significant sharing of best practice and also to support soil monitoring by developing advanced remote sensing services and providing assistance to the Member States in need.

Further analysis of subsidiarity is provided for the policy options in subsequent Chapters and in the separate Staff Working Document with the **subsidiarity grid**.

Views of stakeholders on the need for EU action

The feedback received in response to the **call for evidence** 'soil health – protecting, sustainably managing and restoring soil'[55] (see Annex 2 for more analytical detail) revealed support for an EU initiative across responding stakeholders. 149 of the 189 (79%) replies support or strongly support an EU Soil Health Law. All responding research organizations (n=11), NGOs (n=39) and public authorities (n=9) supported it, while 47 of the 71 responding business associations and organisations, did so. Qualitative analysis showed that some businesses emphasized the importance of soil monitoring and the linkages with EU water policy and favoured the application of a risk-based approach to address issues with soil contamination in the EU. Some businesses voiced concerns about the risk of double regulation and additional administrative burdens. Others would prefer a non-binding approach at EU level and demand that the Soil Health Law leaves enough flexibility to take in to account the diversity and local condition of the soil (no one size fits all).

88% of the 5 782 respondents to the **online public consultation**[56] replied that the causes of soil degradation are currently not sufficiently or not at all addressed at EU level. Regarding the content of the Soil Health Law, respondents found it most important to regulate requirements for the sustainable management of soil (r=4 961) and to impose an obligation of result for Member States to achieve healthy soils (r=4 954).

In general, **Member States** express their support to the Commission in stepping up efforts to better protect soils and stay committed to reaching land degradation neutrality. All Member States welcomed the new EU Soil Strategy and are prepared to make progress towards the objective of 'zero net land take' by 2050. The Council confirmed it remains determined to work with the Parliament and the Commission on soil protection and on any emerging initiatives that would be proposed in this regard. In general, Member States ask for sufficient flexibility to adapt the EU framework to the national conditions and to respect the subsidiarity and proportionality principles.

Regional and local authorities have called the Commission through the European Committee of the Regions to propose a European Directive specifically for agricultural soils and have also welcomed the new Soil Strategy and the announcement of the Soil Health Law. They are of the view that supporting soil protection through a European framework is crucial to move towards climate neutrality, biodiversity restoration, zero pollution and a sustainable food system. At the same time regional and local authorities ask for flexibility in the implementation because of the regional differences in terms of spatial planning, landscape, soil composition and soil use.

[55] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13350-Soil-health-protecting-sustainably-managing-and-restoring-EU-soils/feedback_en?p_id=28624022

[56] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13350-Soil-health-protecting-sustainably-managing-and-restoring-EU-soils/public-consultation_en

4 OBJECTIVES: WHAT IS TO BE ACHIEVED?

4.1 The intervention logic

Figure 4-1: intervention logic

Drivers	Problem	Impact	Objectives	Policy options
Market failures • Costs of harmful practices not borne by those who benefit (cost externalization) leading to a comparative advantage. • Financial gains of land take are considerably larger than the value of ecosystem services provided. • Land tenure and speculative contracts ignore future impact of soil degradation and do not incentivise to improve soil health. • Buyers of land are not aware of soil health and cannot integrate restoration costs into price. **Regulatory failures** • Insufficient national and EU legal framework to monitor, assess, sustainably manage and restore soils; • National spatial planning rules do not prevent the negative impact on soil health of urban sprawl, spatial development and construction; • Cost of soil degradation and the losses of ecosystem services are insufficiently integrated into economic decisions. **Behavioural biases** • Bias in management choices due to the difficulty to timely identify soil degradation and tipping points for loss of ecosystem services. • Lack of awareness of the importance of soil health.	**Main problem** Soils in the EU are unhealthy and continue to degrade. **Sub-problem A** Data, information, knowledge and common governance on soil health and management are insufficient. **Sub-problem B** Transition to sustainable soil management and restoration is needed but not yet systematically happening, e.g. for the unsolved legacy of contaminated sites.	Critical loss of key ecosystem services: • food and biomass provision • carbon sequestration • water filtering and cycling • nutrient cycling • habitat for biodiversity This leads to risks for human health, the environment, economy and society. Including: • Flooding risks, water scarcity and heat islands; • Reduced soil fertility, risk for food security and safety; • Affected terrestrial and aquatic ecosystems; • Climate change deterioration and desertification; • Increased competition for land.	**General objective** To achieve healthy soils across the EU by 2050, ensuring that soils can supply multiple ecosystem services at a scale sufficient to meet environmental, societal and economic needs, and reducing soil pollution to levels no longer considered harmful to human health and the environment. **Specific objective A** To ensure that sufficient data, information and knowledge on soil health and management is available to stakeholders and an adequate governance on soil health is in place. **Specific objective B** To restore unhealthy soils (including contaminated sites) and ensure sustainable management of all soils, whenever possible.	**5 building blocks** **(A)** Soil health and soil districts **(A)** Monitoring **(A)** Definition and identification of contaminated sites **(B)** Sustainable soil management **(B)** Restoration and remediation **2-staged approach** 1) monitoring (Option 1) + SSM 2) Restoration based on monitoring **3 sets of other options** Modulation within building blocks: **O2**: High flexibility **O3**: Targeted flexibility and harmonization **O4**: High EU harmonization **4 'add-ons' considered for integration** **(A)** Net land take definition and reporting **(A)** Soil health certificate **(A)** Passport for excavated soil **(B)** Mandatory 50% reduction nutrient losses

4.2 General objectives

The general objective is to achieve healthy soils across the EU by 2050, ensuring that EU soils can supply multiple ecosystem services at a scale sufficient to meet environmental, societal and economic needs, and reducing soil pollution to levels no longer considered harmful to human health and the environment. This objective stems from the vision of the EU Soil Strategy for 2030 that by 2050, all EU soil ecosystems are in healthy condition and are thus more resilient, which will require very decisive changes in this decade. This is also in line with the long-term objective of the 7th and 8th Environmental Action Programmes to live well, within the planetary boundaries by 2050.

4.3 Specific objectives

The specific objectives to respond to the two sub-problems are:

a. To ensure that sufficient data, information and knowledge on soil health and management is available to stakeholders and an adequate governance on soil health is in place.
b. To restore unhealthy soils (including contaminated sites) and ensure sustainable management of EU soils, whenever possible.

There is a close relationship between these two specific objectives. Putting in place a reliable monitoring and assessment system, producing a solid knowledge base is essential in managing soils. Indeed, taking adequate and effective action to achieve healthy soils requires data, information and knowledge, in particular to account for the high variability of soil types, climatic conditions and land uses. In turn, the information coming from sustainable soil management on the ground informs and helps calibrating the monitoring and governance mechanisms. Furthermore, as the scale of the problem is significant, it is essential to start taking measures ensuring soil health (specific objective b) as soon as possible, so that the general objective is attainable.

4.4 Synergies and trade-offs with other objectives

Restoring unhealthy soils and avoiding their degradation through sustainable soil management would contribute to the achievement of other EU Green Deal objectives:

- healthy content in soil organic carbon would contribute significantly to climate neutrality;
- healthy, and therefore fertile and resilient soils would contribute significantly to the food security and in addressing the request for biomass production, in particular in the long term due to the expected higher resilience to climate change;
- healthy soils, not exposing humans and the environment to unacceptable risks due to soil contamination, would contribute to the zero pollution ambition;
- healthy soils would contribute to achieving good ecosystem condition, addressing the loss of biodiversity.

Furthermore, ensuring sufficient data on soil health will provide a needed basis to monitor forest soils and to monitor the progress in achieving the targets related to soil set in the NRL proposal and in LULUCF.

Potential short-term trade-offs depend on specific options and practices applied – see analysis in 6.3.7.

5 POLICY OPTIONS

5.1 What is the baseline from which options are assessed?

The baseline scenario is detailed in Annex 8 and describes how the current situation is expected to evolve over time without additional policy action.

The baseline assumes the implementation of European Green Deal policies and of the other actions announced in the **Soil Strategy for 2030 (with the exception of the Soil Health Law)**. Beyond that, the baseline also assumes that **other existing and planned EU, global and Member State policies relevant to soil health** are implemented and remain in force.

The baseline therefore includes:
- The implementation of recent policy reforms (e.g. revised LULUCF Regulation, new CAP) and proposals under discussion (e.g. NRL, Certification of Carbon Removal Regulation).
- The implementation of other relevant existing and planned EU and global policies and legislation.
- The non-binding actions for the Commission and Member States set in the EU Soil Strategy for 2030.
- The implementation of national policies relevant for soil health.

5.1.1 The contributions of recent initiatives

Over the last years and months, the Commission has proposed a number of initiatives in the frame of the Union's policy on climate and biodiversity that are very relevant for soils. The new CAP is also expected to contribute to enhance soil health. The potential contributions of the NRL, LULUCF Regulation, CAP and the carbon removal are summarised in Table 5-1 and Table 5-2.**Error! Reference source not found.**

Over the last years and months, the Commission has proposed a number of initiatives in the frame of the Union's policy on climate and biodiversity that are very relevant for soils. The new CAP is also expected to contribute to enhance soil health. The potential contributions of the NRL, LULUCF Regulation, CAP and the carbon removal are summarised in Table 5-1 and Table 5-2.

Firstly, the proposal for the NRL sets EU nature restoration targets to restore degraded ecosystems (i.e. with high importance for biodiversity), and especially those with the most potential to remove and store carbon and to prevent and reduce the impact of natural disasters. The NRL proposal contains a number of provisions directly relevant to soils: obligation for Member States to put in place restoration measures for organic soils in agricultural use constituting drained peatlands, obligations for MS to set two targets, to achieve a satisfactory level of stock of organic carbon in cropland mineral soils and in forest ecosystems. Indirect contributions on soil health are also expected from the restoration measures of terrestrial ecosystems (24% of EU land concerned).

Secondly, under the proposal for amending the LULUCF Regulation, the European Commission proposed a separate land-based net removals target of -310 million tonnes of CO_2 -equivalent by 2030. The EU-wide target is to be implemented through binding national targets for the LULUCF sector, requiring Member States to step up ambition for their land use policies.

Thirdly, the proposed Carbon Removal Regulation aims to facilitate the deployment of high-quality carbon removals through a voluntary Union certification framework with high climate and environmental integrity. Storing carbon in soil is an essential component of reaching climate neutrality. At the same time, carbon removals constitute a new business model in the voluntary market with carbon credits. This initiative is instrumental in ensuring soil's capacity to absorb and store carbon.

Fourthly, the new CAP includes several mandatory requirements for environmental and climate conditions (called Good Agricultural and Environmental Conditions, GAECs) to be respected by the farmers that receive CAP income support. Some of these GAECs are linked to soil management practices and are expected to contribute to enhance soil health. In addition, the CAP provides support to farmers who commit to voluntary measures. Some of those are also of relevance for soils, such as certain eco-schemes or targeted agri-environmental and climate measures (AECM) or investment measures under the second pillar of the CAP (rural development policy).

The contribution of these initiatives to address the different soils threats has been assessed for the different soils (agriculture, forest and other). The major expected contribution (i.e. NRL, revision of LULUCF, Carbon Removal and new CAP) concerns the **loss of soil organic carbon**. For SOC in organic soils, the attainment of the targets set in the proposed NRL is sufficient to reach the corresponding criteria for healthy soils. The revised LULUCF and the carbon removal Regulation will incentivize soil management measures that strengthen the capacity of soils to preserve and capture CO_2. Regarding mineral soils, these initiatives if fully implemented partially addresses the problem.

As regards **soil erosion** on agricultural soils, the new CAP includes some safeguards, especially by two GAECs on soil erosion risk management and soil cover, and certain targeted voluntary measures. This may for example decrease the extent of arable land in the EU left as bare soil without any vegetation cover during winter, which were estimated to be 23 % in 2016. However, due to different priorities and implementing requirements across the Member States it is estimated these instruments would not be suitable to cover the problem to full extent.

Soil compaction is not expected to be specifically addressed by the above-mentioned initiatives.

Positive impacts on **the excess of nutrients** on agriculture soils are expected from the GAEC on soil cover and crop rotation, as well as some voluntary measures where available. However, not all agriculture soils are concerned and there is no binding target to be achieved. Furthermore, the target on water ecosystems as well as the restoration measures on terrestrial habitats under the proposed NRL is also expected to contribute to the reduction of the excess of nutrients in soils. However, this would concern a maximum of 24% of all soils. Hence it is estimated that a large gap would remain.

On **soil acidification**, the target on restoration of terrestrial habitats under the proposed NRL may contribute to reduce soil acidification. However, this would concern a maximum of 24% of all soils. Hence it is estimated that a large gap would remain.

On **soil salinization**, the rewetting target under the proposed NRL may probably contribute locally to reduce soil salinization in some agricultural soils. However, only an indirect contribution is expected. Therefore, a large gap would remain.

On the **loss of soil biodiversity**, some eco-schemes and AECM under the CAP are expected to have some positive impacts on agriculture soils. However, due to the voluntary nature of these measures and the great variation in availability across Member States, the potential of the CAP to fully address this problem is limited and it is estimated that only a share of agricultural soil would be impacted. The restoration measures under the proposed NRL would also contribute to address this problem.

On **water retention capacity**, the measures under the proposed NRL and LULUCF revision aiming to increase the soil organic carbon would improve the soil's capacity to retain water. However, there are no specific targets on the soil's capacity to retain water.

On **soil sealing** and artificialization, prevention and remediation of soil contamination, the non-deterioration of habitats under the proposed NRL may prevent from soil sealing and artificialization. Besides this, no further major contribution is expected from the four initiatives.

In conclusion, these recent initiatives will require Member States to take actions that benefit, inter alia, soil health. **However, they only partially address the objectives of this soil health initiative,** because they approach soils from another angle (such as biodiversity and climate neutrality angles as far as NRL, revised LULUCF and carbon removal regulation are concerned). The (soil) targets in the NRL proposal focus on the carbon sequestering potential, which is only one of the many ecosystem services provided by the soil, and only have limited coverage on mineral cropland soils and organic soils, specifically in agricultural and forest ecosystems. As it was already foreseen in the NRL proposal,[57] additional targets for soil health in all terrestrial ecosystem types would be introduced in a more complete and holistic manner at a later stage through this soil health initiative. Similarly, the target for the removal of carbon from the atmosphere by the LULUCF sector, includes mineral and organic soils, but uniquely focusses on the carbon cycle. The LULUCF Regulation creates incentives for improving land management in the EU, but only in view of achieving land-based climate neutrality, since the Regulation does not address other physical, chemical or biological aspects of soil health, than soil organic carbon stocks. The new CAP is also expected to contribute to soil health for the agricultural soils concerned. A specific objective (SO) has been introduced with the aim to preserve natural resources including soil (SO 5). Three GAECs with relevance to soil contribute to this objective and Member States were asked to design further interventions to address soil degradation causes. It is important to note, however, that a) the CAP is a funding mechanism for those farmers seeking support and does not regulate or incentivises farmers who do not participate under its framework; b) the final design of CAP interventions depends on Member States situation and priorities, leading to a wide range of the extent to which the CAP contributes to soil health aspects (cfr. Annex 8 section 1.4 on result indicators); c) the financial budget dedicated to environmental issues must also sufficiently support many other environmental aspects, such as biodiversity loss or reduced use of pesticides, therefore causing a competition for resources between the targeted aspects; and d) since the CAP addresses a large number of potential beneficiaries and a large physical area, there is a possible danger that support is spread too thinly to have a significant effect.[58] In some cases, specific needs could be better addressed when more accurate data and subsequent indicators would be available, to which the Soil Health Law could contribute significantly.

For the sake of completeness, the following initiatives were also added in Table 5-1**Error! Reference source not found.**:

- The proposal for a regulation on the sustainable use of plant protection products and amending Regulation (EU) 2021/2115 (COM(2022)0196 final)
- The proposal for a revision of the Industrial Emissions Directive (COM(2022)156)
- The future Communication on managing the nutrient cycle for a resilient future - reaping the benefits of an integrated approach (INMAP)

[57] See Proposal for a Regulation of the European Parliament and of the Council on nature restoration, explanatory memorandum
[58] Impact assessment accompanying the proposal for a new CAP: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=SWD%3A2018%3A301%3AFIN

Table 5-1: estimated effect of new EU initiatives on soil health and remaining gap

	estimated effect of new initiatives on soil health			new initiatives					SHL	
	agriculture (~40%)	forest (~40%)	urban & other ~20%	NRL (proposal)*	LULUCF	CAP NSP	CARBON REMOVAL	other ongoing EU initiatives	remaining gap	remaining gap adressed by SHL
Loss of SOC - organic soils				target on rewetting, Art 4	target on climate neutrality	CAP GAEC on peatland protection	carbon farming practices		no major gap (no additional requirement under SHL)	NA
- mineral soils				cropland and forests, Art4	target on climate neutrality	GAEC on soil cover, eco-schemes and AECM to varying extents	carbon farming practices		Missing target at EU to reach adequate level for delivering ecosystems services (beyond storage)	Y
Unsustainable erosion						eco-schemes and AECM to varying extents			soils outside of CAP not covered, soils on certain slopes only partially addressed under CAP	Y
compaction				Art 4, covering 24% of EU land					large gap; topsoil and subsoil compaction	Y
excess nutrients				Art 4, covering 24% of EU land		eco-schemes and AECM to varying extents		INMAP	gap on soils remains; currently no legally binding target on reduction of excess nutients in soil	partially (phosphorus only)
acidification				Art 4, covering 24% of EU land					gap partially adressed; no target in SHL no applicable protection principle or measurement;	(for the part in nutrients)
salinization				Art 4, covering 24% of EU land					large gap on soils remains; other areas not covered by NRL	Y
loss of soil biodiversity				targets on cropland & forests, Art 4		several GAECs, eco-schemes and AECM to varying extents		Proposal on SUR**	no target under SHL; no applicable protection principle or measurement	Y
sealing and artificialization				non-deterioration					not addressed beyond non deterioration obligation under NRL	Partially
Loss of water retention capacity				(targets on SOC)	(target on climate neutrality)	(GAECs on soil cover and crop rotation, eco-schemes and AECM			Increase of SOC will have direct impat but there is no overall measurement and target to prevent disasters.	Y
										TOTAL excluding contamination
Contamination - prevention								propsal for revised IED ; proposal on SUP	good coverage by existing legislation but not all activities concerned;missing overall prevention principle (SSM); no overall measurement of effectiveness in soils	Partially (through SSM)
Contamination - historical									not adressed under existing and ongoing initiatives; legislative gap	Y
										TOTAL

legenda

Soil degradations addressed by new EU initiatives

- addressed to a large extent (roughly 50-100%)
- somewhat to partially addressed (roughly 10-50%)
- minor positive impacts can be expected (roughly from >0 to 10%)
- Gap
- very low or no relevance

(*) the remaining gap depends on the difference between proposal and adopted regulation

(**) SUR = proposal on sustainable use of plant protection products

Table 5-2: quantification of the benefit from SHL reduction of the cost of soil degradation after the positive effects of other EU initiatives (in the baseline). The costs used are the upper values of the quantified costs (see 2.1.4 Costs of soil degradation).

	estimated effect of new initiatives on soil health			SHL			potential remaining benefits of SHL	
	agriculture (~40%)	forest (~40%)	urban & other ~20%	remaining gap	remaining gap adressed by SHL	cost of no action (b€) - upper quantified value	min	max
Loss of SOC - organic soils				no major gap (no additional requirement under SHL)	NA	25,0	-	-
- mineral soils				Missing target at EU to reach adequate level for delivering ecosystems services (beyond storage)	Y		9,1	12,5
Unsustainable erosion				soils outside of CAP not covered, soils on certain slopes only partially addressed under CAP	Y	23,1	17,9	22,1
compaction				large gap; topsoil and subsoil compaction	Y	9,2	9,0	9,2
excess nutrients				gap on soils remains; currently no legally binding target on reduction of excess nutients in soil	partially (phosphorus only)	N/A	-	-
acidification				gap partially adressed; no target in SHL no applicable protection principle or measurement;	(for the part in nutrients)	N/A	-	-
salinization				large gap on soils remains; other areas not covered by NRL	Y	1,0	1,0	1,0
loss of soil biodiversity				no target under SHL; no applicable protection principle or measurement	Y	N/A	-	-
sealing and artificialization				not addressed beyond non deterioration obligation under NRL	Partially	6,6	0,7	3,3
Loss of water retention capacity				increase of SOC will have direct impat but there is no overall measurement and target to prevent disasters.	Y	3,9	3,5	3,9
					TOTAL excluding contamination	**68,8**	**41,1**	**52,0**
Contamination - prevention				good coverage by existing legislation but not all activities concerned;missing overall prevention principle (SSM); no overall measurement of effectiveness in soils	Partially (through SSM)	N/A		
Contamination - historical				not adressed under existing and ongoing initiatives; legislative gap	Y	292,4	292,4	292,4
					TOTAL	**361,2**	**333,5**	**344,4**

legenda

Soil degradations addressed by new EU initiatives

- addressed to a large extent (roughly 50-100%)
- somewhat to partially addressed (roughly 10-50%)
- minor positive impacts can be expected (roughly from >0 to 10%)
- Gap
- very low or no relevance

5.1.2 Contribution of existing EU legislation (see Annex 6 for more details)

Existing EU policies make positive contributions to the improvement of soil health but will not be sufficient to achieve the vision of the Soil Strategy to have all soils healthy by 2050 because they do not comprehensively address all the drivers of soil degradation and therefore significant gaps remain as explained in detail in chapter 2 and Annex 6. **Existing policies have not been able to prevent that 60-70% of soils in the EU are not healthy and that soil health is still deteriorating in the EU**.

Annex 6 includes a gap analysis to show how existing initiatives do not fully enable the achievement of the objectives identified in this impact assessment. At the same time, the link with other initiatives creates an opportunity for synergies: the Soil Health Law can build on efforts already established in other soil-related areas and can support other initiatives through a stronger governance framework and the provision of more harmonised data.

The gap is represented visually in the following tableTable 5-3. Further explanations on the legislative gap are provided in section 2 of Annex 6.

Table 5-3: legislative gap

		EU Waste legislation	EU Water legislation (including nitrates dir)	EU Nature legislation (other than NRL)	EU Air legislation	EU Industrial emissions legislation	EU legislation on specific substances	SEA/EIA (limited to evaluation of impacts)	Environmental liability directive	Environmental crime directive
Nutrient loss/ excess of nutrients in soil	Agricultural		(nitrates)							
	Forestry									
	Urban									
	Industrial									
Loss of/ low soil organic Carbone (SOC)	Agricultural									
	Forestry									
	Urban									
	Industrial									
Soil Erosion (by water or air)	Agricultural									
	Forestry									
	Urban									
	Industrial									
Soil compaction	Agricultural									
	Forestry									
	Urban									
	Industrial									
Soil acidification	Agricultural		By nutrients and pollutants		By air pollution					
	Forestry				By air pollution					
	Urban				By air pollution					
	Industrial									
salinisation	Agricultural		by water abstraction							
	Forestry		by water abstraction							
	Urban		by water abstraction							
	Industrial									
Water retention capacity	Agricultural									
	Forestry									
	Urban									

	Industrial									
Loss of soil biodiversity	Agricultural		By reducing fertilisers				By reducing pesticides			
	Forestry									
	Urban									
	Industrial									
Soil sealing/land take	Agricultural									
	Forestry									
	Urban									
	Industrial									
Prevention of soil contamination	Agricultural	sewage sludge and illegal dumping	Diffuse contamination	Diffuse contamination	Diffuse contamination		Diffuse contamination			
	Forestry	illegal dumping	Diffuse contamination	Diffuse contamination	Diffuse contamination		Diffuse contamination			
	Urban	illegal dumping	Diffuse contamination	Diffuse contamination	Diffuse contamination		Diffuse contamination			
	Industrial	illegal dumping and landfills					Diffuse contamination			
Remediation of soil contamination	Agricultural									
	Forestry									
	Urban									
	Industrial	By landfills				Historical contamination not addressed			Anthropogenic contamination (with strong limitation regarding type of damage)	

	Direct contribution to soil protection
	Indirect contribution to soil protection
	No or very minor contribution to soil protection

5.1.3 EU Soil Strategy for 2030

Section 3 of Annex 8 lists the non-binding policy initiatives under the EU Soils Strategy that have been considered and assessed their expected impacts on the baseline scenario.

5.1.4 Existing Member States legislation

Section 5 of Annex 8 describes and assesses the contribution of existing Member States legislation

5.2 Description of the policy options

The description of the policy options is done through five key building blocks (see the columns in **Error! Reference source not found.Error! Reference source not found.**), responding to the two specific objectives and representing the key areas of intervention. The building blocks on soil health and soil districts, monitoring and identification of contaminated soils respond to specific objective A. The building blocks on sustainable soil management and restoration respond to specific objective B.

There are two factors that need to be taken into account for detailing how the obligations would be defined: the level of harmonization at EU level of the monitoring and action framework, and the level of flexibility provided to Member States to adapt to specific local conditions.

Option 1 has binding requirements only for monitoring, therefore it is relevant under building blocks 1, 2 and 4 only. Options 2, 3 and 4 have been developed for each building block, from a more flexible to a more harmonized approach, specifying how the obligations would be implemented.

The coherence in the combination of the options from the building blocks has been assessed as well.

Block 1: soil health definition and soil governance

Definition of soil health addressing the key aspects of soil degradation

Soil health can be described with a degree of accuracy by a set of relevant parameters. To establish such parameters, it is necessary to consider all the key types of soil degradations, and ensure that, for each of them, at least one indicator or "descriptor" is identified. A list of soil descriptors corresponding to the identified aspects of soil degradations is included in Table 7-1. The list includes descriptors for the excess of nutrients in soil and indicators for the extent of land take and soil sealing. This preferred option and in particular the descriptor for soil organic carbon is aligned with and refers to the target in the NRL proposal for organic soils in agricultural use constituting drained peatlands. No additional organic carbon target is set for organic soils. As regards agricultural (only cropland mineral soils) and forest ecosystems, the Member States are required in the NRL to set a satisfactory level for the stock of organic carbon. The soil health definition provides a solution to the Member States for setting ranges for SOC to ensure minimal soil functionality, supported by recent scientific conclusions; furthermore, the definition extends the applicability of the range beyond cropland mineral soils in agricultural ecosystems and forest ecosystems to all managed mineral soils.

Table 7-1The definition of soil health has important implications for the sustainable soil management and restoration measures as it determines the parameters to be followed to maintain soil in healthy status or to be met when restoring soils to healthy condition. The more precise these values, or narrower the ranges are set at EU level, the less flexibility for the Member State. Conversely, less specific values or broader ranges allows more flexibility to the national level to accommodate specific local conditions etc., but also make the objectives less ambitious. This is an important factor that distinguishes between the options analysed.

In order to assess the level of soil health in a given area, the resulting set of descriptors are to be measured on a soil sample taken in the field (except soil erosion which is estimated for the whole area); the values of the descriptors will describe the soil condition for the specific point where the soil sample has been taken. To do so, it is necessary to evaluate the variability of soil characteristics in that area, which implies taking a sufficient number of geographically explicit samples to be able to extrapolate from point assessment to area assessment with a sufficient level of statistical assurance. This is a typical problem solved by the scientific discipline of geostatistics, which is able to identify, for a given area, the best sampling density for providing a desired level of assurance that soils in a certain area are healthy (or estimate the percentage of the area where soils are not healthy). The denser the grid, the more representative the information received, but the higher the cost of the assessment. Consequently, it is important to strike the right balance between limiting costs and obtaining accurate information about soil health.

As land take is one of the main impacts on soil condition, as explained in chapter 2.1, a common EU definition would provide a degree of harmonisation to the monitoring of land take towards the common objectives.

Soil governance

The assessment of soil health in an area is best done (lower costs and higher statistical assurance) if this area has characteristics of homogeneity in terms of soil type and composition, climatic conditions and land use. This and the need to manage the related tasks require the establishment of sufficiently homogeneous zones (districts) within a Member State where to assess soil health, and which management would be assigned to an authority. Given the great variability of soils in the EU, a reasonable compromise between homogeneity of soil condition in such a district and a manageable number of soil districts is needed. It is at soil district level that soils are best assessed and monitored, and local actions taken to achieve healthy soils.

Options

In Option 2, Member States are given the flexibility to decide the values for a selected set of descriptors for defining the target soil. However, this will result in very different level of ambition in the Member States which would undermine the objectives pursued, considering that the soil assessment and management is based on these parameters. Second, a minimal governance structure has to be put in place as explained above to make sure that soils are assessed and managed. Option 2 includes an obligation to set up soil districts and appoint authorities to manage these but sets no requirement on the form or level. In Option 4, at the other side of the spectrum, soil health values for all descriptors and soil districts are determined at EU level as precisely as possible taking into account parameters like the soil types and land use, for maximum harmonisation. This would pose challenges in reaching an agreement as indicated also in the consultation of the Member States, for example finding a common denominator for soil pollutants or biodiversity parameters. In between option 2 and 4, option 3 defines general criteria for determining soil districts (such as having to cover the whole territory) but the determination is left to Member States and defines soil health values for a selected set of descriptors, based on available scientific knowledge that already takes into account the variability of soil condition. The values selected are those for which an out-of-range value would mean a critical loss of ecosystem services. For the remaining descriptors setting the values would be left to the Member States if this can be done and depends on the local specific conditions (for example water retention) or will set no value if this is difficult at this stage (acidification) – see Table 7-1. Option 1 focuses on monitoring only and can rely on any of the choices above, taking into account the implications.

Block 2: soil health monitoring

Soil health monitoring builds on the existing national soil monitoring systems, on the work done for the EU Soil Observatory and on the knowledge available from science, as assessed in the recent EEA report on soil monitoring in Europe.[59] In the future, soil health monitoring will be able to profit from new knowledge from relevant projects financed under the Soil Mission of the Horizon Europe Programme.[60] A monitoring system for soil health would profit to the requirement of monitoring and reporting of soil organic carbon under the revised LULUCF Regulation and the proposal for the certification of carbon removal, to the requirement of monitoring soil organic carbon stocks in cropland stemming from the Nature Restoration Law proposal and to the Forest Monitoring Law.

Monitoring and assessment of soil health

While soil monitoring has been carried out at both national and EU level, a comparable, coherent and sufficient gathering of soil data needs to be put in place to have a meaningful situation of the soils conditions everywhere in the EU, able to inform and support soil management. LUCAS Soil (part of the periodical LUCAS survey funded by the Commission) could serve as basis for this, as it is the only in-situ soil survey that provides harmonised soil measurements across the EU and can be the reference for comparability of national measurements. LUCAS sampling points are selected from a 2km×2km grid that covers the European territory through a stratified random procedure, which should ensure that the results are representative for all land cover types at NUTS2 (basic regions or province level). However, the current design of LUCAS Soil is not sufficient to adequately assess soil in a representative way at more local level, given the large variability of soil types, climatic conditions and land uses, and thus to inform adequate soil restoration actions. Therefore, a common feature of all options of this building block is to strengthen LUCAS Soil and to create a clear legal basis for it, in synergy with national monitoring systems. LUCAS soil is already collaborating with interested Member States to ensure access to sites (e.g. contact landowners, collection of land management details, etc.), to

[59] https://www.eea.europa.eu/publications/soil-monitoring-in-europe

[60] Two major projects funded under the EU Mission "A Soil Deal for Europe" (Benchmark and AI4SoilHealth – 2022-2026) aim at significantly contribute to the evidence needed to further pursue the harmonisation of soil monitoring in the EU. This will include the delivery of further knowledge on harmonised and cost-effective indicator- and proxy measurements for the assessment of soil health, and on sampling framework, methodology and protocols to support regulation and monitoring needs. Furthermore, work will apply cutting edge Artificial Intelligence methods to soil datasets and measurements.

supplement LUCAS Soil with national monitoring data, to cross-validate results and to improve the harmonisation and comparability between national and EU-wide aggregated indicators.

A key aspect of harmonisation of soil data, and consequent comparability of data at EU level and the possibility for integrating national and LUCAS data, is the "transfer function" between the two different methods of measurement. The Horizon 2020 Joint Research Programme EJP SOIL, involving 24 Member States, is proceeding to validate some transfer functions for the measurements of soil parameters by taking double samples and measuring each with national and LUCAS soil methods. Remote sensing technologies such as Copernicus and related digital solutions have a limited application for soil currently, but already provide key data and information (such as land use and land cover, soil moisture) to complement ground measurements. They provide as well key data for estimating the extent of land take and soil sealing. Recent progress in proximal soil sensing and remote sensing technologies, supported by the development of sensors and computing capacity, facilitate predictive mapping of different soil physicochemical properties (carbon, nitrogen, phosphorus, salinity) with higher accuracy and resolution. Support will be needed from EEA (in cooperation with other institutions as relevant) to provide indicators on soil health based on remote sensing data such as from Copernicus services, for the relevant parameters. A harmonized approach would allow the Commission to provide such services to Member States.

Options

As knowing the condition of soils is essential for soil management and the knowledge gap is significant, all the options rely on an obligation to monitor and assess the conditions of soils and the net land take based on the definitions under block 1. LUCAS Soil uses a list of international standard methods to measure soil parameters. However, Member States could use their own methods (option 2), which would then require converting national measurements into LUCAS-compatible values to ensure comparability at EU level. In this case harmonisation may be limited by the compatibility of these methods for some of the descriptors. Alternatively, the EU methods, based on LUCAS, could be made mandatory for all Member States (option 4). This would provide a high level of harmonisation but requires a major change of methods by the Member States. In-between these two options, option 3 would recommend the use of the methods in the EU list but would allow Member States to use their methods provided that scientifically validated transfer functions would be available for each descriptor. Option 1 focuses on monitoring only and can rely on any of the choices above.

Block 3: sustainable soil management

Using soil sustainably

To achieve healthy soils, it is necessary to ensure that soils are managed in accordance with sustainable soil management principles targeting the types of degradation, by using practices that maintain or increase the soil's capacity to provide ecosystem services on a long-term basis. This requires that the land users gradually and systematically adopt, if not already the case, practices that do not degrade the soil, i.e., that do not cause loss of soil organic carbon, erosion, compaction, salinization, contamination, etc. as described in chapter 2.1. While some initiatives already support the transition to sustainable soil management (see chapter 5.1.2 and Annex 8, section 5), significant efforts are still needed by all Member States to support and ensure this transition on a broad scale.

While a sustainable management principle provides a baseline understanding of the requirements necessary to address one or more causes of soil degradation, a sustainable management practice describes a specific activity that should be applied to comply with that principle. For example, a sustainable management principle could be to avoid bare soils by establishing vegetative soil cover, which would prevent loss of soil organic carbon, excess nutrient content, soil erosion, desertification and loss of soil biodiversity. Appropriate practices could include cultivation of cover crops on arable land between growing seasons, mulching after forest fires, or encouraging groundcover vegetation on all soils of public parks and gardens. Which practices are most appropriate will depend on soil use and local conditions. Principles to be established for sustainable soil management would closely follow existing guidelines and scientific recommendations to best promote sustainable soil management.[61] These principles would target the relevant causes of soil degradations for agricultural, forestry and urban soils described in chapter 2.1 and would guide Member States in developing sustainable management practices, leaving them the choice of the latter.

In the specific case of land use change, there would be one principle whereby a land take hierarchy[62] will be considered in the decision-making process, which is to first avoid soil deterioration and, if this is not possible, to minimise and compensate for it as much as possible. This would leave the choice on land use change in the hands of the Member States, but it would ensure that the impacts of land take and the options available will be considered along other relevant public interests.

Based on the principles of sustainable soil management, sustainable soil management practices would have to be defined according to the specific conditions, so that land managers can apply them to their soils. Table 7.3, chapter 7.1.2 provides examples of practices that are considered sustainable practices and avoid or minimise the risk of various soil degradation. It is important to note that depending on the condition of soil and their impact, not all of these practices would have to be applied at the same time. In addition to the practices listed in that table, an increased application of holistic land management systems, such as agroecological farming, agroforestry, organic farming, close to nature forestry etc., in particular is considered to contribute significantly to achieve healthy soils and prevent the deterioration of the soil health.

Options

In Option 2, an example of principles and practices would be provided in form of an indicative annex to the SHL. In Option 3, common management principles, as explained above, would be set at EU level, while the choice and implementation of specific practices would be left to Member States. Option 4, would, in addition to the common principles, include an obligation to implement certain specific management practices (e.g. integration of nitrogen fixing crops and cover crops in agricultural crop rotation, provision of undisturbed habitats for soil organisms, application of mulching after forest fires) applicable for specific types of soils and soil uses in the EU as well as a ban on certain harmful practices (such as the use of heavy machinery on

[61] Other principles would cover e.g. balanced fertilization and nutrients management, avoiding unnecessary physical soil disturbance, enriching soil structure etc.

[62] Based on the Land take hierarchy set in the EU Soil Strategy

water saturated soils). A staged approach and a flexible application of the non-deterioration principle would be necessary in any case to ensure that sustainable management is phased in in a measured way, to ensure on the one hand that measures that can be put in place are not unnecessarily delayed and on the other, that land managers are not subject to disproportionate costs and the necessary preparations and support are put in place.

Option 1 would not require obligations under this building block.

Block 4: identification, registration, investigation and assessment of (potentially) contaminated sites

Assessing contaminated sites

Tackling the legacy of more than 200 years of industrialisation requires a systematic approach that starts with the identification of sites that are potentially or suspected to be contaminated because of historical or current activities with a high risk but also because of accidents or spills. The contaminated sites are treated distinctly since the concerned localised areas affected by high levels of pollution that require special methods of investigation and management, different from handling the rest of the soils. Out of the estimated 2,8 million potentially contaminated sites in the EU, only 1,38 million sites were registered and known in 2016, 98% of these in only 11 countries. The majority of the locations of potentially contaminated sites and the extent of the contamination are still largely unknown in the EU. Identifying, registering, investigating and assessing the risks of these sites is a prerequisite for soil remediation in block 5.

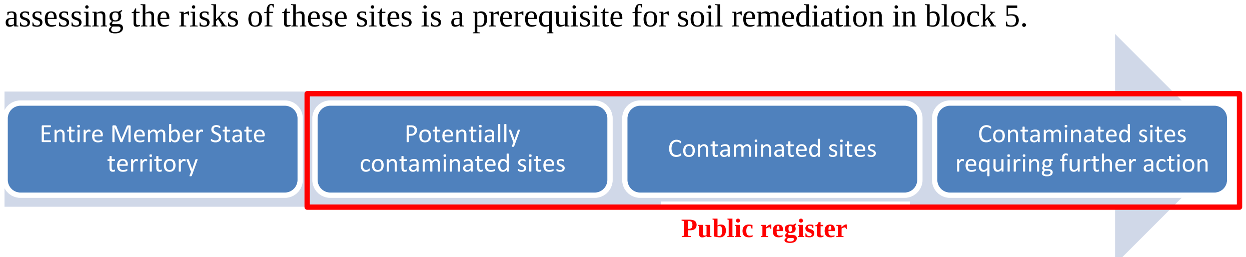


Figure 5-1: registration of (potentially) contaminated sites

Potentially contaminated sites have to be identified and investigated to be able to confirm the presence or absence of contamination. The approach needs to define the conditions that trigger registration, investigation and sampling of potentially contaminated sites (e.g. based on environmental or building permits, systematic historical research, land use changes, transactions with (potentially) contaminated sites, or notifications by citizens). It is important to strike the right balance between maximizing the number of positive soil investigations that detect contamination and minimizing the number of superfluous or negative soil investigations. Member States also need to have a methodology in place to assess whether further action (risk reduction measures) is required on contaminated sites. The information needs to be registered, allowing to track progress over time and to prioritise further action.

Options

Option 2 applies a risk-based approach to estimate the magnitude and probability of the adverse effects of contaminated sites for human health and the environment, including the risk not to achieve good chemical and ecological status of water bodies required by EU water legislation.

Under this option, Member States would be obliged to establish national procedures and methodologies for the assessment of the risks of contaminated sites and risk levels that they find un/acceptable, and they would have full flexibility in the way they would do so. On this basis, Member States would decide for contaminated sites whether further environmental measures are required, and if so, which type of action is needed.

Option 3 also introduces a risk-based approach and obliges Member States to define risk assessment procedures and methodologies, but there will be common EU guiding principles for the risk assessment procedure. These principles could be defined either immediately in the legal proposal or later through a comitology procedure in cooperation with Member States' experts. Under option 3, aspects such as the impact on health and environment could feature among the common criteria, but the risk levels triggering action would be defined at national level.

Option 4 does not apply a risk-based approach for the management of contaminated sites. The need for further action would be systematically triggered if the presence of contaminants exceeds certain limit values established at EU level.

Option 1 could rely on options 2, 3 or 4. The requirements at EU level in building block 4 would only cover identification, investigation, assessment and registration of contaminated sites. Any measure to remediate contaminated sites would be taken based on the relevant national requirements, since option 1 does not include EU requirements on remediation and restoration.

Block 5: soil restoration and remediation[63]

In building block 5, the policy options for the application of restoration measures for unhealthy soils are evaluated. Building on the conclusions of the gap analysis, dedicated soil restoration measures and specific targets additional to the measures already in place serving other objectives, but benefitting soil as well, are crucial to return the 60-70% unhealthy soils in the EU in good condition by 2050. Building block 5 is linked and works in close synergy with all the other blocks: the definition of soil health and the soil districts (BB1), monitoring and assessment of soil health (BB2), sustainable soil management (BB3) and the identification, investigation and assessment of contaminated sites (BB4).

Restoring unhealthy soils

To achieve the 'vision' of the Soil Strategy, that by 2050 all EU soil ecosystems should be in healthy condition[64] restoration measures need to be put in place in a coherent manner on the basis of the assessment of soils. Restoration measures have been shown to be very effective in addressing the soil degradation. An example of successful policy is the US Soil Conservation Act of 1935, which supported farmers to plant vegetation other than commercial crops in order to address the depletion of nutrients in soils linked to over-farming. After four years, wind-inflicted

[63] Soil restoration is an intentional activity with the aim to reverse or rehabilitate soil from a degraded state towards a healthy condition. Remediation is a specific restoration activity to reduce the contaminant concentrations in a site with the aim to re-establish good chemical condition.

[64] For soil contamination, the Zero Pollution Action Plan includes the target that by 2050 soil contamination should be reduced to levels no longer expected to pose risks for human health and the environment.

soil erosion was reduced by 65%.[65] Overall, wind erosion is estimated to impact up to 42 million hectares of European agricultural land.[66]

This process would require reflection and consultations with the concerned stakeholders, which could rely on supporting documents (programmes of measures). Soil districts could be covered by individual programmes or by a single national programme. Alternatively, to these programmes, some intermediary objectives or targets could be envisaged, such as the identification of the soils in need of restoration and of the measures thereof for each district by certain intermediary dates. Nevertheless, as in the case of sustainable soil management (block 3), it is important to note that the restoration measures could be phased in gradually depending on their impact.

Sustainable soil management is closely linked to restoration. Sustainable soil management prevents that a healthy soil degrades by maintaining or enhancing the provision of ecosystem services, and therefore the need to restore in future. Restoration is an intentional activity aimed at reversing or re-establishing soil from a degraded state to a healthy condition. Therefore, restoration measures need to a large extent the results of the monitoring and assessment of the condition of the respective soils. The Member States could also report periodically or be transparent on the progress made in achieving soil health and towards the goal of no net land take by 2050.

Building on the identification of contaminated sites that require further action from building block 4, Member States would need to have in place a systematic approach to reduce and keep the risk of contaminated sites to acceptable levels, e.g. through risk reduction or soil remediation activities.

Options

In option 2, Member States would be entirely flexible to decide on the restoration measures that they put in place, since there would be no specific obligation to develop programmes of measures or to take measures as such – they would only be bound by the obligation to achieve healthy status for soils by 2050. The choice of the risk reduction and remediation measures for contaminated sites would also be left entirely to the Member States. Contaminated sites with unacceptable risks should undergo risk reduction measures, but not necessarily remediation, i.e. they can choose not to remove the contaminants but contain their impacts so that they do not represent an unacceptable risk. Member States would have the possibility to derogate (no opinion from the Commission would be required before granting derogations) from the obligation to have all soils healthy by 2050, when it is not technically feasible or the costs would be disproportionate to restore them. Some categories of unhealthy soils, that could fall under such derogations are:

- soils that are sealed or heavily modified;
- soils that have in natural condition characteristics that could be considered as unhealthy, but that represent specific habitats for biodiversity or landscape features.

In option 3, Member States would be obliged to take restoration measures, subject to derogations, but would be left the choice and form of the programme of measures and the

[65] https://reference.jrank.org/environmental-health/Soil_Conservation_Act_1935.html

[66] JRC (2022) Wind Erosion. Available at: https://esdac.jrc.ec.europa.eu/themes/wind-erosion

measures themselves. The measures would be revised if the monitoring and assessment of soil health comes to this conclusion. The EU could establish some general minimum criteria for the programme of measures that Member States should put in place, e.g.:

- Outcome of the monitoring and assessment of soil health, based on:
  - soil health definition and ranges of the descriptors;
  - soil health parameters to monitor (including net land take);
  - progress in the management of contaminated sites from the national registers;
- Analysis of the pressures on soil health, including from climate change;
- Measures to apply sustainable soil management practices and restoration measures;
- Legislative, policy and budgetary actions taken or to be taken at national level to improve soil health, including also the systematic approach that will be put in place to identify and manage contaminated sites.

It could be required to inform or consult the public on the content of the programme of measures. Contaminated sites with unacceptable risks would need to be remediated as a preference by reducing or removing the contaminant load and source, and not by risk reduction measures that do not address the root of the environmental problem (such as containment, physical barriers, land use restriction or fencing). Prioritisation and planning of the remediation measures for contaminated sites would be left entirely to the Member States in this scenario. Derogations from the obligation remain possible when it is not technically feasible or the costs would be disproportionate to restore them. No opinion from the Commission would be required before granting derogations.

In Option 4, the content of the programmes of measures would be harmonised with an extensive template that needs to be filled in. Measures would need to be selected from a mandatory list in an annex of the Soil Health Law or in delegated acts. Such a list of measures could differentiate between e.g. climatic conditions, land use or soil type, to adapt the restoration practice to local conditions. Member States could derogate from the obligation to have all soils healthy by 2050 based on an opinion from the Commission, as required under other environmental legislation[67] to ensure a harmonised approach. Member States would also have an obligation to have a scheme in place for the liability or responsibility for the remediation of historical and orphan soil contamination. Remediation measures that reduce the contaminant concentrations would be mandatory. Member States should prioritise and plan the management and remediation of contaminated sites based on common EU criteria and intermediary targets for progress. Option 1 would not require obligations under this building block.

5.3 Options discarded at an early stage

Policy option 1 addresses sub-problem A ("*Data, information, knowledge and common governance on soil health and management are insufficient"*) by envisaging a "monitoring only" option to first focus on improving the knowledge base, collecting additional data and information, and strengthen the governance on soil health. Option 1 could represent part of the first phase of a staged approach, where legislative measures on the sustainable use and restoration of soil health would be proposed in a second phase, after the first phase is implemented and resulted in a more developed assessment of soil health in the EU. The basic

[67] Exceptions to the impact assessment requirements under the EIA Directive or approving projects with significant effects on protected sites under the Habitats Directive.

obligations for Member States in option 1 would be to set a definition of soil health through a minimum set of indicators and thresholds, establish soil districts, set up and implement adequate monitoring systems. Member States would also have the obligation to identify, register and assess (potentially) contaminated sites. The advantage of this option would be that it is less demanding for Member States and stakeholders, since it does not require sustainable soil management measures, neither restoration nor remediation. It would also allow setting in place the monitoring framework to generate a more accurate picture of the situation of soils that would inform targeted intervention later on.

The main shortcoming of option 1 is that it only partially addresses the problem, since it provides a solution for sub-problem A, but lacks any measure addressing sub-problem B ("*Transition to sustainable soil management and restoration, as well as remediation is needed but not yet systematically happening"*). It would not set measures to kickstart the urgently needed transition towards sustainable use and restoration of soils, whereas the condition of soils has been very poor for a very long time, as explained in chapter 2. While it is true that the knowledge on soil lacks the accuracy needed to inform immediate action at local level, especially as regards restoration, there is enough data to justify and to set in motion a gradual system to ensure a transition to sustainable soil management towards the goal of preventing further deterioration and ensuring healthy soils. Option 1 would be a missed opportunity that underexploits the current momentum and postpones most of the needed action to an uncertain future. It also does not distinguish between action or requirements that could be put in place at an earlier stage and action that require longer timeframes to prepare. Furthermore, on the basis of the baseline scenario, given the current trends and the outlook for soil degradation, the policy objectives set in 4.2 would not be reached through monitoring obligations alone.

Option 1 would also not meet expectations from the European Parliament who has asked for criteria for the sustainable use of soil and measures to tackle all soil threats. Many of the Member States, stakeholders and the general public agree to a large extent on the importance of taking measures going beyond monitoring. Most stakeholders support an obligation to sustainably use soil, but some farmers, industry and academia ask for sufficient flexibility to adapt sustainable soil management to local conditions. Stakeholders generally support an EU obligation to restore unhealthy soils by 2050 through programmes of measures, but landowners expressed that derogations should be possible for degraded soils. Member States and industry emphasized the need for a flexible approach and to avoid unnecessary administrative burden.

Therefore, this policy option has to be discarded at an early stage. Nevertheless, its main advantage, i.e. less burden and allowing time to gather detailed soil data as a basis for action, will be taken into account when analysing impacts of the various options and in particular the preferred option, notably by considering a staged approached to make sure that the requirements reflect the uncertainties and the time needed to prepare their application.

The Soil Strategy for 2030 undertook to assess the feasibility of the introduction of a **soil health certificate** for land transactions to provide land buyers with information on the key characteristics and health of the soils in the site they intend to purchase (see details of the assessment in Annex 9 chapter 8). A certificate could increase awareness on soil health but there are risks which could impact on its effectiveness, including that significant additional testing could be required. The costs of setting up and maintaining an EU-wide certification scheme linked with land transactions are large, and to have added value, sufficient information on soil health needs to be available. For these reasons this option is discarded as a legally binding provision; however, a voluntary approach by Member States can be envisaged.

The Soil Strategy also undertook to assess provisions for a **passport for excavated soil**, that would reflect the quantity and quality of the excavated soil to ensure that it is transported, treated or reused safely elsewhere (see details of the assessment in Annex 9 chapter 9). The soil passport does not directly address soil health but may have a positive impact by reducing landfilling. Furthermore, a passport could improve the information and data on soil health. However, the passport is expected to have a significant administrative burden for setting up the IT, potential transition costs and maintenance costs, and will bring additional costs for economic operators and construction companies. There is also a high risk of incoherence with the Waste Framework Directive, so this option is discarded.

5.4 Summary of policy options

The following scheme summarizes visually the options previously described:

Figure 5-2: summary of policy options

	Soil health and soil districts	Monitoring	Sustainable soil management	Definition and identification of contaminated sites	Restoration and remediation
Option 2	• MS have to establish soil districts, with choice and form left to them • Values for soil descriptors left to MS, based on an EU definition of healthy soil	Obligation to monitor/assess soil health and net land take, with all the sampling and data collection left to MS	Obligation to use soil sustainably, with principles and practices left to MS, supported by an indicative annex	Obligation to identify contaminated sites and include them in a public inventory, with assessment methodologies and risk acceptability left to MS	Obligation to restore unhealthy soils by 2050 (derogations possible), but no specific obligation at EU level on taking measures (no programs of measures) Obligation to take risk reduction measures where the risk is identified by the MS as unacceptable, choice of risk reduction measures and planning left to MS
Option 3	• Soil district establishment left to MS with common criteria • Common EU values for selected descriptors where approriate, based on an EU definition of healthy soil	Harmonized monitoring based on indicative EU list of methodologies and transfer functions (LUCAS) for national methodologies	Obligation to use soil sustainably supported by some common general principles for sustainable soil management, with practices left to MS	Contaminated sites have to be identified and included in a public inventory based on common principles for assessment defined at EU level but risk acceptability is left to MS	Obligation to restore unhealthy soils by 2050 (subject to derogations) accompanied by obligation to take restoration measures, with choice and form of the programs of measures left to MS - allows for revision if needed based on monitoring Remediation measures with reduction of contaminant load (no containment in situ) where the risk is unacceptable + prioritization and planning left to MS
Option 4	• Soil district establishment defined at EU level • Stricter definition of soil health with ranges for soil health descriptors defined at EU level	Mandatory EU list of methodologies based on LUCAS, and use of transfer functions for MS historical data	Obligation to use soil sustainably with legislative annex that renders some sustainable practices obligatory and bans other unsustainable practices	Non-risk based approach (acceptability defined at EU level) with common EU limit values for contaminants	Obligation to restore unhealthy soils by 2050 and adopt programme of restoration measures with a harmonised content and form Only remediation measures (no containment in situ) + common EU criteria for prioritization and planning
Discarded option 1 - monitoring only option	Considered as part of the monitoring only option	Considered as part of the monitoring only option	Not included in the monitoring only option	Considered as part of the monitoring only option	Not included in the monitoring only option

Increasing flexibility

Increasing harmonization

6 IMPACTS AND COMPARISON OF THE POLICY OPTIONS

The methodology for this impact assessment is detailed in Annex 4. The analysis reflects unavoidable uncertainties (see Annex 9 for more details):

- Because of the greater flexibility allowed to the Member States especially under option 2, the details of the options which will be implemented in practice will not be fully clear until the Member States have determined these elements at national level.
- Quantitative data around the impacts of SSM practices, restoration and remediation measures is limited and dispersed, in particular for environmental impacts.
- It is not possible to quantify at the EU level to what extent local implementation of SSM practices, restoration and remediation measures, changes the value of a soil descriptor.
- Unknown extent of synergy effect of measures: some SSM practices may also lead to improvement of soil health, and consequently have the effect as well of restoration measures, but this effect is not known.

To mitigate these limitations, the following approaches were taken:

- Where possible, working assumptions have been made to facilitate the analysis;
- Based on the data available, an order-of-magnitude estimate of the potential costs has been provided using a selected sample of practices;
- Throughout the analysis, care has been taken to highlight where possible synergies are, focussing in the aggregate analysis on the likely combined, overall benefits.

For each building block, Annex 9 explains how it addresses the sub-problems A and B, details the economic, environmental and social impacts of the option 2, 3, 4, looking as well at the distribution of the effects and link and synergies with the other building blocks. The economic, environmental and social impacts are evaluated based on a comprehensive list of specific impact categories for which the priority level (high, medium, low) for soil has been chosen based on a given rationale.

All options have been assessed with a qualitative score ranging from "---" to "+++" against nine categories grouped into effectiveness, efficiency, coherence and risks of implementation (see Annex 9 section 1.4.2 for details and Annex 4 for further methodological details).

The scoring reflects the direction (positive or negative compared to the general objective) and magnitude (weakly to strongly, limited or unclear). The scale is presented in the table below.

+++	**Very significant direct positive impact**
++	Significant direct positive impact
+	Small direct positive impact
(+)	Indirect positive impact
+/-	Both direct positive and negative impacts, and balance depends on how implemented
0	No impact or only very indirect impacts
(-)	Indirect negative impact
-	Small direct negative impact
- -	Significant direct negative impact
- - -	Very significant direct negative impact

The options have been assessed on this basis against nine categories representing effective, efficiency and coherence (and risks of implementation):

- Effectiveness: (a) Impact on soil health, (b) Information, data and common governance on soil health and management, and (c) Transition to sustainable soil management and restoration
- Efficiency: (a) Benefits, (b) Adjustment costs, (c) Administrative burden and (d) Distribution of costs and benefits (when relevant) - this considers how evenly the costs or benefits are distributed.
- Coherence – highlighting the synergies or not with options under other building blocks, and/or with the broader policy environment
- Risks for implementation.

Risk for implementation is presented separately because it concerns both effectiveness and efficiency. In the case of adjustment and administrative costs, "-" corresponds to less than EUR 1 million, "--" to between EUR 1 and 5 million and "---" to more than EUR 5 million.

For each building block, the scoring of the three options is compared for all nine categories, identifying whether there is an option that results equal or better in all categories.

Quality assurance measures were implemented to ensure a coherent assessment between all policy options.

The main policy choices for the decision makers are over the trade-off between flexibility and harmonisation, in terms of ensuring delivery of the objectives whilst respecting subsidiarity. In terms of the building blocks, the most significant impacts are linked to building blocks 3, and 5 but the other building blocks are essential to enable delivery.

6.1 Analysis of building block 1: soil health definition and soil districts

6.1.1 Environmental impacts

The process of defining soil health indicators and soil districts, will not have a direct impact on the environment. However, these are critical steps necessary to determine the action and measures needed to achieve soils in good health, and hence improve soils and surrounding environment.

6.1.2 Economic impacts

There will be no economic impacts, beyond those discussed under administrative impacts below.

6.1.3 Administrative costs

Administrative costs will be minimal for this block compared to other blocks.

6.1.4 Social impacts

The process of defining soil health indicators will not have direct negative social impacts. However, as mentioned for the environmental impacts, defining soil health descriptors, thresholds and districts is a critical step necessary to determine the action and measures needed to achieve soils in good health, and ensuring an adequate provision of the ecosystem services, tightly linked with food and water security, climate mitigation and adaptation, and preservation of biodiversity. This plays a key role in delivering inter-generational equity, avoiding a greater burden on future generations through the further deterioration of soil health.

Also, defining soil health descriptors can have a positive and direct impact on the provision and use of information for further research and development, such as fertility and erosion studies, remote sensing analysis and ecosystem service assessments. Defining soil health descriptors has as well the ability to contribute to future policy needs, by facilitating the design and delivery of linked regulatory areas (such as climate law).

Soil heath districts can facilitate the engagement of local stakeholders and create a significant incentive towards local participatory approaches for soil management, in particular if the soil health districts are set of a smaller, local size. Participatory processes also enhance knowledge and skills transfer especially in regard to local and traditional ecological knowledge on sustainable management practices, allowing as well intergenerational exchange. Soil health districts are therefore expected to trigger a large social and citizen engagement towards sustainable soil management and soil restoration, fostering ownership of the objectives of the SHL among local communities.

6.1.5 Implementation risks

One implementation risk depends on the partial knowledge on which soil descriptors and related ranges are defined, which may lead to take sub-optimal decisions and actions. Another risk is the potentially great variability of soil districts and the uncertainty on how adequately the different pedoclimatic conditions and land use would be taken into account. Risks to implementation of each option under this building block due to lack of human or financial resources is low, as existing structures can be used to define soil health descriptors and establish soil districts.

6.1.6 Stakeholder views

The majority of stakeholders recognise the value in defining soil health descriptors and thresholds: several highlighted the benefit that these would play in triggering action as soon as a threshold or range is crossed. In response to the OPC, stakeholders overall agreed that a number of different chemical, physical, water-related and biological indicators would be either reasonable or very effective to assess soil health, agreeing that a combination of indicators is required to do so effectively. In particular, several stakeholders highlighted the importance of reflecting ecosystem services and biodiversity, given their importance in addressing the functioning of soils and its services and the minimum levels required to maintain these services. Stakeholders also noted that there has been significant research and consideration of what constitutes soil health over the years, and as such there is a body of evidence already available which can be drawn on. The Soil Expert Group noted that thresholds should be set that motivate actors to take action i.e. they need to be achievable, but also understandable and easy to measure. Concerning the soil district, stakeholders broadly agree that districts should be set on the basis of location specific factors, in particular climate, soil type and land-use, and hence allowing districts to vary in terms of size would be beneficial. The Member States that provided feedback in general called for applying subsidiarity and providing sufficient flexibility to adapt the governance elements and the definition of soil health to the country specificities (see Annex 9 section 2.2.6 for details).

6.1.7 Comparison of options

All options score positively in terms of **effectiveness.** The establishment of soil health descriptors and districts across the EU is a necessary facilitating step to the subsequent implementation of effective soil health management and restoration actions to achieve the general objective set. A set of chemical, physical and biological soil health descriptors must be established with threshold and/or range values to be able to classify which soils are ‘healthy’ and which soils are ‘at risk’.

Options 2, 3, 4 would achieve significant improvements in the availability of information and data on soil health compared to the baseline.

The key difference is the level of flexibility, and how much is harmonised at EU level. Defining thresholds and districts at EU level minimises the risk of a lack of comparability and consistency across Member States. Based on the experience of legislation such as the Ambient Air Quality Directive (AAQD) and Water Framework Directive (WFD), leaving definitions of soil health (i.e. the values for the descriptors) and soil districts to Member States (option 2) could result in a variability in the approach to and the thresholds and ranges defined for different descriptors, and also in the approach to defining districts; there is the risk that the different levels of stringency and ambition will undermine the achievement of objectives. Under Option 2, and somewhat also Option 3, across Member States there may be a variance in the approach to defining thresholds for different descriptors and the number of descriptors for which thresholds are set, whereas Option 4 would not entail this risk, but would be difficult and time-consuming to define and agree on such specific values at EU level.

In terms of **coherence** with the other building blocks**,** Options 3 and 4 are considered marginally more consistent with all options under the other building blocks – for example, it would be more difficult to fit Option 2 in this block–- where Member States define thresholds and districts, with Option 4 under the sustainable management or restoration block- where a set of measures to maintain or restore soil health is defined at EU-level.

Greater harmonisation also somewhat mitigates the **implementation risks** of this building block–- defining soil health descriptors is a technically complex area and not all the Member States may have ready access to the necessary expertise needed to effectively define descriptors and thresholds. Stakeholders highlighted that expert knowledge surrounding the physical and biological aspects of soil health is not widespread, and that constant research, development and communication with experts is required to harmonise the understanding and reporting of the soil health indicators.

Option 3 opts rather for defining common EU values for a selected set of descriptors, based on available scientific knowledge that already takes into account the variability of soil condition. The ranges selected are those for which an out-of-range value would mean a critical loss of ecosystem services. This reduces the risk of variability relative to Option 2, and also the difficulty of the technical implementation under Option 4.

Where setting districts is left solely to the Member States there is a risk that these could be set on an inconsistent basis across Member States and/or on a basis which is not optimal for defining soil health. The provision of EU-wide mandatory criteria but maintaining flexibility for Member States under Option 3 increases the likelihood of addressing the challenges of varying pedo-climatic conditions when setting the districts. The eventual number of districts defined is unknown at this stage. Given the great variability of soils in the EU, a compromise would need to be found between homogeneity of soil condition in a district and a manageable number of soil districts. A working illustration is that the number of districts could be in the range between the number of EU regions and provinces (i.e. between 242 to 1,166).

Together, these challenges are anticipated to have a subsequent effect on the **efficiency** of improving information, data and governance around soil health. Hence, Options 2 and 4 are anticipated to be less beneficial in this respect than Option 3.

All options present low **administrative burden** when comparing across the building blocks and no **adjustment costs**.

Table 6-1: summary scores for building block 1

		Option 2	Option 3	Option 4
Effectiveness	**Impact on soil health**	(+)	(+)	(+)
	Information, data and common governance on soil health and management	++	+++	++
	Transition to sustainable soil management and restoration	(+)	(+)	(+)
Efficiency	**Benefits**	++	+++	++
	Adjustment cost	0	0	0
	Administrative burden	-	-	-
Coherence		+/-	+	+
Risks for implementation		--	-	---

6.2 Analysis of building block 2: soil health monitoring

6.2.1 Environmental impacts

Monitoring soil alone will not have a direct impact on the environment but will inform management and restoration activities actioned under other building blocks. As such, soil monitoring profits indirectly a wide range of ecosystems and the services they provide, such as carbon sequestration, water quality and availability and resilience to natural hazards such as flooding, and basis for biodiversity. This assessment does not substantially change between the options 2, 3, 4 of building block 2.

Implementing a definition and monitoring of net land take could deliver tangible improvements in the information, data and common governance of soil health. This would significantly work towards the standardisation and alignment of the definition of net land take itself and the processes it involves, in addition to assessment methodologies, between Member States, and better facilitate the development of comparable data and enable an accurate oversight of land take trends at the EU-level.

6.2.2 Economic impacts

Recording and assessing the soil status will generate additional costs for Member States. This is detailed in the following section on administrative costs. However, monitoring the health condition of soils across the EU is expected as well to lead to technological development and innovation (productivity and resource efficiency) and stimulate academic and industrial research, for example the use of artificial intelligence solutions from sensing systems and field-based measuring systems (e.g., hand-held spectrometers, portable DNA extraction, on-site chemical analysis) as well as remote sensing. This development would have a direct and positive economic impact. Furthermore, there could also be a direct positive impact on the conduct of business and position of SMEs such as laboratories within each Member State due to the increase in their services to carry out the analysis of the soil samples.

Option 2 would allow Member States higher flexibility to determine the soil testing regime and methodologies with minimised changes compared to their current system.

6.2.3 Administrative costs

The minimum number of soil samples in the EU needed to have a statistically reliable measurement of soil health, taking into account the variability of soil condition, has been estimated at 210 000 points (see section 2.1.5). This is a significant increase (about two times more) compared to the current 34 000 points from Member States added to 41 000 from LUCAS Soil (campaign of 2022). Therefore, there will be additional costs due to the increase of the number of samples to be taken by Member States, transported and analysed as well as an increase in the parameters to be measured for assessing soil health. However, synergies between LULUCF reporting and soil health monitoring can decrease total costs for Member States. There would be similar synergies with the descriptors relating to biodiversity under the NRL proposal and in respect of the forests soils under the upcoming forest monitoring proposal.

Option 4 is anticipated to lead to marginally higher one-off cost relative to Option 3 as there is greater harmonisation in sampling and analysis methods EU-wide that would require a greater change in processes and training to align with these requirements.

The integration of different monitoring systems requires one-off costs linked with determining and validating "transfer functions" between the two systems. However, if a Member State has validated transfer functions towards LUCAS Soil for all parameters, it can integrate LUCAS Soil data to complete the minimum set of sample points needed. This may not be possible in option 2 which has consequently higher recurrent monitoring costs. Other recurrent costs are linked with the functioning of the competent authorities and the resources needed to analyse the sample measurements, to determine the area subject to degradation and the intervention required to restore soil health. Monitoring the net land take would pose an additional, medium administrative burden (3.6 million per annum), but it is anticipated that the benefits of this measure would outweigh the costs (see Annex 9 chapter 7 for details).

The administrative burden for building block 2 will be for the Member States. No administrative burden for any other actors – e.g. businesses nor citizens – has been identified. The following table presents the summary of the different administrative burden for options 2, 3 and 4 of building block 2.

Table 6-2: administrative costs for building block 2

	Member States–- One-off costs (EUR, 2020 prices)	**Member States–- Recurrent costs (EUR pa 2020 prices)**
Option 2	180 000	49 000 000
Option 3	480 000	42 000 000
Option 4	640 000	42 000 000

The ongoing administrative burdens captures the monitoring activities including the processing and assessment of the data, determining trends, assessing the effectiveness of actions taken and identify where additional action is required.

For Member States who already have soil monitoring frameworks in place the administrative burden can be expected to be lower than Member States who will be implementing a monitoring framework for the first time.

6.2.4 Social impacts

Increasing the amount of publicly available soil monitoring data will help to increase the public awareness and societal engagement on soils and the challenges they face. Sharing data and information on soil health can be used to make more informed decisions about sustainable soil management practices. Data and information on soil health can also be used to better inform citizens on the importance of soil, in synergy with the EU Mission '*A Soil Deal for Europe'* who aims to increase soil literacy through wide engagement with citizens and concerned actors. Moreover, soil monitoring and the data collected can have a positive and direct impact on the provision and use of information for further research and development into actions/measures which can improve/maintain the status of soils across the EU.

This assessment does not substantially change between the options 2, 3, 4 of the building block 2.

6.2.5 Implementation risks

If option 2 is selected, there is a risk that the Member States who already have a monitoring framework in place simply continue with (or do not sufficiently expand) these systems. Indeed, stakeholders noted that there is a preference amongst Member States to retain their national systems to maintain continuity in their data sets, hence comprehensiveness and comparability of the data across the Member States may not be substantially improved even if this is needed.

A recognised risk of Option 4 relates to the difficulty to determine a common monitoring framework (including sampling strategies) across the EU; should option 4 be attempted, it may significantly delay the implementation timetable due to the complexity of the task.

Option 3 has a lower risk of inconsistency in monitoring standardisation in comparison to Option 2 whilst also reducing the risk for some Member States not having the necessary expertise to develop a monitoring framework. In addition, Option 3 addresses the risk of delay of Option 4, by determining only the methodologies for measuring soil health descriptors and leaving the possibility to Member States to use instead validated transfer functions.

Even though additional human or financial resources may be needed, especially in those Member States that have not yet established a monitoring framework, the risk that the options identified under this building block cannot be implemented at all due to lack of these resources is rather low, as existing governance structures in all Member States can be used and built upon.

6.2.6 Stakeholder views

Stakeholders emphasised that the key issue presently is the lack of harmonisation of approaches to collect and compare data. The discrepancies between Member States, and the fact that some Member States have set monitoring processes in place whilst others do not, was clear in the evidence provide by stakeholders.

In response to the OPC, there was a strong agreement across all stakeholder types that there should be legal obligations for the Member States to monitor soil health in their national territory and report on it, including on land-take. 89% of all respondents 'totally agreed' this obligation should be put in place, with a further 8% 'somewhat agreeing'. 'Totally agree' was also the most common response across all stakeholder types, with Business Associations being the only exception, where 'somewhat agree' was the most frequent response. The Member States that provided their views overall acknowledged the importance to have long-term soil monitoring (see details in Annex 9 section 3.2.6); among the countries having a national legislation on soil monitoring already in place, the comment was raised to avoid in the SHL incompatibilities with existing obligations.

6.2.7 Comparison of options

All options would deliver significant improvements in the data, information, knowledge and governance of soil health and management. Furthermore, monitoring of soil health descriptors is a critical and necessary facilitating step to the subsequent implementation of effective soil health management and restoration actions. However, there will be some variance between the options concerning effectiveness and efficiency.

Effectiveness

Where full flexibility in these matters is left to Member States (Option 2), there is a greater risk of inconsistency and a lack of harmonisation across Member States. Although some improvements relative to the baseline may be achieved through the application of transfer functions, the variability in the collection, analysis and reporting of soil samples (in particular due to differences in laboratory techniques) is anticipated to be greatest under Option 2 relative to Options 3 and 4. This greater variability in monitoring will lead to lower comparability between Member States in terms of reporting and interpretation of data.

Efficiency

A greater variability in monitoring carries a number of disadvantages, in particular for Member States, which subsequently will need to invest greater financial and human resources and face longer delays in developing knowledge and resolving issues that stem from a lack of harmonisation. Under Option 2, due to the partial integration of national and LUCAS data, the Member States will not be able to fully exploit LUCAS data to achieve the minimum number of points to reliably conclude on soil health at national level and so would need additional costs to reach the minimum number. Under Option 4, due to the need for Member States to modify and adapt all the established soil monitoring practices, it could take a substantial amount of time and costs (e.g. training) for all Member States to implement the full methodological change.

The key impact of this option will be the cost for Member States of undertaking additional sampling, analysis and reporting/data collation, either at existing sampling sites (e.g. where the range of descriptors needs to be expanded), or for new sampling sites (these costs are additional to the costs of existing monitoring network of around 41 000 LUCAS and 34 000 Member State monitoring sites which are captured in the baseline).

Table 6-3: summary scores for the options 2, 3, 4 of building block 2

		Option 2	**Option 3**	**Option 4**

Effectiveness	**Impact on soil health**	(+)	(+)	(+)
	Information, data and common governance on soil health and management	++	+++	++
	Transition to sustainable soil management and restoration	(+)	(+)	(+)
Efficiency	**Benefits**	++	+++	++
	Adjustment costs	0	0	0
	Administrative burden	---	---	---
Coherence		+/-	+	+
Risks for implementation		--	-	--

In summary, options 2, 3 and 4 would deliver a significant improvement to the data and information on soil health and form a critical basis for other building blocks under the SHL. Option 3 appears to be the option that best balances the opposing risks of lack of consistency and comparability across Member States (option 2), and the complexity of one entity defining a set of monitoring processes that are applicable EU-wide (option 4).

6.3 Analysis of building block 3: sustainable soil management

6.3.1 Environmental impacts

Several policies at EU level influence the way soils are managed but there is no dedicated soil policy to ensure the sustainable use of all managed soils, even though this would substantially improve the environment, and the quality of natural resources. Sustainably managed soils that are rich in soil biodiversity positively affect aboveground biodiversity, ensure good water infiltration and retention. They have high fertility. They also reduce risks of nutrient and pesticide leaching into watercourses, resulting in improved groundwater and surface water quality, and flood mitigation, and can improve biotic resistance to pests. They provide a wide range of stable ecosystem services both in natural landscapes and urban areas, highly dependent on the type and extent to which sustainable soil management practices are applied. Air quality would be improved as would climate change mitigation through increased carbon sequestration and reduced GHG emissions (e.g. N_20 and CH_4) from soil linked to fuel use or synthetic fertilizer production.

6.3.2 Economic impacts

The magnitude of the costs and benefits depends largely on the required change in current management practices but also on the ambition of the SSM practices in question, including banning harmful practices as envisaged under option 4. More ambitious practices are associated with higher investment costs for individual soil managers, such as for machinery renewal or agro-forestry investments. Higher ongoing costs may arise for practices of all ambition levels that require e.g. higher or more expensive inputs (e.g. for establishing cover crops on agricultural soils that are usually left bare between harvest and re-seeding of the main crop) compared to current practices. However, many of these costs can be offset or even turned into profits in the long run (see e.g. Table 7-5in chapter 7.1 and Annex 9 (section 4) for details).

Estimating the adjustment costs to achieve sustainable management of all soils is extremely challenging due to several currently unknown factors including incomplete knowledge of soil health parameters, data limitations and complexity (see Annex 9 (section 1.1.4.)) as well as the various measures and practices that could be implemented at Member State level.

Reduced costs for individual soil managers can be expected if newly adopted practices require fewer inputs for production (e.g. synthetic fertilizers or irrigation). If soil fertility is maintained or increased over the long-term, yields from food, feed, and biomass production are likely to stabilise or increase. In agriculture and forestry, the implementation of SSM has the potential to lead to more diverse production systems that may prove more resilient to external fluctuations in climate, market prices, and supply-demand by having a wider range of marketable products (including tourism) and can accelerate the growth of business and livelihoods. Trade-off of economic costs and benefits will vary significantly by practice-type and may vary for each individual practice depending on the conditions and location in which it is implemented. Current studies do not provide exhaustive data for all possible SSM practices on all soil types in the EU, but those that focused on specific practices at farm/land unit level, agree that the costs of implementing SSM are in many cases outweighed by the economic and in all cases by the environmental benefits. Short-term individual costs are likely to be offset over the long-term, but soil managers who are not the landowners may be at a disadvantage as some SSM practices may take up to 10-20 years to deliver benefits.

The costs of sustainable soil management have, on a selection of five illustrative measures,[68] been estimated at between 28 and 38 billion Euro per year at EU level, while the on-site benefits could amount to 20 to 30 billion euro.[69] However, this estimation focuses purely on economic costs and immediate benefits such as impacts on yields or fertiliser use.[70] Off-site (environmental and social) benefits associated with these practices could not be quantified. For forest managers, costs are more difficult to quantify but estimated to be more limited (around 0,7 billion euro per year), while significant proportions of SSM private benefits fall on forest land managers assuming that the forests have been used less intensively and that soil degradation has not yet progressed as far (Annex 11 section 2). 60% of the forests in the EU is commercially owned. On-site costs and benefits would fall on landowners and/or soil managers, while off-site costs and benefits would fall on other parties or society, for example for industrial purification of drinking water. Since SSM practices will maintain and even improve soil heath, it is assumed that landowners may profit from the long-term benefits of sustainable actions taken by land managers, or at least from ensuring that the value of land does not decrease over time because of soil degradation. Costs and benefits falling on urban land managers would be more limited.

The estimation of the overall benefit to cost ratio for addressing soil degradation shows a positive value of 1.7 (see 7.3). This estimation was performed using as many quantifications as possible for off-site benefits; still, a large number of off-site benefits remained unquantified (see Table 2-4). This means that it is overall advantageous for society to implement sustainable soil management (and soil restoration) practices. However, it may be not always advantageous for soil managers to implement them since on-site costs may be higher. Furthermore, the full benefits may come in the medium to long term. To overcome this situation, soil managers are expected to need incentives and financial support to transition to SSM (as well as to implement restoration practices) so that the negative outlooks described in Table 2-1 can be transformed into positive ones. Section 7.3.2 provides elements of reflection on the available funding for this transition.

[68] Cover crops, reduced tillage, crop rotation (barley only), use of organic manures, reduced stocking density.

[69] See Annex 11 section 2.2.2.

[70] see also section 6.6 on the limitation in quantifying the costs and benefits.

Furthermore, the potentially high costs and the related uncertainties can be mitigated by a staged approach, allowing Member States flexibility in the application of sustainable soil management requirements.

6.3.3 Administrative costs

Administrative burden for the implementation of each option, including determining appropriate management practices for different soils and uses, and monitoring their respective application or avoidance in case of banned practices, is estimated to be moderate for Member States, except for option 4 which requires significantly higher costs for the design and establishment of dedicated planning activities for soil management to ensure proper implementation of the management practices. Administrative burden for individual soil managers could increase depending on how Member States ensure and control the correct implementation of SSM practices and the extent of harmonisation with already existing legislation.

6.3.4 Social impacts

Several of the environmental benefits can be associated with positive social impacts in the short to long-term. Increased carbon sequestration potential, for example, helps reduce climate change-related risks, and improved flood mitigation substantially improves the safety and quality of life of people living in flood risk areas. Stable or potentially increased yields due to sustainable soil management support food security. Diversification of agricultural and forestry production systems, accompanied by a greater variety of marketable products, provide opportunities for new jobs and an increased landscape and recreation value. Recreational value, along with physical and mental health, is positively influenced by healthy and sustainably managed soils both in the countryside, but especially also in urban areas where the implementation of SSM practices can contribute to the creation of healthy green spaces and reduce heat islands, contribute to better air quality and housing conditions. Jobs can be created or reduced depending on whether conversion to SSM requires a higher or lower work force but must be paired with necessary reskilling and upskilling measures and preparation.

6.3.5 Implementation risks

Defining sustainable soil management could be either too restrictive or too broad, both of which could reduce the impact on soil itself. Too much flexibility on SSM principles and practices may result in very different levels of ambition in their implementation across the EU, while a more prescriptive approach risks not taking sufficient account of the various climatic, socio-economic, and environmental conditions in each Member State, or being too complex.

A possible risk in implementing the options could be a lack of financial resources for Member States, but also a lack of human and financial resources for soil managers. Differentiating the extent of this risks based on the three different options is, however, not possible as this depends to a large extent on a) which specific soil management practices are to be implemented, b) the extent to which Member States already support and encourage SSM practices, and c) the extent to which soil managers already apply SSM practices and therefore the necessary shift in their soil management. In some cases, additional labour force and budget, e.g. for investment in machinery or salaries for harvest hands, may be needed, while in other cases the application of SSM can lead to reduced costs, e.g. for inputs such as fertilisers and pesticides. In any case, financial support both for Member States and soil managers already is available for a number of practices, e.g. under the CAP or can be further supported in the future, e.g. under the Carbon Removal Regulation.

6.3.6 Stakeholder views

The majority of respondents to the open public consultation strongly agreed on the need for a legal obligation for Member States to set requirements for the sustainable use of soils. Stakeholders indicated the need to consider different soil responses when defining sustainable management and supported the provision of a code of practices for sustainable use of soils for different land uses. In addition, the need to anchor exchange and sharing of experience of farmers and land managers was emphasized to create a toolbox and provide education so that the necessary measures are implemented. With regards to financial aspects of implementing SSM, particular attention should be paid to short-time costs and investments compared to longer term benefits. They also pointed out differences between the various SSM practices and their impacts, the difficulty of producing detailed instructions at EU level, and the possibility that too much flexibility may be ineffective. It was also noted that it should be possible to ban some of the practices that are harmful for soils. While a level playing field with mandatory minimum requirements for all Member States (especially for the farming sector) was requested, a very stringent approach as the one under option 4 was identified to likely generate a pushback from Member States and stakeholders. The Member States that provided their views overall supported sustainable soil management principles to avoid soil deterioration, while allowing flexibility to adapt practices to local conditions (see details in Annex 9, section 4.2.6). Farmers emphasized the need to define SSM practices per region with the involvement of local consultants and professionals while landowners and managers called for voluntary measures but with sufficient safeguards to prevent further damage of soils.

6.3.7 Comparison of options

The limited existing evidence for the precise costs of the implementation of SSM practices throughout all soil types and Member States and the great range of flexibility (e.g. voluntary or mandatory implementation of certain practices) across options under this building block limit the precision of comparison. The transition to sustainable practices may lead to local and temporary decrease in the quantity of food or biomass production (depending on the changed practices and local conditions). However, these effects are usually counteracted in the medium- to long-term, also by reducing the risks and effects of crop loss linked with increasingly extreme climatic events. So, while there are no imminent consequences negatively impacting food security, the envisaged options implemented will contribute to the wider objective of strengthening agricultural resilience and the strategic autonomy of the European Union..

Effectiveness

Full flexibility for Member States to define sustainable management principles and practices based on an indicative annex, as would be the case under option 2, could result in the ambition being reduced to a minimum (a so-called "race to the bottom") as Member States need to consider the demands of a wide range of stakeholders. The implementation of option 4 requires a broad list of sustainable soil management practices at EU level and would prove difficult to adequately address the diverse environmental, climatic and socio-economic conditions and soil types in all Member States. While option 4 would ensure that certain sustainable practices would be applied across the EU, formulating these practices considering the diversity of local conditions and agreeing on them at EU level would be a tremendous challenge and would likely result in an approach of rather broad and simple practices that could be applied in many places, but at the expense of their actual effectiveness and the transition to truly sustainable soil management. The flexibility given to Member States under option 3 could lead to higher ambition than under option 2 because Member States will at least have to reflect the mandatory SSM principles but is less restrictive than option 4. Therefore, option 3 is estimated to have a better impact both on soil health and the transition to sustainable soil management (Option 3 '+++').

All options are considered to contribute equally to improved information, data and governance (option 2, 3, 4 '++') as compared to the baseline as Member States will need to monitor and control the implementation and uptake SSM practices to ensure that soils are sustainably managed.

The mandatory nature of respecting specific SSM principles under option 3 will guarantee effective minimum standards and is therefore expected to have greater environmental benefits than option 2. This could be further accelerated by banning certain practices on which there is broad scientific consent about their harmfulness for soil (option 4). Social benefits will be similar under each option but can be linked to environmental benefits and may therefore also be higher under option 3. Economic benefits to landowners and wider society are expected if soil degradation and associated costs are reduced. While the implementation of option 3 or 4 may target soil threats more effectively than the more flexible approach under option 2, a more precise indication of SSM practices (option 4) may lead to higher economic costs for soil managers in the short-term (depending on the change required). Economic benefits from improved (or maintained) soil health may, however, only occur in the longer term. Consequently, all the options will stimulate significant benefits, with option 3 expected to have the strongest positive impacts (option 3 '+++').

Efficiency

All options will generate significant costs for implementation (option 2, 3, 4 '---'). Adjustment costs under option 2 may be lower given the greater flexibility, while the mandatory implementation of principles (options 3) and certain practices (option 4) may require more stringent enforcement and monitoring, depending on the specific practices and the current state of play in each Member State. Similarly, the administrative costs are likely to be the highest under option 4 ('--').

The distribution of costs and benefits between the various stakeholders involved (Member States, society, landowners and land managers) is highly dependent on the type of implementation (indicative or mandatory provisions), and the extent and area of required principles and practices and is considered unequal under all three options (Option 2, 3, 4 '--'). While some SSM practices may deliver a positive economic return in the short term, others may take years to emerge or to pay back earlier investments, giving a disadvantage to e.g. tenant land managers as compared to landowners. Greater flexibility (option 2) will result in fewer costs for both Member States and individual soil managers but is likely to generate fewer of the above mentioned economic, environmental and social benefits as compared to option 3 or 4. Option 4 is expected to have the highest adjustment costs while benefits are presumably higher primarily for society and only delayed for land users.

Coherence with other building blocks may be positively or negatively affected (option 3, 4 '+/-'), depending on the respective principles (options 3) and practices (option 4). Option 2 is considered slightly more coherent with the other building blocks due to the increased flexibility for Member States which could in turn create higher harmonisation between all building blocks (Option 2 ‘+’), even though this flexibility provides the risk of a weaker implementation of sustainable management measures and leaves room for harmful practices to continue. This risk is reduced under option 3 and especially option 4 (banned practices). There could be overlap between legislation especially in the sectors of agriculture, resulting in additional costs and/or administrative burden (greater under options 3 and 4). A key risk is to establish suitable SSM principles (option 3 ‘--‘) and even higher for practices (option 2 and 4 (‘---‘)) considering every soil type, region and other local parameters.

Table 6-4: summary scores for the options 2, 3, 4 of building block 3

(*) While the score level is the same according to the scoring methodology used, option 4 is expected to have the highest

		Option 2	**Option 3**	**Option 4**
Effectiveness	**Impact on soil health**	++	+++	++
	Information, data and common governance on soil health and management	++	++	++
	Transition to sustainable soil management and restoration	++	+++	++
Efficiency	**Benefits**	++	+++	++
	Adjustment costs	---	---	---**(*)**
	Administrative burden	-	-	--
	Distribution of costs and benefits	--	--	--
Coherence		+	+/-	+/-
Risks for implementation		---	--	---

adjustment costs while benefits are presumably higher primarily for society and only delayed for land users.

6.4 Analysis of building block 4: identification, registration, investigation and assessment of (potentially) contaminated sites

6.4.1 Environmental impacts

Only accurate identification allows Member States to prioritise remedial actions, to collect funding and to make a planning. Enhanced knowledge of the risks to the environment of soil contamination contributes to the achievement of the water and nature objectives. Ultimately, the indirect impacts are decreased presence of toxic chemicals in the environment and consequential positive impacts on species, populations, biodiversity, water, as well as on the provision of ecosystem services. Enhanced identification and registration of (potentially) contaminated sites in combination with full transparency, would increase the pressure and incentives to tackle the problem. Better knowledge of these sites, their risks and liabilities will deter future polluters and encourage prevention. Risk assessment (in options 2 and 3) allows to take account of local and site-specific conditions which would be of benefit from an environmental point of view.. With the application of common EU limit values (option 4), on the other hand, there is only a need for action when these limit values have already been reached or exceeded, which may mean a higher level of contamination.

6.4.2 Economic impacts

The main economic impact of this building block is the cost related to soil investigations. The cost of investigation varies substantially from €500 to €50 000 per site, and exceptionally €5 million. There are generally two main types of soil investigation: a preliminary and a more detailed investigation. Preliminary site investigations are less costly than main site investigations. If a preliminary investigation does not render an indication of contamination, there is no need to proceed with the more expensive in-depth investigation.

It is difficult to separate the additional impact of an EU obligation to systematically register and investigate potentially contaminated sites from the baseline and to project how the situation will evolve without dedicated EU soil legislation. Some Member States have already invested heavily in the identification, registration, investigation and assessment of contaminated sites at their own initiative. It is therefore expected that the economic impact will vary and that Member States that are lagging behind will face higher costs in the following magnitude:

- No significant cost: AT, DK, SE, NL, BE (FL, BXL)
- Lower cost: IT, FI, BE (WAL), DE, LU, FR
- Medium cost: ES, LT
- Higher costs: HR, BG, HU, CY, IE, EL, LV, MT, PL, PT, RO, SI, CZ, EE, SK

The polluter pays principle should be applied whenever possible, also for the cost of investigation. Currently, on average, public authorities bear 43% of the management costs and the private sector 57%, but this number does not differentiate between the investigation and remediation phase. There is uncertainty about where the cost of investigation will eventually fall as this depends on the implementation in different Member States.

6.4.3 Administrative costs

Member States that need to establish or improve registers additionally to the baseline scenario will incur an administrative burden, e.g. staff costs, development of IT infrastructure or a website. As an indication, in 2018, Sweden had a budget of €230 000 for maintaining the national inventory of contaminated sites.[71] Member States who need to establish inventories (e.g. HR, RO, SI) would incur such administrative costs. The administrative cost for the administration, communication, registration and recording is estimated roughly at 1% of the investigation cost.

Specific to option 2, there may be limited costs for Member States that have not yet established a methodology or procedure for risk assessment of contaminated sites or defined the (un)acceptable risk levels for human health and the environment. Common principles (option 3) could provide additional guidance. On the other hand, if Member States had to revise their current methods to assess contaminated sites, additional costs could be incurred.

Given that Member States currently use different approaches and values, devising EU limit values (one size fits all approach) under option 4 would be challenging. The advantages of EU limit values are the ease of application, the clarity for polluters and regulators, comparability, transparency and easiness of understanding by non-specialists.

6.4.4 Social impacts

This building block could have positive social impacts for EU citizens through a better application of the polluter pays principle, leading to more societal fairness and good administration. It helps to decrease exposure to contamination. Socio-economically disadvantaged households are living closer to contaminated sites due to lower costs of living. On

[71] JRC (2018), Status of local soil contamination in Europe, p. 69

the other hand, this building block could also lead to distress among communities and landowners when their properties or neighbouring sites are registered as a (potentially) contaminated site. Requirements to identify contaminated sites will generate jobs and long-term employment (e.g. environmental consultants, geologists, remediation engineers, etc.). Adequate training and education is needed to develop the skill set of these workers and their health on-the-job should be sufficiently protected.

6.4.5 Implementation risks

Option 2 applies a risk-based approach but does not guide Member States to assess contaminated sites and leaves full flexibility. The common risk assessment principles (option 3) should be well designed to bring added value, if not, these might interfere with existing national risk assessment methodologies. This risk can be avoided by the development of further guidance documents through comitology procedure to support less advanced Member States with risk assessment. If Member States decide on the level of (un)acceptable risk, certain differences may apply, reflecting:[72]

- Geographical, biological, environmental variability;
- Socio-cultural, behavioural and land use variability affecting the exposure of receptors;
- Regulatory variability, e.g. constitutional aspects or complementarities with other existing laws;
- Political variability due to the prioritisation of environmental and economic values;
- Variability in scientific views.

Common and ambitious limit values across the EU (option 4) may be difficult to implement and require more time due to the above differences across Member States. Due to the wide variety of soil types, land uses, depths of groundwater tables and building characteristics, EU common limit values might not be appropriate to assess the problem in an efficient and economically viable manner.

Risks to implementation of each option under this building block due to lack of human or financial resources is low, as existing structures can be used for the identification, assessment and registration of contaminated sites.

6.4.6 Stakeholder views

There was strong agreement across all stakeholder types that there should be legal obligations for Member States to identify contaminated sites that pose a significant risk. 89% of all respondents ‘totally agreed’ with such obligation, and a further 8% ‘somewhat agreeing’. There is a strong preference amongst stakeholders for a risk-based approach. Stakeholders also suggested that assessments should take into account the current or future land use. There was also strong agreement that the information and environmental data from a registry of contaminated sites should be publicly available: 85% ‘totally agreed’ with 10% ‘somewhat agree’. The Member States which expressed their view, overall supported a risk-based approach on contaminated sites and called for flexibility for national approaches. The assessment of the acceptability of the risk should remain under national competence, but some Member States would prefer guidance from the EU on the methodology and approach for the risk assessment. Most Member States agree that

[72] Provoost, J., Reijnders, L., Swartjes, F., Bronders, J., Carlon, C., D’Alessandro, M., & Cornelis, C. (2008). Parameters causing variation between soil screening values and the effect of harmonization. Journal of Soils and Sediments, 8(5), p. 24.

risk should be assessed in relation to the current and future land use. No significantly different views were expressed by those Member States already more advanced in the remediation of contaminated sites (for details see Annex 9, section 5.2.6).

6.4.7 Comparison of options

An obligation to identify and register systematically (potentially) contaminated sites, and subsequently, to confirm the presence or absence of contamination, would improve information, data and governance of soil health ('+++'). How the need for further action is decided, will determine the ambition, benefits and costs of building block 5. All options under block 4 deliver only indirect benefits for soil health, because these are attributed directly to building block 5 to avoid double counting (Options 2/3/4 '(+)').

The difference between the options is the degree of flexibility around risk assessment and acceptability. The impact will depend on the risk appetite and environmental ambition: how much risk would Member States be willing to accept or how ambitious would common EU limit values be. Option 2 (relative to options 3 and 4) offers most flexibility, hence also a risk that some Member States would be more permissive towards contamination resulting in a lower than effective level of remediation or risk management and an uneven playing field ('risks for implementation': Option 2 '---'). EU common principles for risk assessment (option 3) as a minimum standard could slightly reduce this risk ('--'). On the other hand, Option 4 provides a non-risk-based approach with common EU limit values for contaminants, which presents a challenge since it does not allow flexibility to reflect the particularities of each Member State and of specific sites, and could result in inefficient and disproportionate remediation. Moreover, it would be difficult to reach an agreement among Member States on the harmonisation of values (Option 4 '---').

Measures under this building block would lead to new obligations on Member States. The cost for investigation is estimated at 1,9 billion euro per year (Options 2/3/4 '---'), while the cost of remediation is captured under building block 5. It is difficult to assess how much would be spent additional to the baseline. The administrative burden under all options is related to the administration, registration and recording of the identification and investigation of (potentially) contaminated sites and is estimated roughly at 1% of the investigation cost depending on the Member State (Options 2/3/4 '---'). Different Member States will face different additional burdens for the identification and testing required. The distributional effect is uncertain, but given the obligation to identify contaminated sites is common across all options, so too will any distributional effect (Options 2/3/4 '-').

Option 4 may be more internally aligned with other building blocks in comparison to Options 2 and 3. For example, EU limit values still align with Option 2 and 3 of building block 5 where priorities (e.g. timing, budget allocation, etc.) for remediation are left to the Member States. Allowing Member States to identify risk acceptability criteria for the assessment of sites (Option 2 and 3) would not be as synergistic with a subsequent remediation programme where the prioritisation for remediation is set at EU-level (Option 4 in building block 5).

Option 3 is the preferred option as it mitigates the opposing risks of a continuing variance in ambition across Member States (Option 2), and challenges that a non-risk based approach under Option 4 could lead to inefficient levels of remediation and risk reduction. The risk of inconsistency in Option 2, could be reduced with the common principles for risk assessment and ensure that Member States reach minimum requirements for good practice in risk assessment.

Table 6-5: summary scores for the options 2, 3, 4 of building block 4

		Option 2	**Option 3**	**Option 4**
Effectiveness	**Impact on soil health**	(+)	(+)	(+)
	Information, data and common governance on soil health and management	+++	+++	+++
	Transition to sustainable soil management and restoration	(+)	(+)	(+)
Efficiency	**Benefits**	+++	+++	+++
	Adjustment costs	---	---	---
	Administrative burden	---	---	---
	Distribution of costs and benefits	-	-	-
Coherence		+	+	+/-
Risks for implementation		---	--	---

6.5 Analysis of building block 5: soil restoration and remediation

The impacts are linked to the ranges of the soil health descriptors under block 1 and the outcomes of the monitoring and assessment in block 2. Sustainable soil management in block 3 reduces the need for restoration. The more sites are identified as contaminated and requiring further action under block 4, the higher the costs of restoration. The costs and benefits of restoration and remediation scale with the area of land to which they are applied and will depend on how unhealthy the soil is initially, and the measures that are required.

6.5.1 Environmental impacts

All options will deliver significant environmental benefits and improve soil health with knock-on effects on the quality of both water and air (e.g. storage and infiltration of water, risks of flooding, drought, and soil erosion), biodiversity (e.g. providing food sources and habitats), and climate benefits (e.g. carbon removals, climate adaptation by mitigating climate hazard risks).

6.5.2 Economic impacts

Soil restoration results in economic costs and benefits. 60-70% of land is currently unhealthy and underproviding ecosystem services, with a loss that could be quantified at EUR 3.4 - 292.4 billion for soil contamination and at 16.5 – 68.8 for the other soil degradation (see 2.1.4). Soil restoration, that is addressing soil degradation, delivers clear economic benefits for society (see the conservative estimation of the benefit-to-cost ratio of 1.7 in 7.3) while for the landowner and/or soil manager the on-site benefits may not always compensate the costs, or do it rather in the medium to long term. However, the potential benefit under Option 2 is likely less than under Options 3 and 4 because there is a greater risk of variance in the ambition of the measures.

The adjustment costs will be relatively high as restoration and remediation activities carry upfront and ongoing costs. The costs will depend on the practices that are implemented in each Member State. The distinction between sustainable soil management and restoration is not always obvious. It depends on the status of the soil (healthy vs. unhealthy). Sustainable soil management is an act of good stewardship or a duty of care to prevent that a healthy soil degrades by maintaining or enhancing the provision of ecosystem services. Restoration is an intentional activity aimed at reversing or re-establishing soil from a degraded state to a healthy condition. This is why examples of sustainable soil management and restoration practices have been presented together in Table 7-3. Therefore, restoration costs other than for contamination are considered substantially overlapping with the costs and benefits of the SSM building block.

The precise costs of remediation are uncertain. The median cost of site remediation is estimated at €124 000 per site with the majority between €50 000 to €500 000 per site. Costs of € 1 billion per annum over a 25-year period could be expected. It is however difficult to assess how much would be spent anyhow in the baseline, and what percentage would be additional due to new EU obligations. It is also uncertain where these adjustment costs would fall. The obligation will be placed on Member States but costs could be passed on to businesses and landowners. Costs would also be distributed unevenly between Member States. For example, Germany, Finland, and Belgium reported the highest number of remediated sites and are therefore closer to completion. Others like, Latvia, Lithuania, and Estonia reported very low levels, which indicates that they may incur significant costs.

6.5.3 Administrative costs

An obligation for Member States to adopt measures (options 3 and 4) would increase the administrative burden. Prescribing restoration measures, enforcement and follow-up also require administrative efforts at national level. For soil remediation, the upfront burden is marginally higher for Options 2 and 3 as all 27 Member States must define prioritisation criteria, and for Option 2 associated with the ongoing management of the derogation process.

6.5.4 Social impacts

A transition towards healthy soils could improve social perception and the image of the farming and industrial sector.[73] Soil restoration improves the safety, health, and infrastructure of communities and sustains the livelihood in the surrounding areas, e.g. (agro-)tourism, markets, infrastructure[74]. Soil restoration is important to protect the cultural heritage.[75] Various studies have explored the health risks of living close to contaminated sites. Communities with large numbers of brownfields have poorer health.[76] Closer residential proximity to contaminated sites is linked with higher rates of low-birth-weight infants.[77] Remediating contaminated soils will undoubtedly have a positive impact on public health and associated social security costs, benefitting especially to the socio-economically disadvantaged groups that often live in these areas. Job creation would be expected from increased investigation and remediation, and brings positive social and health impacts.

6.5.5 Implementation risks

Not all restoration activities lead to positive economic or environmental outcomes in the short term, e.g. lower agricultural yields in the short-term may be a barrier for farmers. Knowledge

[73] The Business Case for Investing in Soil Health
[74] Gómez, J.A. et al. (2021), Best Management Practices for optimized use of soil and water in agriculture
[75] Expert Stakeholders (FR response to Sustainable Use)
[76] https://www.dur.ac.uk/news/newsitem/?itemno=20467
[77] Baibergenova, A., Kudyakov, R., Zdeb, M., & Carpenter, D. O. (2003). Low birth weight and residential proximity to PCB-contaminated waste sites. Environmental health perspectives, 111(10), 1352-1357.

sharing is essential for organising restoration at the right place within a reasonable timeframe. More flexibility for the Member States could result in more inconsistency, both in terms of the programmes of measures, their content and coverage, but also their ambition. On the other hand, certain flexibility for Member States is necessary to ensure tailored restoration and remediation. EU prioritisation criteria may lead to inconsistencies with national and regional regulations and budgets. Member States have a better understanding of the local economic and environmental pressures, which could allow for a more efficient and tailored approach. For these reasons, Member States would also be best placed to apply derogations. Implementation risks arise also in relation to the links with other building blocks. A fully harmonised restoration and remediation approach is likely incompatible with the options that offer most flexibility in other blocks.

The risks to the implementation of each option in this building block due to lack of human or financial resources in the Member States are low, as existing structures can be used to identify and allocate remediation and restoration measures. Similar to Building Block 3, the actual amount of additional labour and funding required is highly dependent on the condition of the soils and thus the need for their restoration, as well as the restoration measures ultimately selected. This affects both Member States and soil managers. However, the fact that restoration measures will be gradually phased in provides sufficient time to prepare for these potential additional needs in a targeted manner. It should also be noted that restoration measures are not required if the costs of restoration measures are disproportionately high. Restoration measures are rather viewed as an investment with an expected economic return over the years through the restoration of soil health and associated increased ecosystem services, offsetting increased financial needs.

6.5.6 Stakeholder views

86% of the respondents to the public consultation on soil health ‘totally agreed’ that the Soil Health Law should set obligations for Member States to achieve healthy soils by 2050. This was the most common response across all respondents (with the exception of business associations, which were split fairly equally across all possible responses). There was also strong agreement that there should be legal obligations for Member States to remediate contaminated sites that pose a significant risk to human health and the environment. 81% of all respondents ‘totally agreed’ this obligation should be put in place, with a further 14% ‘somewhat agreeing’. Furthermore, ‘totally agree’ was the most frequent response across all stakeholder types. In addition, the majority of respondents also ‘totally agreed’ that Member States should be required, within a legally binding time frame, to establish and implement a national plan to remediate sites. 72% ‘totally agreed’ with this obligation, with a further 18% ‘somewhat agreeing’. The few Member States replying on restoration of soil health and the programme of measures, expressed support for minimum requirements at EU level together with flexibility (see details in Annex 9, section 6.1.2). Member States stressed the need to minimize the additional administrative burden, to avoid overlap with other legislation and to exploit synergies with other plans and programmes required by EU law. The timeline and periodicity for the programme of measures and the reporting should be realistic and feasible.

6.5.7 Comparison of options

It is anticipated that the benefits under option 2 are less than under options 3 and 4 because under option 2 there is no obligation to take measures. Common criteria and harmonisation under

Option 4 mitigate this risk, which is also reflected in a higher implementation risk (Option 2 '---') because it would be challenging to prescribe a programme of measures for the whole EU and requires time to develop. Strict common criteria can result in implementation risks for inefficient restoration or remediation activities (Option 4 '---'). Option 3 partly mitigates this risk through a minimum set of common criteria for the programmes that Member States should put in place (Option 3 '--').

The adjustment costs under the building block will be relatively high as restoration and remediation activities carry upfront and ongoing costs. This will likely be one of the most significant impacts associated with the SHL. The costs will depend on the practices that are implemented in each Member State. Crucially though, Member States will not be required to undertake restoration measures where they are technically not possible or where the costs are disproportionate, ensuring that the costs are proportionate overall. Where such measures are implemented EU-wide the adjustment costs could be significant (in the billions). The adjustment costs under Option 2 are anticipated to be slightly lower than under Options 3 and 4, because there may be greater variance in effort between Member States, resulting in some implementing perhaps fewer measures (Options 2/3/4 '---'). Administrative burdens are anticipated to be moderate in particular compared to options under the other building blocks ('Administrative burden': '--').

It is uncertain on whom the costs of restoration will fall as this will depend on the implementation in each Member State. Landowners and managers will have an important role. Some measures may not deliver an economic return, and the environmental and social benefits they deliver are societal in nature (Options 2/3/4 '+/--'). There will also be a variance in costs and impacts across the EU, e.g. Member States that have a wider area of unhealthy soils and/or soils will require more extensive restoration and remediation, and hence also costs. However, the cost of inaction remains higher than the overall investments costs for restoration, because of the burden of soil degradation on many socio-economic sectors, such as public health.

All options are broadly coherent with options under other building blocks. Option 4 is slightly less coherent with the more flexible options under other building blocks (Options 2 and 3 '+', Option 4 '+/-'). Option 4 has a greater risk of overlap with other legislation. All options under this building block would improve governance of soil health, as they directly place an obligation on the Member States to restore and remediate contaminated sites (Options 2/3/4 '+++').

The management of contaminated sites incurs adjustment costs that are a key impact associated with all options and are likely to be significant (Options 2/3/4 '---'). It is uncertain where these adjustment costs would fall. The obligation will be placed on Member States to ensure all sites are remediated, but Member States could pass on these costs to businesses and landowners. Under Options 2 and 3, Member States can prioritise the remediation of sites. Member State's CS and PCS has its own particular characteristics based on geographical, economic and historical reasons, which can be difficult to harmonise. On the other hand, flexibility also brings a risk of inconsistency between Member States, e.g. some Member States may choose to prioritise uniquely based on cost, rather than a combination of cost, technical feasibility and environmental or human health risk, and leave the most challenging sites until later. Option 4 would establish EU level prioritisation criteria, but this would be challenging given the variability across Member States. It would provide a level playing field for Member States but potentially also a less efficient solution.

Option 2 allows derogations for specific sites where particular criteria are met. Some categories of unhealthy soils can be derogated by Member States from the obligation to have all soils healthy by 2050, because it is technically not feasible or economically disproportionate to restore them. Derogations reduce implementation risks under Option 2, but also the environmental and human health benefits that could be achieved.

Remediation costs would likely be distributed among the public and private sector. Countries with more significant costs and benefits will likely have more contaminated sites. Finally, across stakeholder groups, there would be significant benefits for all the citizens, which would achieve health, food and water security for the present and subsequent generations. ('Distribution of costs and benefits': Options 2/3/4 '+/--'). Option 4 is marginally less coherent with the options under other building blocks that offer more flexibility to Member States (Indicator 'coherence': Options 2 and 3 '+'. Option 4 '+/-').

The options under this building block will be the most impactful of the SHL package and deliver the improvements in soil health which is the core objective. As for the sustainable soil management practices (see 6.3.7), the restoration of soil health may also lead to local and temporary decrease in the quantity of food or biomass production (depending on the changed practices and local conditions). However, these effects are usually counteracted in the medium- to long-term, also by reducing the risks and effects of crop loss linked with increasingly extreme climatic events. So, while there are no imminent issues on food security, the transition can be implemented to contribute to the wider objective of strengthening the strategic autonomy of the European Union.

The options also have the potential to deliver economic benefits, but will also incur significant adjustment costs (and moderate administrative burden to do so). Option 3 appears to present the best option for soil restoration and option 2 specifically for the remediation of contaminated sites.

Table 6-6: summary scores for the options 2, 3, 4 of building block 5

		Option 2	**Option 3**	**Option 4**
Effectiveness	**Impact on soil health**	++	+++	+++
	Information, data and common governance on soil health and management	+++	+++	+++
	Transition to sustainable soil management and restoration	++	+++	+++
Efficiency	**Benefits**	++	+++	+++
	Adjustment costs	---	---	---
	Administrative burden	--	--	--
	Distribution of costs and benefits	+/--	+/--	+/--
Coherence		+	+	+/-
Risks for implementation		---	--	---

6.6 Difficulty of quantifying costs and benefits

The knowledge available in the literature on the quantification of socio-economic aspects of soil degradation is often incomplete or ambiguous. Especially for Europe, economic data are relatively scarce. Improvement of soil health through sustainable soil management and restoration is often considered to be cost-effective. However, costs and benefits – also of well-known technologies – can vary significantly depending on the economic, social and biophysical context, and also over time as practices and knowledge on how to best implement them improve.

Cost and benefits of SSM and restoration practices are also often analysed from the perspective of an individual land manager and not from the viewpoint of the society as a whole. Off-site effects of soil degradation (e.g. health costs) are often difficult to quantify and so not accounted for.[78] Society usually bears higher public costs than individual land managers or private owners as a result of soil degradation. However, the benefits of soil health for society will not be realised unless land managers implement SSM and restoration practices in their day-to-day activities, which requires a positive financial investment case from the private perspective.

Whilst the transition to SSM usually involves immediate costs, benefits are often enjoyed over the medium to long term.[79] Methods that value natural resources usually struggle to account for the full range of damage caused by degradation. The difficulty of taking into account benefits and ecosystem services of SSM and restoration is a common feature of economic assessments and is a limitation recognized in the literature. Some researchers plead to move beyond a pure cost-benefit logic, and to err on the side of taking actions given the uncertainties.

7 PREFERRED OPTION

7.1 What is the preferred option?

The **preferred option is based on option 3 for all building blocks, except option 2 for the remediation of contaminated sites**, balancing between the need to reach the objective of healthy soil by 2050 in an effective manner and avoiding unnecessary regulation at EU level as well as administrative burden. It includes setting a measured definition of healthy soils taking into account the current scientific limitations and limited knowledge regarding each soil in the EU, as explained below. Second, as illustrated below, the preferred option proposes a staged approach. In a first stage, Member States would set up their governance system, monitor and assess soil health, and implement easily and immediately applicable sustainable soil management measures. The second stage would rely on the assessment of soils of the first stage and gradually phase in the restoration and remediation measures as well as the other sustainable soil management measures. . Third, the preferred option would leave to the Member States the choice of the measures to manage soils sustainably, supported by guidance at EU level, and to restore with the possibility to be exempted to do so, where technically possible and economically proportionate and subject to further procedural conditions.

In the preferred option, Member States would have flexibility to prioritise and to define their budget interventions, also using available EU funds[80] for achieving healthy soils.

Block 1: Soil health definition and soil districts – option 3

In the preferred option, soil health is first described by a minimum set of soil descriptors, at least one for each of the listed 11 aspects of soil degradation (see Table 7-1 below), based on the

[78] Tepes et al. (2021) Costs and benefits of soil protection and sustainable land management practices in selected European countries: Towards multidisciplinary insights

[79] Reynolds et al. (2022), Methodology and analysis of the costs and benefits in comparing sustainable land management practices in the WOCAT database

[80] A staff working document providing guidance to EU funds for healthy soils will accompany the legislative proposal.

scientific evidence available.[81] Monitoring of this minimum set is mandatory for Member States, but they may complement it with additional descriptors in their monitoring scheme.

In addition, criteria are set for several of these descriptors concerning the following aspects of soil degradation: loss of soil capacity for water retention, loss of carbon, soil erosion and eroded soils, salinization, excess nutrients (phosphorus),[82] subsoil compaction and soil contamination. Soil is in healthy status when the criteria for these descriptors are met, as each of these descriptors is critical for soil functioning. Outside these criteria, soils suffer a significant loss in the provision of vital ecosystem services (e.g. reaching an excessive salt concentration prevents most of the plants from growing). These criteria as well as the feasibility of meeting them are based on existing scientific knowledge and reflect the diversity of soils in the EU (see details in Annex 11 Table 2-4: rationale for SHL objectives being realistic and proportionate). It for this reason that for two of these descriptors (water content and contamination), flexibility is left to the Member States to set out more precise values for these criteria depending on the local conditions of soils. For the other descriptors, criteria have not been set at this stage because they vary widely depending on local conditions. Nevertheless, these descriptors correspond to essential functions of the soil and it is important that all Member States monitor them and identify variations and trends. This should also facilitate the emergence of sufficiently homogenous data so that in future soil health ranges can also be identified for those descriptors.

The preferred option provides for further flexibility to adapt, following new relevant knowledge developed by research, the soil descriptors and criteria which could be amended at a subsequent revision of the legal instrument.

Exclusion of specific areas from assessment are considered justified and are therefore accepted under the preferred option. Member States will have to map out the situations where such exclusions are applicable.

The preferred option also incorporates substantial flexibility for Member States in setting out some of the criteria, to take into account specific situations that cannot be dealt with in a fully standardised manner at EU level. The determination of a threshold for water holding capacity in soil is left for the Member States to define for each soil district, to take account the specificity of each river basin management, and specific climatic conditions (risk of floods or draught). The criteria set for soil organic carbon (SOC) in mineral soil can be approximated at this stage based on some studies mainly in Central Europe pedoclimatic conditions. Therefore, Member States are allowed, where specific climatic conditions would justify it, to apply a corrective factor reflecting the actual SOC content in permanent grasslands for a given soil type and climatic condition. For subsoil compaction, Member States are allowed to opt for an equivalent parameter and range than the one set. This is because of the lack of a strong scientific consensus on the best parameter. For phosphorus content, Member States should set the maximum threshold within the two values set, allowing each country to adapt to the different environmental pressure of the country. For soil contamination, a number of heavy metals are listed to be monitored, whereas

[81] In particular EEA (2022). Soil monitoring in Europe – Indicators and thresholds for soil quality assessments. https://www.eea.europa.eu/publications/soil-monitoring-in-europe-indicators-and-thresholds

[82] Including a specific target of reducing nutrient losses will be beneficial to reduce nutrient losses in soils and thus preserve soil fertility. However, this has broader implications and is analysed under the integrated nutrient management approach.

the selection of the organic contaminants is left to the Member States to allow flexibility on the choice of the priority substances, while taking into account the limits set from other EU legislation e.g. on contaminants in water. There are no ranges set as such, given the extreme variability of the national screening values, when they exist. Instead, Member States should provide reasonable assurance that no unacceptable risk for human health and the environment exists from soil contamination.

Coherence of this preferred option with other EU initiatives

This preferred option and in particular the descriptor for soil organic carbon is aligned with and refers to the target in the NRL proposal for organic soils in agricultural use constituting drained peatlands. No additional organic carbon target is set for organic soils. As regards agricultural (only cropland mineral soils) and forest ecosystems, the Member States are required in the NRL to set a satisfactory level for the stock of organic carbon. The soil health definition provides a solution to the Member States for setting ranges for SOC to ensure minimal soil functionality, supported by recent scientific conclusions; furthermore, the definition extends the applicability of the range beyond cropland mineral soils in agricultural ecosystems and forest ecosystems to all managed mineral soils.

Table 7-1: set of soil descriptors and criteria for soil health assessment

Aspect of soil degradation	Selected soil descriptors	Criteria for healthy soil	Exclusions *
Loss of soil capacity for water retention (affects water absorption, storage and filtering function)	Soil water holding capacity (all uses)	Thresholds to be set by the Member States for each soil district, at a satisfactory level to mitigate the impact of extreme rain or drought, accounting as well for artificial areas (EU guidance to be developed).	
Loss of carbon (affects several functions: carbon reservoir, soil fertility, water storage, etc.)	SOC (all uses)	- For organic soils in agricultural use: respect EU targets set at national level under the NRL (drained peatlands); - For managed mineral soils: SOC/Clay ratio > 1/13; Member States can apply a corrective factor where specific climatic conditions would justify it, taking into account the actual SOC content in permanent grasslands.	
Soil erosion and eroded soils (affects biodiversity and crop support function, increases pollution)	Soil erosion rate/risk	At soil district level: no eroded soils or unaddressed unsustainable erosion rate or risk (>2 tonnes/hectare/year), considering relevant climate change projections for that area.	Badlands and other natural areas.
Excess nutrients: phosphorus (water pollution, eutrophication)	Extractable phosphorus in mg/kg (all uses)	<[30-50] mg/kg; Member States to select the maximum threshold between the two values.	
Salinization (affects soil fertility and biodiversity)	Electrical Conductivity dS/m (measurement only in dry and coastal areas)	<4 dS m−1;	Soils expected to be directly affected by sea level rise; naturally saline soils.
Subsoil compaction (affects water absorption, storage and filtering function, increases flood risks)	Bulk density in "subsoil" (B horizon) (all uses); Member States can replace it with equivalent parameter and range	Sandy <1.8; Silty <1.65; Clayey <1.47; Member States can replace this with equivalent parameter and range.	
Soil contamination (risks on human health and environment, biodiversity)	- concentration of heavy metals: As, Sb, Cd, Co, Cr (total), Cr (VI), Cu, Hg, Pb, Ni, Tl, V, Zn (all uses); - concentration of a selection of organic contaminants defined by Member States and taking into account existing EU legislation (e.g. on water quality).	Reasonable assurance that no unacceptable risk for human health and the environment exist.	Soils naturally high in heavy metals.
Excess nutrients: nitrogen (water pollution, eutrophication)	Nitrogen in soil (all uses)	No criteria;	
Acidification (affects soil fertility and biodiversity)	pH	No criteria;	

Soil biodiversity loss (affects delivery of multiple eco-system services)	Potential soil basal respiration Additionally, Member States may select other soil biodiversity indicators such as: - Metabarcoding of bacteria, fungi and animals; - Abundance and diversity of nematodes; - Microbial biomass (all uses); - Abundance and diversity of earthworms (cropland).	No criteria;	
Topsoil compaction (affects water absorption, storage and filtering function, increases flood risks)	Bulk density in "topsoil" (A horizon) (all uses)	No criteria;	
Separate assessment and monitoring			
Land take and soil sealing (loss of soil functions)	Net land taken and imperviousness area	(objectives set voluntarily by Member States)	

* Exclusions require separate mapping and monitoring of derogated areas

Another part of the building block refers to the soil districts. Under the preferred option, **Member States would have the obligation to establish soil districts and appoint a competent authority**. This should take place in stage 1 (some additional time after the deadline of transposition of the directive into national law would nevertheless be granted to Member States).

A soil district would be defined as a geographical area (established at national level) for the purposes of applying the obligations to monitor and assess soil health and achieve good soil health. The preferred option sets common general criteria for the establishment of soil districts, but the choice is left to the Member States:

- the whole national land territory must be covered by soil districts;
- in defining soil districts, Member States should take into account administrative units and seek as much as possible a certain homogeneity in terms of the following parameters:
    - soil type as defined by the World Reference Base for Soil Resources;
    - climatic conditions or environmental zone;
    - land use/land cover class.

A minimum number of soil districts should be established.

In order to have an adequate assessment of soil health at national level, under the preferred option **each Member State shall set up a grid of points for taking soil samples, on the basis of geostatistical methods**. The density of the grid should be such as to provide a level of uncertainty of soil health measurement of maximum 5% at national level, which statistically represents a reasonable assurance level. This corresponds, according to a first estimation, to **approximately 210 000 points for the whole EU** (about 5 times the current density of LUCAS soil measurements) - see Annex 9 showing what this would mean in terms of costs. Member States will be able to count also LUCAS soil points in their national territory to achieve the resulting minimum level of soil sampling required, provided that validated transfer functions between LUCAS Soil measurements and national measurements are available. In order to support the implementation of this provision, Member States will be able to refer to the JRC methodology for the geostatistical determination of the soil sample grid, consistent with LUCAS soil approach. The Commission would also develop remote sensing services to support the Member States in monitoring the relevant descriptors.

The preferred option for BB1 partially corresponds to the views of those Member States and other stakeholders who submitted feedback (Annex 9 2.2.6). However, there was no clear consensus among Member States on this issue, as some Member States and other stakeholders requested a definition of soil health at EU level, while others (e.g., representatives of industry) requested it at Member States level. Specifying some mandatory ranges for soil health parameters while allowing additional flexibility for Member States reflects these views to a large extent. The designation of soil district is delegated to the Member States, which was fully supported by all types of stakeholders who commented on this issue.

Block 2: monitoring – option 3

In the preferred option, the Member States have the **obligation to monitor and assess soil health and net land take**.

The soil health descriptors will be measured in soil samples taken in the field using a set of measurements based on LUCAS Soil. This would integrate the national and LUCAS Soil systems, allowing to reduce the overall number of soil sampling needed. LUCAS Soil, operated by the Commission, would remain part of the soil monitoring system for the Member States willing to use these services, together with remote sensing monitoring and modelling.

The use of transfer functions to LUCAS Soil is part of the flexibility included in the preferred option; it will allow the Member States to integrate their measurement with LUCAS Soil when they decide to maintain their own methodologies. Furthermore, the frequency of measurement is set at minimum 5 years, and the Member States can decide whether data will be collected in one measurement campaign or on a rolling sampling plan. They can also decide whether the location of the grid points are fixed or not and the grid can be adapted when a sampling point is not accessible or no longer relevant objectively, so that the identified degradation continues to be monitored.

Net land take and soil sealing indicators will be measured by Member States based on data and information available EU and national level.

This option integrates a **clear obligation to make the monitoring data publicly available**, in line with the data protection rules. Soil assessment data is environmental information and should be publicly available to all citizens under the Aarhus Regulation and the INSPIRE Directive, but this is not always the case. This will also address the asymmetry of information between the landowners and buyers, which has been identified as one of the drivers of the problem of soil degradation.

The obligation to monitor and assess soil health and net land take would start during stage 1.

Coherence of this preferred option with other EU initiatives

The soil health measurements will be spatially explicit, which will allow them to be used in forest monitoring, for water and air monitoring. SOC measurements performed following option 3 will represent a common solution for the monitoring of the achievement of relevant NRL and LULUCF targets, translating into synergies and consistency.

Member States will be able to analyse and use soil spatially explicit data to define the appropriate restoration actions needed (complementary to those already planned in other initiatives); in this process they will take advantage to include in the analysis as well any spatially explicit data coming for example from forest, water and air monitoring.

The preferred option for BB2 largely corresponds to the views of those Member States and other stakeholders who submitted feedback (Annex 9 3.2.6). Member States generally support an obligation for regular long-term monitoring and most of them prefer harmonised minimum requirements at EU level. It also reflects stakeholder's requests that a harmonised approach should sufficiently consider both Member States individual monitoring systems, the integration of LUCAS soil, and avoid duplication with other monitoring requirements.

Block 3: sustainable soil management – option 3

Member States will be subject to **an obligation to take appropriate action to use soil sustainably while respecting some common general principles for sustainable soil management**.

Some existing initiatives, such as the LULUCF Regulation, or the Soil, Biodiversity, Farm to Fork and EU Forest Strategies, indicate or promote sustainable soil practices. Additionally, some policies, such as the Common Agricultural Policy, the Nitrates Directive, the Sustainable Use of Pesticides Directive (currently under revision),[83] are more prescriptive for some elements and incentivise some relevant practices. However, they cover only a limited range of soil threats, target a subset of soils, and are not sufficient to achieve overall soil health. The preferred option on the other hand will take these aspects into consideration, to ensure coherence and synergies, and to minimise additional costs and burden.

In this context, the preferred option will **set out a list of common general principles of sustainable soil management that will guide soil management practices at national level**. They

[83] Commission proposal for a Regulation of the European Parliament and of the Council on the sustainable use of plant protection products and amending Regulation (EU) 2021/2115, COM/2022/305 final

will be science-based principles and will target all types of soil degradation, such as reducing soil compaction and increasing soil biodiversity and will allow **Member States to take into account** their specific local, climatic and socio-economic conditions.

These common principles must be translated into specific practices by the Member States. The Commission would assist the process with advice and guidelines.[84] Member States will choose the form in which they will implement these principles and practices in their soil districts, and they may rely for their implementation on other instruments, such as financial support for voluntary measures under the CAP and national funding schemes for agriculture, forestry and urban areas.

Sustainable soil management practices should start to be put in place in stage 1, after sufficient time is given to prepare them (four years after the adoption of this initiative), in parallel with the setting up of the monitoring network to the extent that they do not depend on the results of this assessment of soils. The measures that require substantial adjustment or depend on the assessment of soils can be left to stage 2. This approach will provide Member States and subsequently individual soil managers with sufficient flexibility in selecting further sustainable soil management practices to suit local conditions. In stage 2 it will also be possible for Member States to assess whether the soils are further deteriorating and, where necessary, to take further adequate measures to ensure, as far as possible, that the principle of non-deterioration of the soils is respected.

This option therefore ensures a fair balance between ensuring healthy soils by 2050 and allowing sufficient flexibility at national level.

The preferred option for BB3 is fully consistent with the views of Member States and other stakeholders who submitted feedback (Annex 9 4.2.6). All types of stakeholders support an obligation to sustainable soil use. Many Member States, but also farmers, representatives of industry, and research and academia were calling for flexibility to adapt sustainable soil management practices to local conditions. The preferred option provides sufficient flexibility for Member States to decide on mandatory and voluntary practices according to their needs, while providing guidance to Member States, as requested by some stakeholders, by specifying general principles of sustainable soil management in the law.

Block 4: identification, registration, investigation and assessment of (potentially) contaminated sites – option 3

In the preferred option, **Member States must put in place a systematic approach using the available information to identify, register, investigate and assess the risk of contaminated sites on their territory**. This process starts with the registration of potentially contaminated sites that have an increased risk or suspicion of soil contamination. The identification of the potentially contaminated sites should start in stage 1 and all potentially contaminated sites should be identified and registered at the end of stage 1. **Subsequently, the presence of soil contamination on these sites needs to be confirmed through soil investigation and sampling.** The conditions that trigger registration as a potentially contaminated site and that require a soil investigation, must be defined by Member States. This preferred option does not prescribe these conditions because several countries already have different trigger points in place, making it difficult to harmonise at EU level.[85]

[84] Findings from the EU "A Soil Deal for Europe" Mission's living labs will be relevant in this respect.

[85] Triggers that are applied in some Member States and that require confirmation of the absence or presence of contamination are: operation in the past or present of potentially contaminating risk activities beyond the IED scope, land use changes, building permits, excavation activities, one-off obligation for historical risk activities that are no longer active (e.g. after systematic historical research), transfer or selling of land with risk activities, suspicion or notification of contamination (e.g. in case of accidents, flooding, odours, spills, etc.), contractual civil agreements between buyer and seller, mortgage by a bank.

In the past, the Commission has already confirmed it is in favour of a risk-based approach for contaminated sites,[86] which means that an assessment of the risks for human health and the environment of the present concentrations should decide on the need for further action. This allows to apply a site-specific approach that takes into account local conditions and the specificities of the contamination source, the pathways and receptors. **All Member States need to have in place national risk assessment procedures and methodologies**, knowing that most of them already apply such an approach. Member States can decide on the level of risk they find acceptable that humans and the environment can be exposed to from the current and planned use of the location taking into account the precautionary principle. Unacceptable risks could result from contaminated sites that cause:

- chronic or acute adverse impacts for human health or demonstrated nuisance (e.g. smells, skin irritation, etc.);
- harm for biodiversity (e.g., protected species), disturbance of ecological functions, bioaccumulation or biomagnification;
- spreading of contamination through groundwater.

Sites with unacceptable risks require further action and risk management under building block 5. This is the most appropriate way to fill the gaps that exist at EU and Member State level and at the same time to avoid too much conflict or interference with existing policies that some Member States have already put in place. **However, to ensure some basic consistency and transparency across the EU, building on option 3, the preferred opinion will set out some common general principles for risk assessment**: e.g., a site-specific risk assessment always starts with the identification and characterisation of the scope, then an analysis of the hazard level and toxicity, of exposure, and then to conclude with an evaluation of the risks. **If needed, these principles could be further refined through a delegated act and a guidance document on risk assessment could be established by the Commission if needed**. This would allow to involve scientists and experts and to build further on work done in several EU projects. The EU could also take up a coordinating role in the facilitation or exchange of knowledge between Member States, e.g. information on the fate and behaviour of certain contaminants, a repository or toolbox for risk assessment tools or models.

The potentially contaminated sites, contaminated sites, and contaminated sites requiring further action should be kept in a register that should be publicly available, which allows to track progress over time and to prioritise further action. The register should be regularly updated and reflect as much as possible also historical information, e.g. sites that have been remediated. Maximum transparency should be ensured: this information should be easily available online in a spatially explicit format, as this is already the case in some Member States. Information on the health and contamination of the soil can be considered as "environmental information" and falls under the scope of Aarhus Convention and the Environmental Information Directive. Environmental information should be made publicly available with the necessary exceptions to comply with General Data Protection Regulation and the relevant Union law.

The preferred option for BB4 is fully consistent with the views of Member States and other stakeholders who submitted feedback (Annex 9 5.2.7). Member States generally agreed on being responsible for identifying and registering contaminated sites, and all stakeholder types agreed this should be done based on a risk-based approach. Member States also support the public availability of the generated data if privacy rights will be assured, as it is foreseen under so preferred option.

Block 5: soil restoration (option 3) and remediation (option 2)

[86] E.g. in the EU Soil Strategy, the 7th Environment Action Programme or the Zero Pollution Action Plan (the zero pollution ambition refers to risks for human health and the environment)

In the preferred option, the Member States would be bound to achieve the objective that by 2050 soil ecosystems should be in healthy condition, where technically possible and economically proportionate to do so.

This obligation translates, for each soil degradation, in complying with the criteria presented in Table 7-1Table 7-1 together with the rationale for the target's realistic achievement and proportionality (see table 2.9 in Annex 11). As explained under block 1, the way the criteria are set for each of the descriptors amount to a realistic objective for 2050, with gradual milestones as possible and needed, reflecting the level of the knowledge of soils in the EU and the capacity to take measures to meet this objective.

Achieving the objective gradually and with a final target by 2050 requires the application of sustainable soil management and restoration practices to actively or passively assist the recovery of the soil ecosystem towards a healthy state, according to the soil health definition set in the building block 1. However, the measures under this building block, in particular the restoration and remediation measures require first the results of the assessment of soils (block 2) and good preparation since unhealthy and contaminated soils need to be brought in line with the criteria of the descriptors. Therefore, they should be implemented in stage 2, Member States being allowed flexibility in further staggering these measures for the transition to healthy soils.

Prioritisation of restoration, remediation and risk management actions to achieve the 2050 targets would be left to the Member States, to allow for sufficient flexibility and subsidiarity and to take the different local and budgetary conditions into account (no option 4). Option 2 does not include an obligation to take measures under this block, however it is considered ineffective as attaining the objective requires good preparation and measures. Such an approach also limits the capacity of stakeholders and authorities, including of the Commission, to measure the distance to target and adapt accordingly. That is why, similar to other EU legislation,[87] **Member States would have to adopt measures to achieve the objectives of the Directive**, which for coherence and transparency will need to be grouped within some programs of measures. The alternative would be to set some intermediate targets, however this would require prioritizing certain measures or objectives, which would be difficult at this stage given the limited knowledge on the condition of soils. Nevertheless, the choice and form of the programme of measures is left to the Member States, but they should include some minimal elements: the outcome of the monitoring and assessment of soil health, an analysis of the pressures on soil health, including from climate change, and the actual measures. Member States can also choose the administrative level for the programmes provided that all the soil districts of the country are covered. Although some minimum general content would apply for the programmes of measures (option 3), full harmonisation is not deemed appropriate because it would leave no flexibility to adapt to the local situation (no option 4). The programs can rely on measures included in other instruments, without repeating them. In fact such synergies are encouraged.

Exemptions from the restoration obligations would apply to unhealthy soils where restoration is technically not feasible, disproportionately expensive, or not desirable. Such cases could be, but are not limited to:

- soils that are heavily modified (e.g. sealed soils, mines);
- soils in natural condition that do not meet the values for soil health, but that represent specific habitats for biodiversity or landscape features (e.g. naturally saline soils, badlands).

Flexibility would be left to Member States to decide what is technically infeasible or disproportionately expensive. The decision on the derogation would be left to the Member States

[87] River Basin Management Plans, Nature Restoration Plans, Air Quality Plans, Marine Strategies, CAP Strategic Plans, etc.

and their competent authorities and would not require the endorsement of the Commission. However, the exemption from the restoration obligations would need to respect certain conditions such as the need to establish a less stringent objective, to set out the reasons for the derogations and the justification of the less stringent objective in the programme of measures (which will be subject to consultation of the public before its adoption and access to justice). In addition, in case of soil contamination, Member States would still be obliged to take the necessary measures to ensure that the contamination does not pose unacceptable risks for human health and the environment. The examination of the implementation of the derogations by the Member States should be part of the evaluation of the SHL to be carried out by the Commission.

As regards diffuse contamination and contaminated sites the zero pollution ambition[88] applies, namely that by 2050 soil contamination should be reduced to acceptable risk levels for human health and the environment. This concept brings in the risk dimension for soil contamination, as defined, identified and assessed under building blocks 1 and 4. Risk-based actions that ensure contaminated sites no longer pose an unacceptable risk, are called risk reduction or risk management measures which may include remediation (= reducing or removing soil contamination) but also isolation or containment of the contamination, use restrictions or safety measures, that break the source-pathway-receptor chain, but do not necessarily remove or reduce the contaminant load. Remediation is considered as a form of soil restoration.

The approach to manage unacceptable risks from contaminated sites based on the identification, registration, investigation and assessment in building block 4, is part of this building block 5, and should be addressed in the programme of measures. All available risk management or risk reduction measures are allowed to keep the risks below acceptable levels (option 2). In case of unacceptable risks, Member States are obliged to manage and reduce the risks, but not necessarily through remediation of the contamination (no option 3). In line with a risk-based approach, reducing the risk from the current or planned land use for human health and the environment is not only possible by addressing the contamination source but also by breaking the source-pathway-receptor chain.

The programmes of measures should be adopted by a certain date (at the beginning of stage two, after the assessment of soils) and revised periodically at least after each monitoring cycle (every five 5-6 years) depending on the conclusions of the assessment. In their programmes, Member States need to define their pathway towards the achievement of the 2050 targets. The programmes will need to be subject to adequate public consultation before adoption and be made public. The Commission will check progress on a periodic basis, including by using data and monitoring gathered and analysed by the Joint Research Centre and the European Environment Agency. Guidelines or support would be developed by the Commission as needed. The development of the programme of measures, stakeholder feedback and review of implementation are instrumental in ensuring ownership, engagement, and implementation by the Member States.

The programme of measures should be synergetic to relevant plans required by other EU legislation, e.g. the Common Agricultural Policy, the Nitrates Directive, the NEC Directive, the LULUCF decision, the Regulation on the Governance of the Energy Union and Climate Action, and the proposed Nature Restoration Regulation. The following table gives a brief overview of these plans and the synergies with the programmes of measures under the SHL initiative.

The preferred option for BB5 is largely consistent with the views of Member States and other stakeholders who submitted feedback. Member States and other types of stakeholders generally support an EU obligation to restore unhealthy soils by 2050, even though landowners expressed that derogations should be possible for degraded soils. The adoption of a program of measures is

[88] Cfr. EU Action Plan: ‘Towards Zero Pollution for Air, Water and Soil, COM/2021/400 final

generally supported, but especially some Member States and representatives of industry emphasized the need for flexible approach on this, which is foreseen under the preferred option (cfr. Annex 9 section 5.2.7).

Table 7-2: brief overview of plans required under other EU legislation and synergies with the programmes of measures under the SHL initiative.

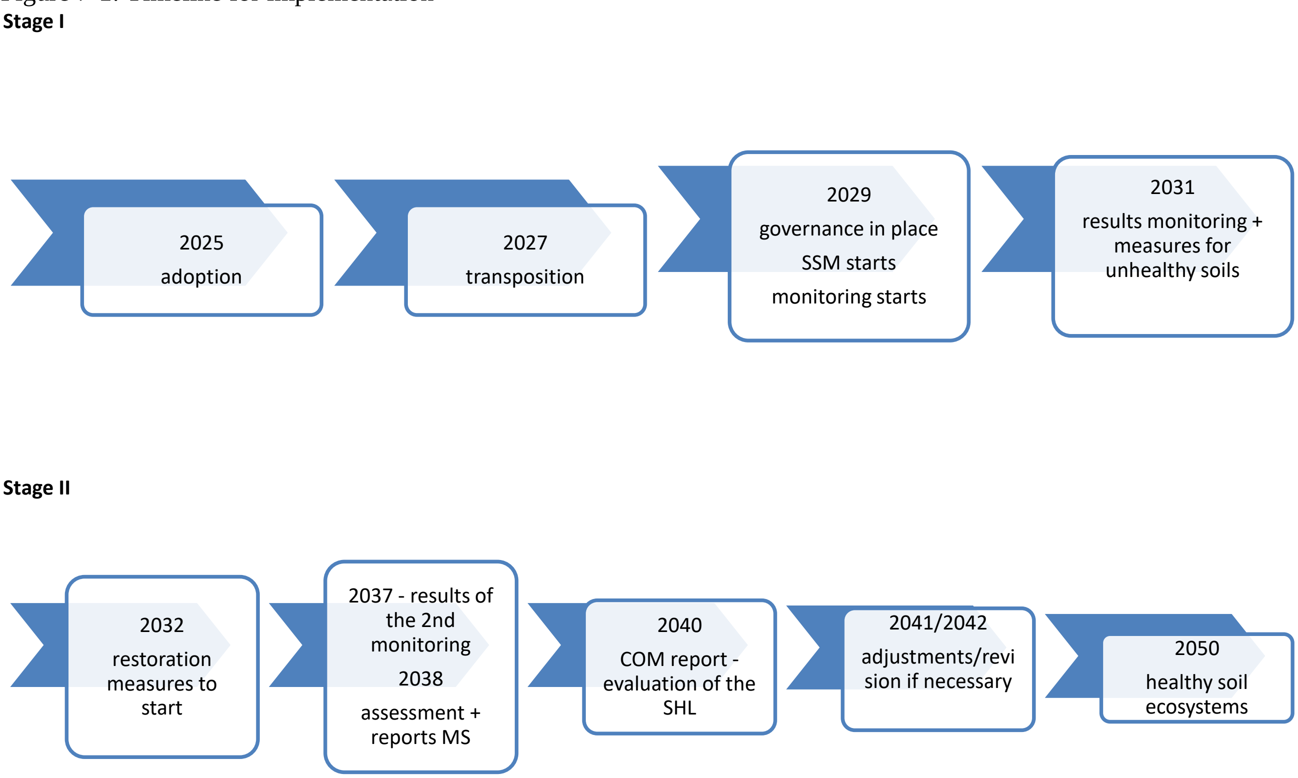
	(Future) nature restoration plans	**CAP Strategic plans**	**River Basin management plans (RBMP)/ Programme of measures (PoM)**	**Nitrates action programmes**	**National air pollution control programmes (NACP)**	**Integrated national energy and climate plan**	**Information on LULUCF actions**
Legal basis	Proposal Nature Restoration Regulation	Regulation (EU) 2021/2115 establishing rules on support for strategic plans to be drawn up by MS under the CAP	Articles 13 and 11 of Directive 2000/60/EC Water Framework Directive	Article 4 of Directive 91/676/EEC	Art 6 of Directive (EU) 2016/2284	Articles 3 to 9 of Regulation (EU) 2018/1999	Art 10 of Decision No 529/2013/EU of the European Parliament and of the Council of 21 May 2013 on accounting rules on greenhouse gas emissions and removals resulting from activities relating to land use, land-use change and forestry and on information concerning actions relating to those activities
Coverage (national/local)	National plan	National plan	One PoM and one RBMP per river basin districts (whole territory to be covered)	1 or several action programmes covering all vulnerable zones	National plan	National plan	National plan
Objective and Content (relevance for soi)	Restoration plans quantification of the areas to be restored to reach the restoration targets description of the restoration measures planned, put in place and timing indication of the measures to ensure no deterioration the monitoring; process for assessing the effectiveness of the measures estimated co-benefits the estimated financing needs	Strategic plans set targets, specify conditions for interventions and allocate financial resources under the CAP, according to the specific objectives and identified needs. CAP Strategic plans set national standard for each of the GAEC, taking into account the specific characteristics of the area concerned, including soil and climatic conditions, existing farming conditions, farming practices, farm size and farm structures, land use, and the specificities of outermost regions.	RBMP: Description of the basin, identification of pressures, summary of measures, objectives per **water body** (and derogations) PoM: Aims to achieve the objectives of the WFD i.e no deterioration and good status of **water bodies.** PoM includes: -basic" measures (including measures under other EU environmental legislation and measures to control/prevent pollution) - "supplementary" measures to achieve the objectives such as : • codes of good practice • recreation and restoration of wetlands areas	Mandatory measures for the purpose of realizing the directive's objectives i.e. reducing **water pollution** caused or induced by **nitrates from agricultural sources** and preventing further such pollution Some measures relate to: periods when the land application of fertilizer is inappropriate; the land application of fertilizer to steeply sloping ground and to water-saturated, flooded, frozen or snow-covered ground; the conditions for land application of fertilizer near water courses; land use management, including the use of	Programme to limit annual anthropogenic emissions and to contribute to the directive's objective i.e. to achieve levels of **air quality** that do not give rise to significant negative impacts on and risks to human health and the environment Policy context, policy options, measures considered to meet emissions reduction + specific measures for agriculture sector to control ammonia emission and emissions of fine particulate matter and black carbon such as national advisory code of good agricultural practice; ban open field burning of agricultural harvest residue and waste and forest	Part of the overall governance of the **Energy Union and Climate Action** Plan sets objectives, targets and contributions to the objectives of the 5 dimensions (one being decarbonisation) of the Energy union); description of measures; description of the situation. Plan contains information on GHG emissions and removals related indicators GHG emissions by policy sector (EU ETS, effort sharing and LULUCF) Non-CO2 emission related parameters Nitrogen in crop residues	Information on actions to limit or **reduce emissions** and maintain or **increase removals of greenhouse gases** including: - trends, projections and analysis - list of measures intended or implemented, expected results and timetable for implementation The LULUCF decision gives a list of indicative measures which are relevant for SHL, i.e measures related to • cropland management, • grazing land management and pasture improvement, management of agricultural organic soils, • prevent drainage and to incentivise rewetting of wetlands; restoration of degraded lands, • forestry activities, • preventing deforestation

			• promotion of adapted agricultural production such as low water requiring crops in areas affected by drought • water-saving irrigation techniques	crop rotation systems and the proportion of the land area devoted to permanent crops relative to annual tillage crops; the maintenance of a minimum quantity of vegetation cover	residue.	returned to soils; Area of cultivated organic soils	
Frequency of submission	Every 6 years	Covers the MFF ; amendments possible; review if regulation is modified	Every 6 years	Every 4 years	Every 4 years	10 years with update every 5 years (or justification not to update)	18 months after beginning of each accounting period (2013-2020; 2021-2025; 2026-2030)
Involvement of EC in approval/review process	Draft plan to be sent to EC for assessment EC may sent observations to MS within 6 months MS to take into account the observations MS to adopt and publish within 6 months after receipt of the observations	Draft plan sent to EC EC to assess the plan and approve it (if need be after modification by MS to take into account COM's assessment)	Adopted plans to be sent to EC Interim report to be sent 3 years after publication of RBMP on implementation of PoM	(Revised) action programmes to be sent to EC	Adopted plans to be sent to EC	Draft plan to be sent to EC EC to assess draft plan and may issue country-specific recommendations to MS. MS shall take due account of any recommendations.	Information to be sent to EC EC may, in consultation with the MS, synthesise its findings from all MS' information on LULUCF actions with a view to facilitating the exchange of knowledge and best practices among MS.
Synergies with Soil Health programmes of measures	**Carbon in organic soils**: healthy soil criteria on SOC in SHL will be considered achieved if NRL targets are met. No overlap, just reference. **Carbon in mineral soils:** measures in restoration plans on SOC in cropland mineral soils and in forest ecosystems to be assessed if adequate and sufficient) when preparing SHL plans to reach SOC criteria under SHL. Salinisation/ excess of nutrients: Impacts of NRL measures to attain targets on water ecosystems to be assessed against salinisation/excess of nutrients.	For **agricultural soils**: Measures implementing GAEC 2,5,6,7 &8 in CAP strategic plans may correspond to SSM and restoration practices under SH plans. SH plans would need to assess to which extent these measures are sufficient to address the relevant degradations, for the lands/farmers where these GAEC measures are applied.	For **erosion, compaction, water retention**: Information on groundwater status in RBMP/ pressures relevant for defining measures in SHL. Measures contained in PoM may also contribute to prevent soil degradation (e.g. erosion, compaction, water retention as well as diffuse contamination). Conversely reduced pressures on soils targeted by SHL may improve water status.	For (mainly) **erosion and excess of nutrients**): SH plans covering unhealthy soils located in vulnerable zones would take into account the impact of measures of the nitrate action programmes (e.g crop rotation).	**Excess of nutrients and acidification**: . NACP measures aim to limit ammonia emissions and eutrophication is to be monitored (hence acting on excess of nutrients). SHL plans will identify areas where soils are facing acidification and excess of nutrients. SH plans would need to assess to the possible contributions of the measures taken under NACP to meet the target on nutrients. ,	Measures identified in climate and NRG and climate plans may concern soil and soil, soil use and soil management (e.g. on carbon storage in soils). SHL and SH plans will help to quantify impacts of measures, identify areas where there is a need for action. In addition, some measures in SH plans addressing some other degradation (e.g erosion) may also be beneficial for increase of SOC and hence contribute to NRG and climate targets.	Synergies possible regarding **content of soil organic carbon (SOC).** SH plans covering would take into account measures reported under LULUCF actions and specify where they need to apply ('unhealthy soils'). Measures included in SHL plans may contribute to reach the LULUCF objectives Information on assessment of SOC level in SHL plans may further help to describe potential of further removals of greenhouses gases.

7.1.1 *Timeline for implementation*

The implementation of the obligations of the preferred options from the five building blocks would follow a 2-staged approach. The indicative timeline (assuming an adoption by the co-legislators of the proposed initiative in 2025) is summarized in the following scheme:

Figure 7-1: Timeline for implementation



In stage 1, a period of two years would be given after the expiration of the transposition deadline to Member States to put in place soil districts and to establish the competent authorities (BB1) who will carry out the obligations laid down in the initiative. The monitoring and assessment of soil health (BB2) and the implementation of sustainable soil management (BB3) would also start during stage 1. The identification of potentially contaminated sites (BB4) would take place during stage 1 with the obligation to have all potentially contaminated sites registered at the end of stage 1.

In stage 2, the obligation to restore unhealthy soils (BB5) would start and Member States would have the obligation to establish and implement restoration measures based on the results of the soil health monitoring and assessment.

7.1.2 *Expected effects of the preferred option on stakeholders*

The following set of actions serve as a basis of measures that may be needed, targeted and feasible to address the different causes of soil degradation, based on scientific evidence. In general, these measures can serve either as sustainable soil management practices or even for restoration purposes, depending on how they are used and always depending on the initial condition of the soil in question. This set of measures will be further developed for use in the context of the Soil Health Law through discussions and exchanges with relevant experts. It serves as a starting point to better estimate and indicate the expected effects of the preferred options on different stakeholders. This list of measures can be extended, as the scientific literature and a multitude of research projects already point to a large number of practices that can be designated as sustainable management and/or restoration practices (estimated at about at least 200 different practices), but whose applicability and suitability for different types of soils and land uses need to be confirmed. This already shows that both Member States and individual soil managers can potentially benefit from a wide range of measures, with sufficient flexibility to adapt practices to local, climatic and economic circumstances and needs, while ensuring sustainable soil management. Due to the voluntary nature of the respective practices and the great flexibility in their application and implementation, conflicts with existing policies and initiatives, such as the Common Agricultural Policy for agricultural soils, are not expected. Many are in use or have been tested in practice. Instead, synergies can be harnessed and help to make the best use of available incentives and funding to enable the necessary transformation to sustainable management.

Table 7-3: Potential actions to sustainably manage and / or restore soils, per type of degradation

Aspects of soil degradation	Actions to sustainably manage and restore		
	Agriculture	**Forest**	**Urban**
Loss of soil organic carbon in mineral soils	• Crop rotation • Intercropping • Incorporation of plant residues into the soil • Balanced use of organic fertilisers (ensuring that total fertiliser inputs follow the concept of balanced fertilisation) esp. on arable soils • Ban on burning plant residues • No / reduced physical soil disturbance (no-till, minimum-tillage, strip-tillage, conservation tillage) • Livestock grazing in low to moderate intensity • Vegetative soil cover to avoid bare soils or mulching • Conversion of arable land to grassland in areas of high risk for erosion • Agroforestry and establishment of hedges or landscape features	• No / reduced physical soil disturbance • Avoid burning tree / plant residues • Site-specific harvesting methods and harvesting frequency • Soil cover with vegetation • Forest residue management considering the site-specific conditions • Avoid clear cutting • Mulching after forest fires or clear cutting, or similar site-preparations ensuring soil cover	• No / reduced physical soil disturbance • Ban on burning plant residues • Storing and preserving litterfall, plant residues and lawn cuttings in parks and gardens • Application of compost • Establishment and maintenance of permanent vegetation cover in public parks and gardens • Planting of trees and hedges
Loss of soil organic carbon in organic soils	• Protection of wetlands from draining and conversion to other uses [under NRL] • Rewetting of peatlands [under NRL] • Raising water levels • No / reduced physical soil disturbance (no-till, minimum-tillage, strip-tillage, conservation tillage) • No extraction of peat on agricultural soils • Paludiculture [under NRL]	• No / reduced physical soil disturbance • Protection of wetlands from draining and conversion to other uses [under NRL] • No further drainage of wetland and peatlands / maintenance of high / optimal water levels • No extraction of peat on forest soils • Rewetting	• No / reduced physical soil disturbance • Protection of wetlands / Rewetting if applicable in urban areas • No further drainage of wetland and peatlands / maintenance of high water levels • No extraction of peat on urban soils
Excess nutrient content	• Application of fertilizer following an area based nutrient management plan • Application of soil nutrient testing for optimised	• Avoid clear cutting • Mulching after forest fires or clear cutting and similar site-preparation	• Vegetative soil cover to avoid bare soils (excl. mulching or stubble retention, alive vegetation only)

	fertilizer management • Crop rotation • Cultivation of catch or n-fixing crops • Cultivation of leguminous crops • Undersowing and intercropping • Vegetative soil cover to avoid bare soils (excl. mulching or stubble retention, alive vegetation only) • Growing deep-rooting perennial species to take up nitrogen from greater depths	techniques that ensure soil cover	
Acidification	• No application of acidifying fertilisers • Vegetative soil cover and leaving plant residues on the soil • Application of soil amendments (e.g. lime, dolomite) • Application of alkaline stabilized biosolids, e.g. rice husks, animal manure, wood ashes, etc.	• Avoid clear cutting • Mulching after forest fires • No application of acidifying fertilisers • Application of soil amendments (e.g. lime, dolomite) • Application of alkaline stabilized biosolids, e.g. rice husks, animal manure, wood ashes, etc. • Liming based on the scale of acidification	• No application of acidifying fertilisers • Application of soil amendments (e.g. lime, dolomite) • Application of alkaline stabilized biosolids, e.g. rice husks, animal manure, wood ashes, etc.
Erosion	• Vegetative soil cover and residue management to avoid bare soils throughout the year • No tillage on frozen, water-saturated, flooded or snow-covered soils • Ban on burning plant residues • Application of undersowing in crops with higher risk of erosion (e.g. maize, sugar beet) • No / reduced physical soil disturbance (no-till / direct seeding, minimum-tillage, strip-tillage, conservation tillage, no tillage or ploughing in sensitive period over winter months) • Establishment and maintenance of (permanent) grassland in risk areas for erosion • Cross slope barriers, such as grass or vegetative strips or contour bands	• Reduced and site-specific harvesting and logging • Mulching after forest fires • Avoid clear cutting • Avoid burning tree / plant residues • Avoid building terraces and creation of other edge-effects • Small water retention infrastructure (ponds, leaky dams) • Quick reforestation after harvesting or calamities, quick restore the soil cover with suitable tree or shrub species, which could play also nursing role for the new forest	• Vegetative soil cover and residue management to avoid bare soils • No /reduced physical soil disturbance • No physical soil disturbance on frozen, water-saturated, flooded or snow-covered soils • Ban on burning plant residues • Establishment and maintenance of permanent grass cover in public parks and gardens

	• Low intensity grazing management • Transformation of arable land into permanent grassland • Reducing the size of individual fields		
Compaction	• Compulsory training to understand the risk for soil compaction and prevention measures • Avoid use of heavy machinery in wet periods / under wet conditions (especially flooded or waterlogged soil) • Reduce tyre pressure • Application of bio-subsoiling, such as cultivation of deep rooting crops • Use of tracked vehicles on sensitive soils • Controlled traffic farming	• Increased training to understand the risk for soil compaction and prevention measures • Avoid use of heavy machinery in wet periods / under wet conditions (especially flooded or waterlogged soil) • Reduce tyre pressure • Use of slash and brush mats • Use of skidding trails • Application of bio-subsoiling, such as cultivation of deep rooting trees • Use only tracked vehicles on sensitive soils • Limited traffic and harvest paths for machinery (ensure the optimal level of access network, including harvest paths, skidding trails and forest roads, so machinery only uses the dedicated paths or roads)	• Avoid use of heavy machinery in wet periods • Reduce tyre pressure • Limited paths and access to certain areas in parks and public gardens • Application of bio-subsoiling, such as cultivation of deep rooting plants • Use only tracked vehicles on sensitive soils
Contamination	• Integrated pest management (combining crop rotation, resistant varieties, landscape features, monitoring and risk assessment, mechanical and biocontrol measures) • Reduce the use of chemical pesticides, e.g. by using precision farming techniques, eliminate the use of most hazardous pesticides • Use of mechanical weeding techniques • Avoid the use of sludge and mineral fertilizers • Replace plastic mulching with biodegradable mulches • Prohibit the use of slow-release fertilizers coated	• Integrated pest management • Reduce the use of chemical pesticides, eliminate the use of most hazardous chemical pesticides • If irrigation is used, avoid use of low quality / non-purified wastewater for irrigation / regularly test water quality • Testing and monitoring water quality for irrigation • Plant selection for contaminant uptake (e.g. phytoremediation)	• Eliminate the use of chemical pesticides • Application of best available techniques to prevent releases of contaminants to soil • Identification, investigation, registration, and risk assessment of contaminated sites • In-situ and ex-situ physical, chemical or biological remediation • Land use restrictions for activities which are potential sources of contamination

	with microplastic • If irrigation is used, avoid the use of recycled wastewater for irrigation / regularly test water quality • Testing and monitoring water quality for irrigation • Remediation of contaminated soil (e.g. phytoremediation)		• If irrigation is used, avoid use of recycled water for irrigation • Testing and monitoring water quality for irrigation • Circular use of excavated soil with clear minimum standards regarding contamination levels
Secondary salinization	• Avoiding irrigation and if irrigation is used, no use of recycled wastewater for irrigation, or saline or brackish water; at the same time, continually test and monitor water quality for irrigation • Mechanical removal of salt crusts • Drainage or leaching of salts • Soil amendments • No extraction from aquifers at risk of salination from sea water • Permanent vegetative soil cover • Sustainable crop selection and rotation (cultivation of salt-tolerant species, or crops with the ability to eliminate salt from soils, thus supporting soil recovery, such as halophytic plants (e. g. Salicornia)) • Top soil replacement for restoration • Cultivation of deep rooting crops for biological restoration	• Replanting and afforestation with multipurpose and salt tolerant tree species • Testing and monitoring water quality for irrigation • If irrigation is used, avoid use of recycled water for irrigation • No extraction from aquifers at risk of salination from sea water	• Testing and monitoring water quality for irrigation • If irrigation is used, avoid use of recycled water for irrigation • Planting of adapted and salt tolerant tree and plant species • No extraction from aquifers at risk of salination from sea water
Desertification	• Vegetative soil cover to avoid bare soils • Increase of soil organic matter (see above)	• Mulching after forest fires • Sustainable water management • afforestation or reforestation with appropriate technique if there is available deep layer water (e.g. deep drilling planting for poplar) • Reforestation with adapted tree species	• Vegetative soil cover to avoid bare soils • Increase of soil organic matter (see above)
Water retention	• All measures that contribute to maintaining and increasing soil organic carbon (see above)	• Afforestation with increased and appropriate tree species diversity	• Vegetative soil cover to avoid bare soils

	• Conversion to agroforestry systems to increase water retention and reduce maximum temperatures in the microclimate	• Site specific forest cover to reduce surface run-off • Areas dedicated to water infiltration • Appropriate scale of water engineering interventions, infrastructure, slowing down or mitigate the run-off	• Mulching • Incorporation of compost and plant residues • Replace impervious surfaces with semi-impervious surfaces • Solutions to allow water retention and infiltration in sealed areas (green roofs, underground water storage basins, etc.) • Planting of trees to cool temperature and reduce evapotranspiration
Loss of soil biodiversity	• Crop rotation • Vegetative soil cover to avoid bare soils • Land lying fallow, non-productive strips • No / reduced physical soil disturbance • No / reduced application of mineral fertilizers • Reduce or eliminate the use of pesticides, especially the most hazardous chemical pesticides • Avoid large areas of monoculture on landscape level • Avoid conversion or ploughing of grassland • Establishment of field margin strips and landscape features	• Planting of multipurpose tree species • Enhanced use of natural regeneration of forests • No / reduced physical soil disturbance • No / reduced application of mineral fertilizers • Reduce or eliminate use of pesticides, especially the most hazardous chemical pesticides • Avoid clear cutting • Minimize monoculture • No or limited removal of deadwood • Limited traffic and harvest paths for machinery	• Vegetative soil cover to avoid bare soils • No / reduced physical soil disturbance • No / reduced application of mineral fertilizers • Reduce or eliminate use of pesticides • Land lying fallow / establishment of undisturbed areas • Animal grazing with low stocking density instead of machine mowing of grass • Establishment of wild / native vegetation and landscape features
Sealing and land take			• Ensure permeability and water infiltration of urban grounds • Urban green infrastructure and green roofs • De-sealing and renaturation • Brownfield and land redevelopment • Sustainable land use planning and densification

Together with the other elements described under the different building blocks, the above list of actions for a sustainable use and restoration / remediation of soils leads to the following assumptions of what can be the expected impacts on stakeholders, which is displayed in the Table 7-4 below. When looking at this table it is important to note the following:

- This list aims to give an overview of all potential impacts, for all stakeholder types, during the application timeline of this initiative, i.e. the next 25 years.
- The obligations for end users, notably soil managers, will phase in gradually, based on the staged approach presented above, but also depending on the condition of the soil, what is feasible, and the practices already applied. As explained, the national authorities will be those deciding what practice applies to the various soils. Obviously, the benefits will depend on the implementation of these measures.
- The administrative obligations for the authorities are more certain, nevertheless in case of well-established systems for soil monitoring or surveying contaminated land, fewer adaptations are needed.

Table 7-4: Impacts on stakeholders

Stakeholder type	**Expected impacts of SHL**	
	Costs/obligations related impacts	**Benefits related impacts**
Soil managers (farmer, forester, urban green area manager, etc.)	*The actual Impacts for the soil manager will depend on the current status of knowledge and already implemented soil management practices. Help, advice and financial support (e.g. loans) to overcome the short-term costs before the benefits materialise can be expected to be provided to ensure a just transition.* • Need to evaluate their current soil management practices in the light of the guidance or requirements established by the authorities once these are issued - stage 1. Help and advice can be expected to be provided as needed. • In case the practices are evaluated as not sustainable there is the need to adjust as soon as it is feasible the management practices that they are applying, or transition to new sustainable management practices (e.g. to enhance the share of soils with vegetative soil cover, reduce physical soil disturbances, apply more organic fertilizer while following a balanced fertilisation approach, provide and enhance higher share of landscape features, ensure proper crop rotation and avoid large areas of monocultures on landscape level and other sustainable soil management practices (see indicative list of actions -	*Impacts depends on the current status of knowledge and already implemented soil management practices* • Long-term soil fertility and productivity • Maintaining or increasing yields on productive soils over the long-term but also in short term (depending on the measures) • Access to decontaminated sites, or soils that may otherwise remain or become degraded by desertification, compaction, salinisation etc • Transparency and better decision making on taking agricultural lands to other uses • Enhanced availability of possibilities for training and advice due to obligations on MS to achieve healthy soils (dedicated authorities and knowledge) • Knowledge about the health of own soils by regular monitoring

	(see examples in Table 7-3**Error! Not a valid result for table.*****Error! Not a valid result for table.***)- stage 1. The transition should be realised in such a way not to compromise the continuity of the soil use • Need to take training and advice to access to relevant funding and ensure application of sustainable soil management practices – stage 1 and 2 • Need to take measures to restore unhealthy soils depending on the situation of soils following the monitoring and assessment, in line with the guidance or requirements established by the authorities – stage 2. The restoration should be realised in such a way not to compromise the continuity of the soil use • Up-front investment costs (new / different machinery, seed), potential decrease of quantity of production in the short term (depending on the measures) • Potentially increased administrative burden (depending on the manner of implementation of the SHL by individual Member States);	• Financial support for sustainable soil management practices at national and EU level • Discover and access more cost-effective production (e.g. decreasing use of inputs) • Access to funding for precision farming techniques if provided by MS to achieve reduction of fertilizer and pesticide use, e.g. under Rural Development measures of the CAP • Increased social and recognition for sustainable management as a result of increased consumer awareness • Some of the agricultural products (grapes) depend highly on the quality of the soil, hence sustainable practices will result in market recognition as well. • Cleaner water and air (due to less erosion, contaminants or run-off nutrients) in the immediate neighbourhood • More resilience to flooding or drought • Reduced need for local handling and transfer of sediments resulting from water erosion • Increased knowledge and skills transfer and/or exchange across soil managers on sustainable soil management practices
	For the potential of such sustainable soil management measures to offset costs by benefits on short or longer term please see	
Landowners	*Only additional impacts listed here if the landowner is not the land manager* • Allow access to authorities carrying out soil sampling • Inform land managers of own land about status of soil health	*Only additional impacts listed here if the landowner is not the land manager* • Ensuring long-term soil fertility and productivity and thus a stable or increased value of their land • Solid legal baseline and better data to ensure value of land is not decreased while land is let out on lease / returned to the landowner • Appropriate knowledge-base to inform on land use and possible change (e.g. from arable land to permanent grassland) • Increased awareness and recognition for keeping land in a healthy state and contributing to healthy and functioning ecosystems
National	• Need to ensure compliance with the provisions of the SHL first by	• Ensuring long-term soil fertility and productivity and thus

authorities	transposing it (directive) • Put the governance system in place: designate soil districts and authorities • Set up the monitoring system and assess the situation of soils • Coming up with guidance or/and rules on sustainable management practices and in stage 2 restoration measures • Check compliance and ensure compliance • Facilitate advice and training on SSM and access to funding • Inform the main categories of stakeholders on their role and obligations • Need to identify and fill in the public registers on contaminated sites • Need to take measures to reduce what they identify as unacceptable risks in case of contaminated sites • Need to provide for training and education of workers working on sites registered as contaminated • Increased administrative burden in relation to monitoring activities (e.g. assessment of the data, determining trends, assessing the effectiveness of actions taken and identifying needs for additional action) or to national inventories for contaminated sites (e.g. IT infrastructure/website);	improve their contribution to economy and food security • Ensure good knowledge on soils in the country as an informed basis for high-level decision-making • Set up favourable premises for SMEs and experts, research, development and training, in the field of sustainable soil management • Ensure contribution of soil to attaining the countries carbon storage objectives (limiting loss of soil organic carbon, increasing storage of organic carbon in soils) • Increased resilience to climate change by better water retention and erosion management • Soil data and governance (soil districts) facilitate the implementation of other initiatives such as the carbon removal certification • Remote data sensing developed at EU level would support MSs in need
Land use planners	• Need to consider soil health status and land take hierarchy when planning new infrastructure, urban and industrial settlements etc. • Need to seek information about soil functions and how to make best use of soil functions for society in general	• Better knowledge and awareness about soil health and soil functions • Availability of financial support based on incentives to ensure the general objective of the SHL is achieved
Businesses – agro-food-forestry sector	• Need to increase understanding of environmental processes and how to ensure soil health • Need to cover (e.g. with pooling over several farms) the short-term fluctuations in the quantity and quality of supplies related to the transition of each individual farm to sustainable soil management practices • Due to increased consumer awareness of soil health, this may need to be given greater consideration in the manufacturing and processing of products and adjusted as necessary	• Ensuring long-term security of supplies (quantity and quality) for raw products due to soil fertility and quality • Increased product attractiveness and sales when environmentally friendly production and marketing strategies convince consumers • Better understanding and awareness of environmental processes and importance of soil health • Increased social and market recognition for sustainable production as a result of increased consumer awareness,

	• Possibly adaptation of production and marketing strategies • Need to support the farmers with training and financing to take up sustainable soil management practices (this will not be an obligation, but has already proven to be a win-win)	including better income opportunities for all involved actors
Businesses – other (depending on the type and relationship with soil management)	• Need to consider soil health status and land take hierarchy when planning new infrastructure, urban and industrial settlements etc. • Need to seek information about soil functions and how to make best use of soil functions for society at large • Need to follow the principles for land use change and ensure sustainable soil management, such as ensure permeability and water infiltration of urban grounds, include sufficient green infrastructure in urban and industrial areas • Exploit options of de-sealing and recycling of sealed grounds • Apply brownfield and land redevelopment • Need to shift and adjust to products less damaging for soils	• Better understanding and awareness of environmental processes and importance of soil health • Increased social recognition for sustainable management as a result of increased consumer awareness • Access to restored/remediated land, and hence of higher market value, in urban areas already equipped with utilities networks (especially for project developers) • Business and funding opportunities especially for SMEs on sustainable soil management, remote sensing etc. • Increase in business opportunities for businesses / SMEs within individual Member States carrying out analysis of soil samples as a result of increased monitoring of soil (e.g. laboratories)
Citizens	• No direct obligation or cost	• Improved public health, including increased air and water quality and higher recreational value (especially for those living close to polluted areas) • Long-term food security • Access to information on contaminated sites • Access to healthier products (less contaminants) • Higher awareness about importance of soil health, which will empower them to contribute to a healthier environment by purchasing sustainable produced food and biomass • Improved protection can lead to an improved protection of cultural/natural heritage, human capacity and public health • Improved landscape and recreational value of soils in the countryside and in urban areas, leading to improved living condition (creation of green spaces or recreational areas) and potential job creation connected to those. • Job creation related to identification and restoration of contaminated sites (e.g. environmental consultants, geologists,

		remediation engineers, lower-skilled workers, trainers, etc.).

While it is currently not possible to give a full indication of quantified costs and benefits for all actions listed under Table 7-4 above, the table below gives an overview of the quantified costs and benefits for a selection of sustainable management practices for which data and estimations are available (see Annex 9 for details). It is important to note that: 1) whereas the long-term benefits (appearing under 'additional benefits' in the table) were not quantified for these practices in this study, they are reflected under the costs of degradation described in chapter 2.1.4 above; 2) the costs/benefits are aggregated at EU level, however in practice they may be used at a smaller scale (this is left as explained to be decided at national level).

Table 7-5: Impacts of certain sustainable soil management practices

Practice	Costs	Quantified benefits	Additional benefits	Potential challenges
Cover crops	• Average total costs of cover crop implementation: **262 EUR/ha** • Total costs for application of cover crops to all arable bare soils in Europe: **5.8 billion EUR**	• **Yield increase** in main cereal: 16 %, equating to an **additional value** of **8.8 billion EUR** at EU level • **Yield increase** in potato by 3 tonnes/ha, equating to an **additional value** of **767 EUR/ha** and an additional total of **264.5 million EUR** at EU level • **Saving in nitrate fertiliser costs**: 52 – 73 EUR/ha, equating to **1.2 – 1.6 billion EUR pa** for all bare arable soils in Europe	• Increased soil nutrient and water retention • Improved soil structure and soil quality • Reduced risk of erosion, surface run-off, and diffuse pollution • Reduced soil compaction • Reduced biodiversity loss • Improved soil health, supporting higher yields	• Rotational conflicts • Partially increased weed pressure
Reduced tillage	• **Reduced value** from grain crops due to reduced yields on EU level: **12.9 billion EUR pa** • **Costs** for weed control: **35-100 EUR/ha**	• **Reduction of overall operation costs** compared to conventional tillage: 194.40 EUR/ha, equating to savings of **11.9 billion EUR** at EU level • Approximate **average saving** in reduced tillage: **116 EUR/ha** • Estimated **profit increase: 108 – 123 EUR/ha**	• Increase in soil organic carbon • Improved GHG emission mitigation • Reduced soil erosion • Improved soil biodiversity (earthworms) • Improved soil health, supporting higher yields in the medium- to long-term • Reduced need for artificial inputs in	• Often initial short-term decreases in crop yields (average reduction of 8.6 %) • Risk of higher need for weed control

			the medium- to long-term	
Crop rotation	• **Costs** for implementation of one additional crop over a five-year period: **61 EUR/ha,** and **0.6 billion EUR** in total for all land used for barley in the EU	• **Increased market revenues** from introducing one additional crop over a five-year period: **289.2 EUR/ha**, and a total additional benefit of **3 billion EUR** for barley growing in the EU	• Lower incidence of weeds, insects, and plant diseases • Improved water holding capacity and aggregate stability • Increase in soil organic carbon • Increased soil nutrient retention • Improved GHG emission mitigation • Improved soil health, supporting higher yields	• Selection of crop composition to maximise benefits • Harmonisation of rotation cycles • Integration of extra crops in standard rotations • Potential need for investment
Use of organic manures	• Estimated **costs of** investment for **storage** and ongoing **application** on farm level: **1,543 – 9,646 EUR pa** • Estimated **costs** of the implementation of the use of organic manure at EU level: between **8 – 8.9 billion EUR pa**	• Manure can save costs on chemical fertilisers in the range of **82-140 EUR/ha** • The estimated benefit per farm is approximately in the range of **1,427-2,436 EUR pa** • Estimated **benefits** of the implementation of the use organic manure at EU level: approximately **1 billion EUR pa**	• Reduced nutrient leaching • Enhanced microbiological activity • Increase in soil organic carbon • Reduced biodiversity loss • Reduced soil compaction • Improved soil health	• Potentially increased logistic effort for farms without livestock • Relatively high one-off costs for installation of storage facility • Limits on use in nitrates-polluted areas
Reduced stocking density	• **Costs** for temporary relocation of livestock from certain grassland areas: **< 8.1 billion EUR pa**	• **Savings** through reduction of soil compaction: **0.6 billion EUR – 2.7 billion EUR pa**	• Reduced soil compaction • Reduced soil erosion • Increased biodiversity • Improved soil health, leading to increased yields in the medium- and long-term	• Temporary relocation of livestock from certain grassland areas may not be feasible for some farms

Notes: Selected SSM practices are widely accepted and applicable SSM practices across the EU; the analysis is based on an extensive literature review, however this is limited to these practices; while there is good evidence of the benefits of SSM practice at farm level, there are a number of limitations and gaps in the evidence base (quantitative data not always available, strong differences in impacts due to different local conditions, limited availability of studies, often not available for MS level, etc), leading to the need to simplify some assumptions; the quantified benefits are those accrued immediately (yields from additional crops, savings) and that could thus be measured over a short period of time, not those resulting from the improvement of soil health and quality.**[89]** However, the latter are the real added-value of improving soil health – for example, earthworm presence in agricultural soil (positively influenced by reduced tillage) leads to a 25% increase in crop yield and a 23% increase in aboveground biodiversity.**[90]** The costs are also higher at the beginning as they include up-front investments costs; detailed information in Annex 9, 11.3 – 11.7.

[89] For example, there is no quantification of the effect on health of the huge loss of nutrients that have fallen between 10 and 100 percent in foods (Cu -76% in vegetables and -24% in meat, Ca – 40% in each, K -16% etc) and are ascribed mainly to loss of soil quality and of the benefits of reverting this.

[90] https://www.nature.com/articles/srep06365

7.1.3 Overview of impacts on competitiveness

Table 7-6: Overview

Dimensions of competitiveness	Impact of the preferred option	References to sub-sections of the main report or annexes
Cost and price competitiveness	+	Part 1/3 of the SWD, Chapter 3 Part 1/3 of the SWD, Chapter 6 Part 3/3 of the SWD, Annex 11
Capacity to innovate	++	Part 1/3 of the SWD, Chapter 3 Part 1/3 of the SWD, Chapter 7
International competitiveness	0*	Part 1/3 of the SWD, Chapter 3 Part 3/3 of the SWD, Annex 10
SME competitiveness	+	Part 1/3 of the SWD, Chapter 7 Part 3/3 of the SWD, Annex 11 Part 3/3 of the SWD, Annex 11

*= note: on a longer time horizon, this is likely to be a positive (+) impact

Cost and price competitiveness

The preferred option is likely to impact cost and prize competitiveness of economic actors based in the EU, both directly and indirectly. Costs can be expected from the implementation of measures, particularly those in relation to sustainable soil management (block 3), identification and investigation of contaminated sites (block 4), restoration (block 5) and to a lesser extent monitoring (block 2). The nature of these costs will vary significantly depending upon the exact measures which Members States select due to the flexibility offered allowing for local conditions to be reflected, and disproportionately costly measures to be avoided. However, the costs associated with the preferred option are lower than the positive economic impacts, particularly when analysing over medium/long-term time horizons. In the short term, the competitiveness may be nevertheless temporarily affected negatively in case a Member State would not adequately support the costs of the transition to sustainable soil management practices or the restoration measures, before the benefits are reaped. However, the longer-term benefits, such as maintaining or increasing soil fertility or reducing input use, can ensure long-term productivity and reduce costs, thus increasing competitiveness in the long term.

The key economic actors impacted by the preferred option are likely to be the landowners and managers who rely upon soils as a key input for their production processes, e.g. foresters, agricultural operators and industry. For these actors, the preferred option has the potential to diversify production systems, resulting in greater resilience to climate fluctuations of their businesses, with subsequent cascading impacts on the value chains that they supply. Furthermore, diversified and more sustainable production systems which maintain or increase soil health will generate stabilised or increased yields from food, feed and biomass production in the long-term. The analysis offered in Annex 11 outlines such economic benefits.

However, not all activities prescribed under the preferred option will lead to immediate positive impacts on competitiveness for those incurring the costs. For example, lower agricultural yields can be expected from some restoration activities (such as the introduction of seasonal non-productive zones), yet these can be partially overcome through knowledge sharing, support from national and EU funds, increased soil fertility and resilience in the longer run. Furthermore, some of the economic benefits will occur for different stakeholders and society as a whole (e.g. climate benefits, protection of shared water resources, public health, job creation). However, common criteria, principles and management practices established by the EU and MS will help to stimulate standardised yet flexible approaches to soil management which will ultimately lead to efficiency gains in the long term for soil managers. This will also reduce internal market distortions and unfair competition. Currently, national legislation targeting soil health is divergent, resulting in contrasting obligations for economic actors. Ensuring a level-playing field across all Member States in relation to soil policies will ensure a better and fairer functioning of the internal market.

Capacity to innovate

The preferred option will lead to more innovation in tools, instruments, practices and methods to monitor, assess and improve soil health in the EU. It is foreseen that technological development in, for example, the use of monitoring approaches (eDNA, remote sensing, use of space data and services, in-field monitoring systems) will further enhance and stimulate soil-related research in the EU, further motivated through EU funding mechanisms. The intensified use of technologies such as precision farming and remote sensing are likely to lead to efficiency gains in the long-term, which could imply cost savings for Member State monitoring authorities/agencies. In addition, such uptake in innovative solutions is likely to increase the competitive edge of the EU companies in relation to expertise and technologies exportable to non-EU countries.

International competitiveness

The implementation of the preferred option is likely to generate impacts on international competitiveness. The most obvious is that non-EU producers would not be subject to the costs to comply with obligations stemming from EU legislation. These costs incurred on EU SMEs and sectors (through trade and finance flows) can negatively impact the EU's international competitiveness footing in the short term, yet it is likely that international competitiveness in the medium/long-term will benefit from the implementation of the preferred option (e.g. improved productivity, trade, jobs public health) as measures taken will be proportionate and net beneficial. Through its implementation, the long-term sustainability of EU soils will be secured, whereas geographic locations with less stringent legislation will likely continue to be exposed to continued soil degradation amplified by climate change events. Ultimately, it is expected that this would place the EU in a better competitive position in the long-term, e.g. as regards to the export of expertise and technologies to solve soil-related issues.

SME competitiveness

The results of the SME test (see Annex 11.3) show that this initiative is considered relevant for SMEs, since the business sectors that are expected to be indirectly concerned by at least some aspects include:

- Agriculture and forestry and related extension services (where micro SMEs such as farmers operate)
- Business activities that have polluted soil (SMEs could be part of them)
- Remediation of contaminated sites (it is often SMEs operating in this sector)
- Research and laboratories (it is often SMEs operating in this sector)

Following the obligations for Member States to assess and monitor soil health, use soil sustainably and restore unhealthy soils, there is expected to be a direct and positive impact on the conduct of business and position of SMEs in the sector of research and laboratories, remediation of contaminated sites as well as in advisory services linked with soil health within each Member State due to the increase in their services and from innovation. In these sectors, it is estimated that the SHL package could have an associated employment effect of 35,900 FTEs on an ongoing basis over the first ~20 years, of which SMEs are expected to profit.

In case the cost of remediation of contaminated sites falls on private companies, given the significance of costs, there may be important impacts for SMEs and on the sectoral competitiveness, trade, and investment flows of affected sectors as producers in non-EU countries would not be subject to the same costs. SMEs could be more vulnerable to additional costs. The preferred option leaves a significant degree of flexibility and discretion to Member States to design the measures in such a way that they minimize potential negative impacts on businesses and in particular SMEs. While the problem of soil degradation needs to be addressed urgently, the target date of 2050 for achieving healthy soils provides a proportionate timescale to realize the transition while phasing it so that adverse impacts for SMEs can be minimized.

Since the Soil Health Law provisions require a transition from unsustainable to sustainable management practices, and the implementation of restoration measures where soils are assessed as unhealthy, whenever restoration is possible, small and medium enterprises acting in particular in the agricultural and forestry sectors are expected to face the need for additional resources, human capital and face transition risks (e.g. in terms of skills and training). At the same time, additional implementation costs are expected to lead to significant employment effects associated. The estimation of these effects presents high uncertainty; however, using illustrative costs and simplified extrapolation to EU level, it is estimated that 300,000 to 420,000 annual working units (AWUs) could be created associated with implementation of three SSM practices EU-wide on an ongoing basis.

7.2 Legal form

The Soil Health Law will provide a coherent framework for soil assessment, monitoring, sustainable management and restoration, and will indicate the goals and targets to be achieved by Member States in 2050. The variability of soil condition and uses across the EU, as well as the flexibility left to the Member States in the preferred option, would fit a directive as a legal instrument. A directive would provide the necessary flexibility to Member States to reach the 2050 objective and implement the necessary measures in a manner adapted to the specific national context, so respecting the subsidiarity principle. It would indeed be difficult to design a ‘one size fits all’ regulation (along the lines of option 4) that would regulate all the necessary detail at EU level and directly apply at Member States’ level, especially considering the diversity of soils and conditions affecting them at local level.

The transposition step is absolutely needed to determine the correct adaptation of the frame to the national specificities, despite the urgency necessary for action. To address the urgency, the preferred option provides, where the choice is left to the Member States, indicative solutions and assistance to facilitate a swift national transposition.

7.3 Overview of costs and benefits

The overall preferred option is designed to take action and tackle the costs of no action, due in particular to ecosystem services loss from soil degradation. The detailed costs and benefits are summarized here below in Table 7-7 and used for the estimation of the benefit to cost ratio. Not all the impacts (in particular benefits) of the SHL could been quantified and monetised, in particular the off-site benefits (see Table 2-4). There is considerable uncertainty around many of the quantitative estimates. Nevertheless, the temporal profile of the impacts was assessed to present an overall net-present value or benefit-cost ratio for the SHL after discounting (cfr. annex 11).

While noting the uncertainty on the estimated benefits, the calculation assumes an estimate of annual benefits of the order of EUR 50 billion (excluding contamination) – based on the results from theTable 5-2 (benefits from SHL as reduction of the costs of soil degradation after deducting contributions from other initiatives in the baseline – upper end of quantified costs) - plus a prudent amount of EUR 24.4 billion for contamination – taken as the intermediate estimation between the lower and upper quantified value for soil contamination (which differ by a factor of about one hundred) – see costs of soil degradation from section 2.1.4. The benefit/cost ratio obtained with these values (see below) results to be sensibly lower that other comparable estimations available in literature: this indicates that the values chosen are conservative and prudent.

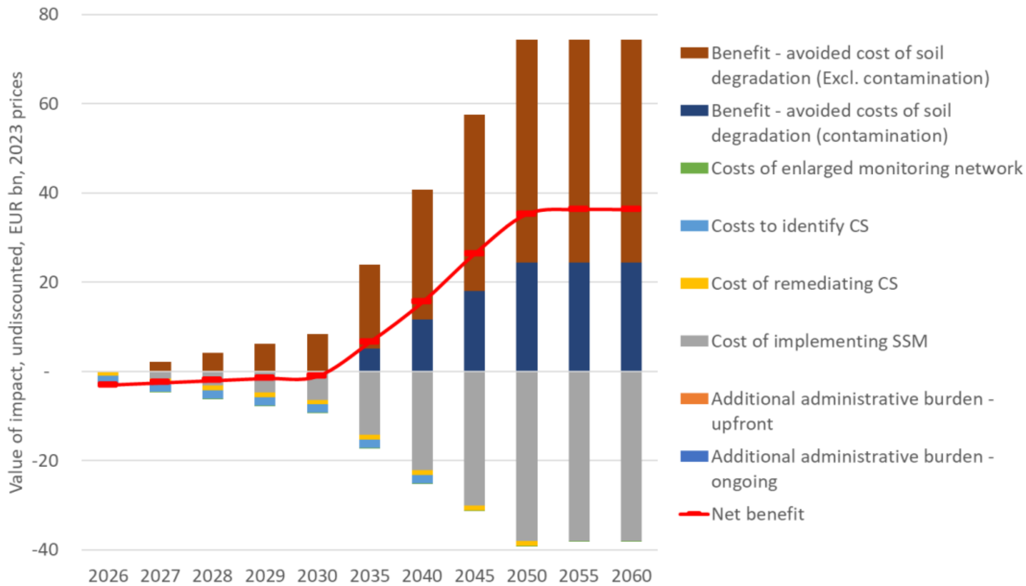
Table 7-7: The benefit/cost ratio

Quantified effect	Effect estimate (2023 prices)	Explanation of point estimate	Assumptions around temporal nature of effect
Benefit – avoided costs of soil degradation (excl. contamination)	EUR 50 bn pa	- Estimate of the annual costs caused by soil degradation. - Represents the benefits that can be captured should all soils achieve good health. - Hence this represents the value that can be captured as from 2050.	- SHL achieves EUR 50 bn pa benefits by 2050, and each year after. - Benefits will start to accrue when Member States begin to implement SSM and restoration measures. - For simplicity, assume linear increasing trend from start date to 2050
Benefit – avoided costs of soil degradation (contamination)	EUR 24.4 bn pa	- Estimate of the annual costs caused by soil degradation. - Represents the benefits that can be captured should all CS be remediated. - Hence this represents the value that can be captured as from 2050.	- SHL achieves EUR 24.4 bn pa benefits by 2050, and each year after. - Benefits will start to accrue when Member States begin to remediate CS. - For simplicity, assume linear increasing trend from start date to 2050
Costs of enlarged monitoring network	EUR 46 m pa	- Estimate of annual cost of enlarged network	- Annual cost spreads total monitoring cost over each 5-year campaign. Hence assume flat cost pa.
Costs to identify and investigate contaminated sites	Total EUR 29 bn (1.9 spread over 15 years)	- This represents the total, cumulative cost of identifying and investigating all CS.	- Member States have to set up the register of CS. - Costs assume flat, constant trend over investigation period. Assume full investigation period lasts 15 years. - Once all sites have been identified and

Quantified effect	Effect estimate (2023 prices)	Explanation of point estimate	Assumptions around temporal nature of effect
			investigated, assume no ongoing cost.
Cost of remediating contaminated sites	Total EUR 24.9 bn (1 bn spread over 25 years)	- This represents the total, cost of remediating all CS.	- Costs will accrue when Member States remediate CS. - For simplicity, assume flat, constant trend in cost increase from start date to 2050
Cost of implementing SSM	EUR 28 bn to 38 bn pa based on illustrative sample of 5 measures. (2006 IA estimate based on 4 agriculture threats + forestry and construction measures totalled EUR 20.3 bn)	- Illustrative estimates of total, annual costs of SSM to improve soils to good health - Costs are ongoing once deployed, not one-off. - Represents the costs that can be captured should all soils achieve good health. Hence maximum benefits are achieved as from 2050.	- Costs will start to accrue when Member States begin to implement SSM and restoration measures. - For simplicity, linear increasing trend from start date to 2050, and constant thereafter.
Additional administrative burden - upfront	EUR 48 m	- Total upfront costs to Member States to implement different elements of the SHL package.	- Costs will likely begin to impact at transposition. - Costs will then be spread over an implementation period of a number of years as Member States set up functions and systems to implement different elements of the SHL. This period is somewhat uncertain, but assume this lasts 5 years. Costs in practice may vary over this period, but assume flat, constant profile for simplicity with equal costs in each of the 5 years.
Additional administrative burden - ongoing	EUR 8.0 m pa	- Total ongoing costs to Member States and businesses to implement different elements of the SHL package.	- Costs will begin to impact after transposition. - Costs will then occur each year on an ongoing basis. Costs assume flat, constant profile for simplicity.

Many of the impacts have a different time profile but continue on an ongoing basis until and after 2050. An appraisal period to 2060 has been selected to capture the ongoing benefits (and costs) of soils in good soil health after 2050. All impacts are discounted to 2020, using a discount rate of 3% (as recommended in the Better Regulation Toolbox). Based on the assumptions in the table above, the figure below depicts the temporal trend of impacts over the appraisal period in 5-year steps. The cumulative, discounted present value of each effect and net-present value and benefit-cost ratio of the SHL package is then presented in the table below.

Figure 7-2: Temporal profile of impacts



The cumulative, discounted present value of each effect and net-present value and benefit-cost ratio of the SHL package is then presented below.

Table 7.8: Present value of impacts, and summary economic metrics

Quantified effect	Discounted present value (EUR m, 2023 prices, discounted to 2023, cumulative over appraisal period to 2060)
Benefit – avoided costs of soil degradation (excl. contamination)	550,000
Benefit – avoided costs of soil degradation (contamination)	230,000
Costs of enlarged monitoring network	-940
Costs to identify CS	-22,000
Cost of remediating CS	-16,000
Cost of implementing SSM*	-420,000
Additional administrative burden - upfront	-41
Additional administrative burden - ongoing	-160

Quantified effect	Discounted present value (EUR m, 2023 prices, discounted to 2023, cumulative over appraisal period to 2060)
NET PRESENT VALUE	**320,000**
BENEFIT-COST RATIO	***1.70***

Notes: *Adopts high end of the range of EUR 35bn pa

Under the given assumptions, the quantified impacts suggest that the preferred option will likely deliver a significant net benefit estimated to be around EUR 320bn (2023 prices, discounted to 2020) over the appraisal period to 2060. This net benefit would become greater when the appraisal period would be extended beyond 2060 to further capture the ongoing benefits. The benefit-cost ratio of the preferred option over the appraisal period is around 1.7. This is lower than other benefit-cost ratios taken from the literature, in particular:

- The cost of inaction on soil degradation, which outweighs the cost of action by a factor of 6 in Europe;[91] and
- Every €1 investment in land restoration brings an economic return of €8 to €38.[92]
- A report by the ELD initiative[93] concluded that investing in sustainable land management is consistently shown to be economically rewarding with benefits outweighing costs severalfold in most cases.

Different studies have adopted different approaches to estimating both benefits and costs. The BCR of 1.7 in this impact assessment is tailored for the preferred option and is a lower bound estimate which would be higher if a lower bound cost of SSM measures is applied, or when the appraisal period is extended. The calculated BCR is consistent with scientific findings that actions to sustainably manage, restore and remediate soils delivers a net benefit in the long-run.

While this calculation estimates the overall ratio of sustainable soil management and soil restoration, there may be specific restoration cases where costs are excessive and disproportionate to the benefits and would not be justified. The staged approach and the flexibility provided to Member States in the preferred options provide a safety mechanism to avoid unjustified obligations for those extreme cases.

Given the uncertainties in the estimation of costs and benefits and the impact of such uncertainties on the estimation of the BCR, a sensitivity analysis has been performed on those variables.

The results are the following (see Annex 11 section 2.2.1 for details):

- For the BCR a variation of +/- 30% in the benefits translates into a maximum value of 2.05 and a minimum of 1.33, while a variation of +/- 30% in the costs makes it variate to a minimum of 1.33 to a maximum of 2.34.

[91] Nkonya et al. (2016), Economics of Land Degradation and Improvement - A Global Assessment for Sustainable Development."

[92] https://ec.europa.eu/commission/presscorner/detail/en/ip_22_3746

[93]https://www.eld-initiative.org/fileadmin/ELD_Filter_Tool/Publication_The_Value_of_Land__Reviewed_/ELD-main-report_en_10_web_72dpi.pdf

- These figures show that the conclusions based on the calculated central value of costs and benefits maintain their validity within a significant range of uncertainty of costs and inputs.

7.3.1 *Impacts on urban and rural areas*

The preferred option is likely to have a different impact on rural and urban areas. Sustainable soil management and restoration measures (except remediation) are more likely to impact rural areas. Although some measures will be delivered in urban areas, the measures will predominantly impact agricultural and forest land, covering around 80% of the EU. As a consequence, the costs and benefits of implementing these measures will also fall more so on rural areas.

Table 7.9: Costs and benefits for certain stakeholders (2023 prices)

Stakeholder type	Costs	Benefits
Rural	- Private costs of implementing SSM and restoration in agricultural and forest soils – illustrative range of 28 bn to 38 bn EUR pa.	- Private SSM benefits (increased yield, lower input costs) for agricultural and forest land managers – illustrative range of 20 bn to 30 bn EUR pa. - 'Off-site' benefits of SSM to other businesses (e.g. reduction in sediment removal, or infrastructure repair). Partial estimate ranges from 1.0 bn to 18.5 bn EUR pa - Off-site' benefits to local communities (e.g. reduction in flooding risk) – benefit per landslide event avoided is estimated to be 1.7 bn EUR. - Employment benefits for local communities - SSM practices could deliver a further 300,000 to 420,000 extra annual working units (AWUs) pa.
Urban / semi-urban	- Cost to private sector of 1,110m EUR pa for identification and 569 m EUR pa for remediation of CS (although may be spread across wider portfolios of sites) - Private costs of implementing SSM and restoration measures on urban soils.	- Increase in value of remediated land – estimated ongoing benefit of €12 - €59 m pa if used for agricultural purposes, higher for other uses. Remediation unlocks brownfield redevelopment potential and reduces need for additional sealing and land take. - 'Off-site' benefits of remediation of CS to businesses (e.g. reduction in costs of water treatment) - 'Off-site' benefits of remediation of CS for local citizens (e.g. reduction in health impacts linked to exposure to hazardous substances) - Total 'off-site' benefits of CS remediation estimated to range from EUR 3.2 bn – 24.1 bn (2023 prices) - Investigation and remediation of CS could deliver a jobs benefit of 34,000 FTEs over the deployment period (proportion of which could fall to local community) - Benefits of restoration of urban soils - encourage more sustainable development of industry, residence, and tourism in urban areas[94,95]

7.3.2 *Available funding and expertise*

The transition to sustainable soil management requires investments and availability of information, knowledge and advice, particularly for land managers to reap the long-term benefits of healthy soils. Successful implementation of the preferred option will require tapping into various sources of funding at European, national, regional and local level. Therefore, this impact

[94] https://sustainablesoils.org/images/pdf/SUSHI.pdf
[95] https://webgate.ec.europa.eu/life/publicWebsite/project/details/1817

assessment is accompanied by a Staff Working Document (SWD) with an overview of the 2021-2027 EU Multiannual Financial Framework (MFF) funding opportunities available for the protection, sustainable management, and restoration of soils. The SWD targets different stakeholder groups (business, practitioners, public sector, research, civil society) and provides guidance on how to successfully make use of available EU funding to finance the transition. It explains the eligibility criteria, application process, thematic priorities and conditions of EU funds such as e.g. Horizon Europe and its Mission 'A Soil Deal for Europe', the CAP, Cohesion Funds, the LIFE programme, the Recovery and Resilience Facility or InvestEU, and their relevance in relation to soil health. As announced in the Soil Strategy, the Commission will also set up a dialogue with the public, private and financial sector to see how financing can support sustainable management and restoration of soils.

The Mission 'A Soil Deal for Europe', with a total budget of +/- 1 billion euro, will play a crucial role in developing and sharing the knowledge on soil health. The Mission will establish 100 living labs and lighthouses by 2030 to lead the transition towards healthy soils and to co-create knowledge, test sustainable soil management solutions and demonstrate their value in real-life conditions. The Mission will also fund an ambitious soil research and innovation programme, contribute to the development of a harmonised EU soil monitoring framework and help to raise awareness on the importance of soil health.

Member States will be able to exchange knowledge, experience and expertise in several interconnected EU platforms on soil health:

- For the implementation of the Soil Health Law, the Commission would be assisted by a soil health committee where Member States can exchange and coordinate best practices;
- The Enlarged Soil Expert Group with Member States' experts and stakeholder representatives will continue to support the Commission in the implementation of the Soil Strategy for 2030;
- The European Environment Agency provides support through the Thematic Group on Soil and the Working Group on Soil Contamination under the EIONET Group on Land Systems;
- The EU Soil Observatory, led by JRC, has set up a stakeholder forum, including Member States, to exchange on the state of knowledge on soil health;
- The European Soil Partnership of Member States and non-governmental stakeholders facilitates the exchange of knowledge and technologies for sustainable soil management. The network is linked to the Global Soil Partnership and implements region-specific aspects of the global soil protection agenda.

7.4 Coherence with other policies

The Soil Health Law will work in synergy with and add value to the existing acquis: especially the Common Agricultural Policy, the Water Framework and daughter Directives, the Birds and Habitat Directives, the upcoming Nature Restoration Regulation, the revised LULUCF Regulation, and EU policies on air, climate, chemicals, waste, industrial emissions, and environmental liability. It will complement the acquis with a clear time bound target, a definition of what soil health entails, and a common understanding of sustainable soil management, restoration and remediation principles. In that way, the Soil Health Law will work in synergy and become the reference to guide other policies towards enhanced soil health. The scope will cover the entire terrestrial territory of the EU and all land uses. Significant contributions to climate policies will be established following from carbon removal, storage and disaster risk reduction services of healthy soil ecosystems. Synergies with several related initiatives such as the strategies on soils, forest, climate adaptation, biodiversity, bioeconomy, farm to fork, and the plans on zero pollution and circular economy and others will be ensured.

The implementation of the Soil Health Law will represent a major contribution to food security and very likely to quality of food. Indeed, according to a recent analysis done by the Commission services[96] the current high input intensive agricultural model, based on chemical pesticides, is likely to pose a food security threat in the medium term due to a loss of biodiversity, the likely increase in pests, decline in soil health and loss of pollinators which are essential to agricultural production. In the EU, 95% of food is produced on soil[97] and depends on soil health. Intensive agriculture with high chemical inputs together with unsustainable drainage increased potential for soil erosion. Once the soil is degraded, food production is at risk and requiring time and effort to revert to healthy condition and full production capacity. Certain forms of soil degradation can take decades or even hundreds of years to restore. Degraded soils also lose the capacity to filter contaminants, thereby releasing pollutants which may end up in the groundwater or enter the food chain, where they can pose a threat to food safety.

Monitoring, sustainable soil management and restoration are key measures to maintain and enhance soil fertility on arable land. The new CAP Strategic Plans for 2023-2027 already address part of these problems by ensuring minimum soil management standards e.g. for crop rotation, soil cover, erosion risk management as well as a number of voluntary measures. The Soil Health Law which will address all aspects of soil degradation will further improve the provision of sufficient, safe and nutritious food. The Soil Health Law will help to secure our access to food in the long-term. A range of factors across the food system, including the whole value chain from production practices, technology, processing methods, supply chains and logistics, consumption patterns, will have to make a transition to make all soils healthy by 2050.

7.5 Simplification and improved efficiency

As a new piece of legislation, the Soil Health Directive is not a simplification of existing legislation. However, the coherence with other legislation has been considered to ensure that there is no duplication or unnecessary burden in reaching the agreed objectives, and indeed the different pieces of legislation should complement and work in synergy.

7.6 Application of the ‘one in, one out’ approach

This impact assessment has assessed the administrative costs for public authorities and businesses for all policy measures. No costs have been identified for citizens (Annex 3).

Administrative costs for businesses have been identified only for one policy measure i.e the identification of contaminated sites, for the part concerning the registration of investigation and risk assessment results. As a consequence, the administrative cost relevant for the ‘one in, one out’ approach is EUR 9.1 million per annum. However, the actual administrative burden (as

[96] SWD(2023) 4 final, Commission Staff Working Document “Drivers of food security”
[97] FAO (2022): Soils for nutrition: state of the art. https://doi.org/10.4060/cc0900en.

opposed to costs) element for offsetting will be smaller as not all of the costs are additional to the baseline.

8 HOW WILL ACTUAL IMPACTS BE MONITORED AND EVALUATED?

Given the importance of monitoring to the delivery of the objectives, the governance and monitoring process has already been considered as part of the options. The preferred option reflects the need for the Member States to regularly and adequately assess the soil health and monitor its evolution over time, together with the monitoring of the effectiveness of the measures taken, together with reporting obligations. This will allow an evaluation of the impact of the SHL based on core indicators in the form of factual data along with information on different measures undertaken, and also allow for best practice to be shared between soil districts.

It will be up to the Member States to set up a monitoring system, usually through adapting their existing ones. The determination by the Member States of soil districts and their authorities will allow a governance process that ensures coherence and adaptation of the actions to the local context, following the principle of subsidiarity.

The programmes of measures will indicate and describe Member States' actions to ensure and monitor the required implementation of sustainable soil management and restoration practices.

All efforts will be made to keep the burden of reporting low. Coherence with other monitoring and reporting requirements relevant to soil will be ensured, such as those under the Birds and Habitats Directives, and the Natura 2000 network of protected areas established thereunder, Water Framework Directive, the River Basin Management Plans, and the Common Agricultural Policy as well as under the Nature Restoration Law proposal and the upcoming Forest Observation Law proposal. This will allow for administrative and cost synergies at Member States level. Another example is the Land Use, Land Use Change and Forestry (LULUCF) Regulation, which was recently revised and where the target is distributed among Member States along yearly trajectories, and its achievement is underpinned by spatially explicit monitoring and robust governance. Actions taken by Member States to monitor and achieve their LULUCF target will be in synergy with the objectives of the Soil Health Law.

Furthermore, the oversight system at EU level based on LUCAS can provide consistency and a needed independent evaluation of the progress. The intensified use of new technologies in areas like remote sensing and earth observation (Copernicus and LUCAS) supported by EU funding and research and innovation policy shall accompany and support the efforts made.