SOIL AND LAND MANAGEMENT ONTOLOGY REFERENCE DOCUMENT

SOIL HEALTH ONTOLOGY AIMED TO FACILITATE STAKEHOLDER ENGAGEMENT IN THE ACHIEVEMENT OF THE SOIL MISSION OBJECTIVES

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ABBREVIATIONS

AI	Artificial Intelligence
BFs	Brownfields
CA	Conservation Agriculture
CAP	Common Agricultural Policy
CCC	Carbon Carrying Capacity
CCS	Current Carbon Stocks
DPSIR	Drivers Pressures State Impact Response
EC	European Commission
EEA	European Environment Agency
EQS	Environmental Quality Standard
ETS	Emissions Trading System
GHA	Global hectares
GHG	Greenhouse gas
IT	Information Technology
LH	Lighthouses
LL	Living labs
MRV	Measurement, Reporting, Verification
NT	No tillage
OECD	Organisation for Economic Cooperation and Development
PoM	Programme of Measures
PRB	Permeable Reactive Barrier
R&I	Research and Innovation
SDG	Sustainable Development Goal
SMS	Soil Mission Support
SOC	Soil Organic Carbon
SPR	Sources-Pathways-Receptor

SUMMARY

The Soil Mission Support (SMS) project supports the European Commission and the Mission Board of the Horizon Europe Mission in the area of Soil Health and Food in delivering its objectives and related targets. It is assumed that the Soil Mission and its related objectives and specific targets can only be achieved through healthy soils and for that, stakeholder engagement is needed. Healthy soils are defined as soils that are in good chemical, biological and physical condition and thus are able to continuously provide as many ecosystem services as possible (EC, 2021a). Stakeholders are defined as those who are affected in their interest or concern by changes in soil and land management (Brils et al., 2022).

With multi-stakeholder processes, language and use of language is very important. The capability to understand each other is critical. Communication difficulties originate to a large extent from the 'jargon' used in the different communities. A common language facilitates 'learning together' which helps to build trust, develop a common view on the issues at stake, resolve conflicts and arrive at joint solutions that are technically sound and that can be implemented in practice. Ontology defines a common vocabulary for those who, for example, need to converse about a common issue or share information in a specific domain.

This document represents the initial attempt at a soil and land management ontology and should be regarded as a living document that matures by interaction with stakeholders. In first instance the aim of this document is to define the shared domain of discourse and then at different levels of hierarchy:

- Select the primary objects of relevance for the domain of discourse;
- Conceptualizing the inter-relational links between these objects (conceptual model); and
- Defining these objects in a representational vocabulary (a common language).

The **domain of discourse covers soil and land management aimed to achieve the first six (of the eight) Soil Mission objectives**, which are: 1. reduce desertification, 2. conserve soil organic carbon stocks, 3. stop soil sealing and increase re-use of urban soils, 4. reduce soil pollution and enhance restoration, 5. prevent erosion, and 6. improve soil structure to enhance soil biodiversity.

The first level of hierarchy covers **soil and land and its use**. At this level the following objects have been selected, interrelated in a conceptual model (i.e. visual of soil and land-use) and defined in a common language: soil, land, land-use and land-use types (including: urban, industrial, agriculture, forest, nature and protected land).

The second level of hierarchy covers **soil management**. At his level the following objects have been selected, interrelated in a conceptual soil management model and defined in a common language: soil management (including: soil management strategy, measures, program of measures), soil ecosystems (including: ecosystem services, pressures, healthy soil ecosystems), users (stakeholders) and information.

Lastly, the third level of hierarchy covers the **achievement of the first six Soil Mission objectives**. At this level the most relevant objects related to each of these objectives are selected and interrelated to their position in the DPSIR (Drivers-Pressures-State-Impact-Response) framework which is at this 3rd level superimposed on the soil management model as used for level 2.

The **remaining two Soil Mission objectives**, i.e. 7. reduce the EU global footprint on soils and 8. improve soil literacy in society, do not directly relate to the actual management of soil and land. However, also for these mission objectives some important objects have been selected and defined in a common language.

1 INTRODUCTION

1.1 About the Soil Mission Support (SMS) project

Soil health is vital for the delivery of food, energy, and biomaterials, as well as climate change adaptation and mitigation, biodiversity below and above ground and wide range of further ecosystem services. Pressure on land and soil is growing due to competing demands for land and bio-based products. A sustainable soil management that satisfies the increasing demand and avoids soil degradation requires coordinated research and innovation (R&I). The Soil Mission Support (SMS) project employs a multi-actor approach to create an effective framework for action in the wider area of soil health and land management by coordinating efforts and pooling resources, by developing a coherent portfolio of R&I activities and by identifying criteria for Living Labs and Lighthouses to demonstrate solutions. SMS brings together the main players in soil health and management in a transdisciplinary approach. Activities include the analysis of the needs for R&I on soil and land management as expressed through stakeholder/citizen consultation and research projects, the identification of gaps, priority areas and types of action for intervention including Living Labs and Lighthouses. The action fields range from agriculture and forestry to spatial planning, land remediation, climate action, and disaster control. SMS outcomes and results will include:

- A stakeholder-based, co-created roadmap for R&I on soil and land management;
- Improved coordination with existing activities in Europe and globally, thereby raising visibility and effectiveness of R&I funding. Identification of and learning from existing and potential Living Labs and Lighthouses for testing and demonstrating solutions in order to simultaneously satisfy competing demands of soil use.

1.2 Purpose and target group of this document

This document "*Soil and Land Management Ontology Reference document*" forms part of the output from SMS Work Package 4 "*SMS Platform Co-Design*". The key objective of this document is to be the ontology reference document for soil health and land management. Thus, it aims to support the engagement of stakeholders in such management.

1.3 Status and recommended use of this document

This document is a first attempt for a soil and land management ontology and should be regarded as a living document that matures by interaction with stakeholders. Thus, it is recommended to use this document in any SMS follow-up projects that aim to support the Soil Mission, including use in Living Labs and Lighthouses. Whenever the need arises in these projects, the document may be updated.

2 ONTOLOGY THEORY

2.1 Ontology

The term ontology is borrowed from philosophy, where ontology is defined as a systematic account of existence. For knowledge-based systems, what “exists”, is exactly that which can be represented (Gruber, 1993).

Ontology is an explicit specification of a conceptualization, which can be defined as an abstract, simplified view of the world that we wish to represent for some purpose. Or in other words: a conceptualization is the objects, concepts, and other entities that are presumed to exist in some area of interest and the relationships that hold them (Genesereth & Nilsson, 1987). When the knowledge of a particular domain is represented in a declarative formalism, the set of objects that can be represented is called the universe of discourse. This set of objects, and the describable relationships among them, are reflected in the representational vocabulary with which a knowledge-based program represents knowledge. Thus, the ontology of a program can be described by defining a set of representational terms. In such an ontology, definitions associate the names of entities in the universe of discourse (e.g., classes, relations, functions, or other objects) with human-readable text describing what the names are meant to denote, and formal axioms that constrain the interpretationand well-formed use of these terms (Gruber, 1993).

Ontologies are commonly used in Information Technology (IT) and according to Gruber (1993) they support the sharing and reuse of formally represented knowledge among Artificial Intelligence (AI) systems. Ontologies have become common on the World-Wide-Web. In an IT setting this also includes machine-interpretable definitions of basic concepts in the domain and relations among them (Noy & MgGuinness, 2017).
The reasons for developing an ontology include (Noy & MgGuinness, 2017):

- To share common understanding of (the structure of) information among people;
- To enable reuse of domain knowledge;
- To make domain assumptions explicit;
- To analyse domain knowledge.

Ontology defines a common vocabulary for those who need to share information in a domain (Gruber, 1993).

Different types of ontology can be distinguished, each of which might be used for different purposes. An overview on ontology types is presented by Kaewboonma et al. (2012). Within the context of soil and land management the most appropriate ontology type is probably the ‘domain ontology’.

A domain ontology provides vocabularies about concepts within a domain and their relationships, about the activities taking place in that domain, and about the theories and elementary principles governing the domain (Kaewboonma et al*.,* 2012).

This type is probably most appropriate for soil and land management as domain ontologies can explain generic concepts and relations within the natural resource management domain (Kaewboonma et al., 2012). The ontology should be designed and developed in relation to the application and context. For example, a domain ontology is used to collect all knowledge about resource management, as well as represent all terms in noun form (such as basic knowledge of the soil and land systems, and land use) in order to facilitate future reuse of the ontology (Kaewboonma et al., 2012).

2.2 The need for a dedicated ontology for soil and land management

The SMS project supports the European Commission and the Mission Board of the Horizon Europe Mission in the area of Soil Health and Food in delivering its objectives and related targets. It is assumed that the Soil Mission and its related objectives and specific targets can only be achieved through healthy soils and for that, stakeholder engagement is needed (Brils et al., 2022). Healthy soils are defined as soils that are in good chemical, biological and physical condition and thus are able to continuously provide as many ecosystem services as possible (EC, 2021a). Stakeholders are defined as those who are affected in their interest or concern by changes in soil and land management (Brils et al., 2022).

With multi-stakeholder processes, language and use of language is very important. The capability to understand each other is critical. Communication difficulties originate to a large extent from the 'jargon' used in the different communities. A common language facilitates 'learning together' which helps to build trust, develop a common view on the issues at stake, resolve conflicts and arrive at joint solutions that are technically sound and that can be implemented in practice. Ontology defines a common vocabulary for those who, for example, need to converse about a common issue or share information in a specific domain.

2.3 How to create an own ontology for soil and land management

According to Brils et al. (2019) four activities need to be performed in order to achieve an appropriate domain ontology for soil and land management:

1. Define the shared domain of discourse;

   And then at different levels of hierarchy:

2. Select the objects of relevance for this domain of discourse;
3. Conceptualize how these objects interrelate (conceptual model);
4. Define these objects in a representational vocabulary (common language).

Activities 3 (conceptual model) and 4 (common language) are further described below.

The most straightforward definition of a model is that it constitutes a simplification of reality, created in order to assist in clarifying and understanding of some aspect of the real world (Rocher and Schnell, *sine anno)*. The key to successful application of such a model is achieving an appropriate balance between simplifying a complex reality, making it both easier to understand and applicable to a wider range of circumstances, whilst preserving the most important relationships to yield results that are a realisable, representative indication of the functioning of the original system (Merrit et al., 2003, Chapman et al., 2008).

A conceptual model is a theoretical construct of the interrelationships between a range of known and quantifiable variables acting within a specified area of influence (Merrit et al., 2003). Almost all models of any description begin life as a conceptual model: some are developed and subsequently expanded into a quantitative model, while others remain as a concept to aid understanding and develop or test ideas. A conceptual model – and potentially a subsequent quantitative or semi- quantitative model – is an ideal format to assist in improving understanding of the inter-relationships between the biophysical and societal system (Manley et al., 2000).

In general, a conceptual model should be as simple and logic as possible in order to be useful in practice. Also non experts should be able to grasp it, when the model and its logic are explained to them (Brils and Maring, submitted).

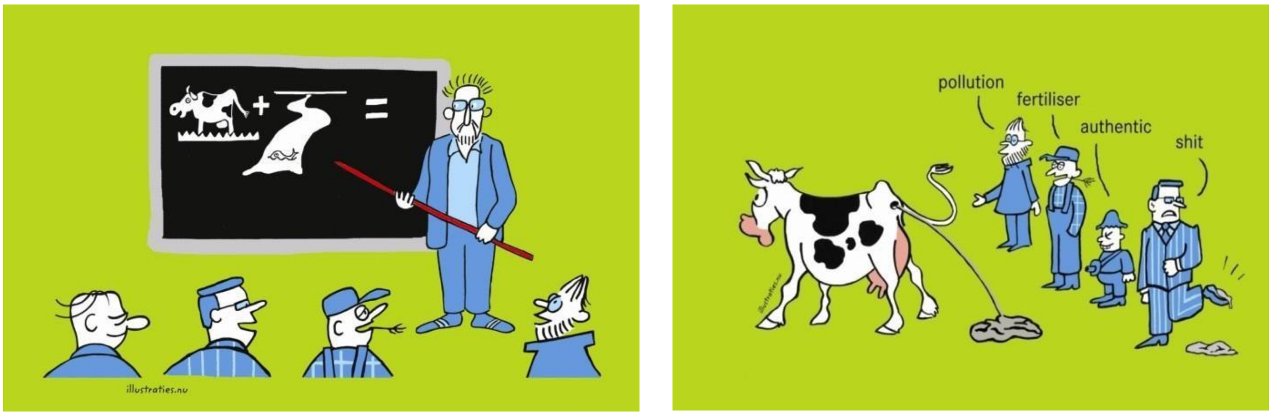

Figure 2.1 - 'Jargon' used by different communities (figure left) complicates communication, while a common language (right) facilitates 'learning together' (Source figures: Brils et al., 2014).

With interdisciplinary and multi-stakeholder processes, language and use of language is very important. The capability to understand each other is critical in bridging the gap between science disciplines as well as the gap between scientists and policy makers, natural resource managers, spatial planners and entrepreneurs (Slob et al., 2007; Slob and Duijn, 2014). Making the effort to speak the language of stakeholders is a prerequisite for successful engagement in natural resources management (Brils et al., 2015). Communication difficulties originate to a large extent from the jargon used in the different communities (Quevauviller et al., 2005; Hooimeijer and Maring, 2018). A common language facilitates learning together (Figure 2.1). Learning together helps to build trust, develop a common view on the issues at stake, resolve conflicts and arrive at joint solutions that are technically sound and implemented in practice (Ridder et al., 2005). It thus enables common understanding, collaboration and co-creation.

3 THE SOIL AND LAND MANAGEMENT ONTOLOGY

3.1 Shared domain of discourse

The domain of discourse covers soil and land management aimed to achieve the first six Soil Mission objectives, which are:

1. reduce desertification
2. conserve soil organic carbon stocks
3. stop soil sealing and increase re-use of urban soils
4. reduce soil pollution and enhance restoration
5. prevent erosion
6. improve soil structure to enhance soil biodiversity

3.2 The 1st level of hierarchy: soil and land and its use

3.2.1 Objects

The following objects have been selected as being of relevance for the Soil and Land Management domain of discourse at the 1st level of hierarchy:

- Soil
- Land
- Land-use
- Land-use types: Urban, Industry, Agriculture, Forestry, and Nature.

3.2.2 Conceptual model

A graphically conceptualization of soil and land and land-use types in an easily understandable way by all stakeholders, is presented in Figure 3.1a and 3.1b.

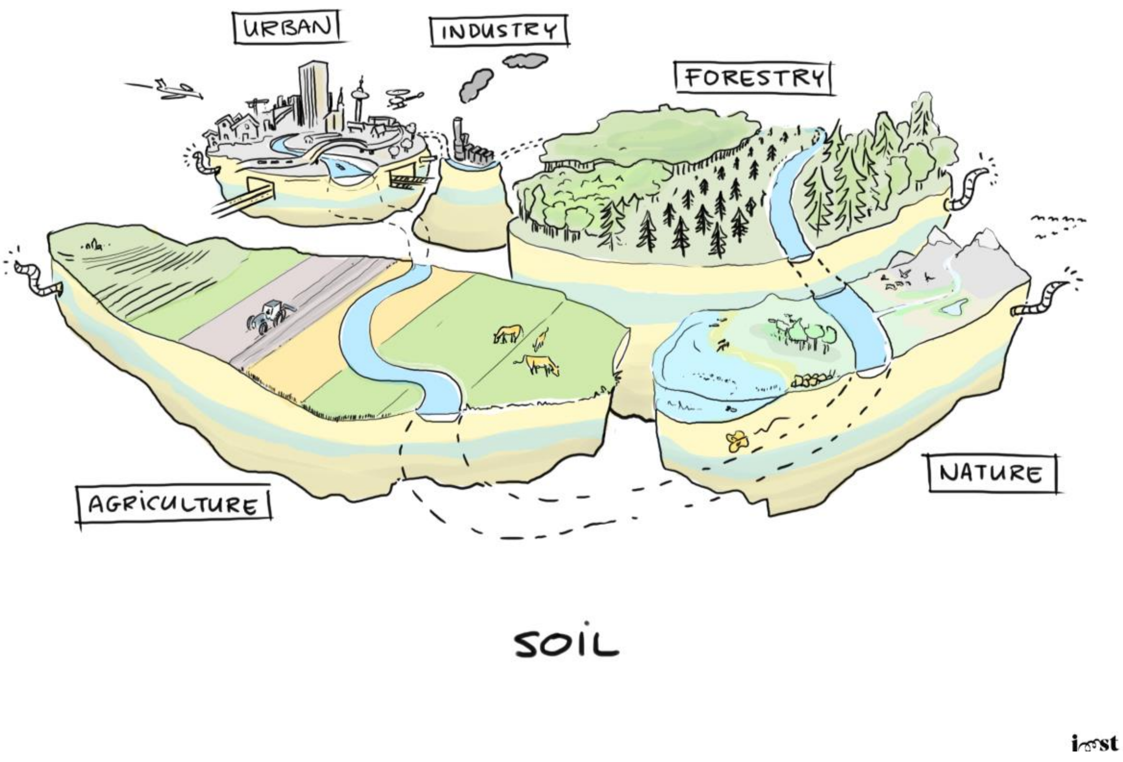

Figure 3.1a – Conceptualization of soil and land and land-use (Drawings: Joost Fluitsma).

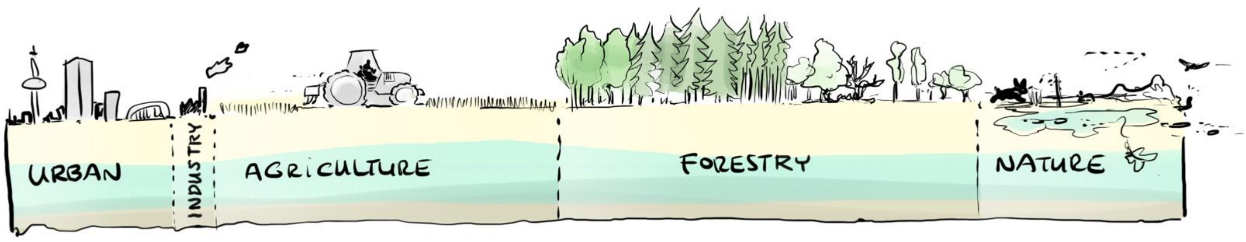

Figure 3.1b – Conceptualization of the land-use types. The length of the box is indicative for the percentage that that land-use covers Europe. All lengths added equals 100% (Drawings: Joost Fluitsma).

3.2.3 Common language

Table 3.1 - Objects at the 1st hierarchy level of the soil and land management ontology.

Object	Described in common language	Source
Land	The ground, including the soil covering and any associated surface waters, over which ownership rights are enforced.	OECD glossary, 2008
Soil	Upper layer of the earth in which plants grow.	EC, 2018a
Land cover	Observed (bio)physical cover of the Earth's surface.	EC, 2018a
Land-use	Arrangements, activities and inputs people undertake in a certain land cover type to maintain it or produce change.	EC, 2018a
Urban	Cities, parks, urban ecosystem, household and wastewater treatment.	SMS D3.2: actor analysis
Industry	Commercial and industrial sites (factories, industrial halls), mine, contaminated land, recultivated areas.	SMS D3.2: actor analysis
Agriculture	Farmland, agricultural land use: arable land, grassland, rise, orchard, vineyard and others, semi-natural land.	SMS D3.2: actor analysis
Forestry	Forest, afforestation, deforestation.	SMS D3.2: actor analysis
Nature	Natural and cultural heritage (National parks, archaeological sites, cemeteries).	SMS D3.2: actor analysis

3.3 The 2nd level of hierarchy: soil management

3.3.1 Objects

The following objects have been selected as being of relevance for the Soil and Land Management domain of discourse at the 2nd level of hierarchy:

- Soil Management:
  - Soil Management Strategy
  - Measures
  - Program of Measures (PoM)
- Soil ecosystems:
  - Ecosystem services
  - Pressures
  - Healthy soil ecosystems
- Users (stakeholders)
- Information

3.3.2 Conceptual model

A graphical conceptualization of the interrelation of the objects under the 2nd level of hierarchy is presented in Fig. 3.2. The Soil Mission targets the achievement of healthy soils, which are soils that have the continued capacity to support ecosystem services. The figure shows that soil ecosystems provide services to the benefit of users (stakeholders), but in turn, the unsustainable use of these services exerts pressures on, and thus impacts the soil health and its service provision capacity. Therefore, soils need to be managed to maintain and, where needed, restore its health. Through monitoring and observation of the soil ecosystem, information can be gathered about the state of the soil. Brils et al. (2022) assume that appropriate soil management can only be achieved through the engagement of all stakeholders in that management area. The users (stakeholders) should engage in the co-creation of a Soil Management Strategy, based on gathered soil state information. This Soil Management Strategy should include a Programme of Measures (PoM) tailored to protect and restore soil ecosystem health. Measures implemented in the soil ecosystem should be monitored and observed, restarting the soil management cycle.

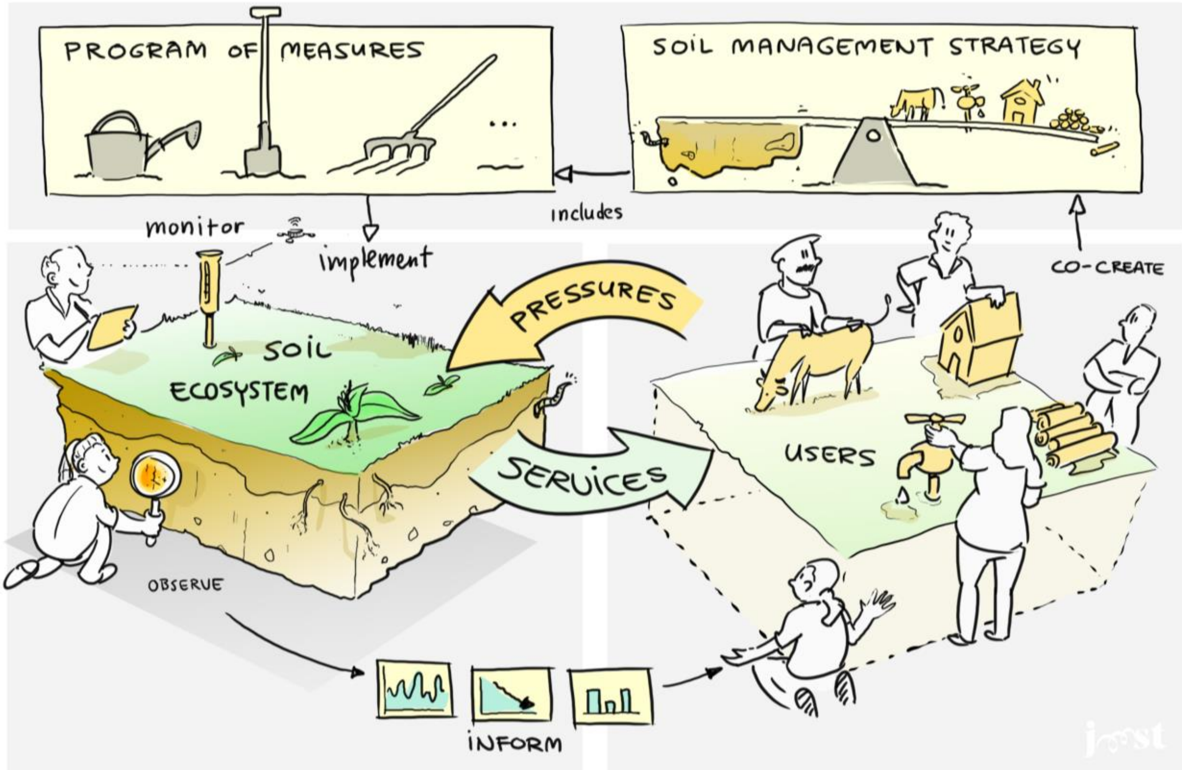

Figure 3.2 – Conceptual model for soil management (Drawings: Joost Fluitsma).

Brils et al. (2022) also assume that the better we understand the functioning of soil ecosystems – and how they respond to human (miss)use and climate change – the better we will be able to manage them sustainably. Scientific observation of soil ecosystems provides information on that functioning. That scientific information is ideally used to design the PoM and then implementation of these measures should demonstrate their effectiveness. Targeted monitoring provides information to assess the effectiveness of the PoM and thus assess whether the (policy) objectives in the Soil Management Strategy are achieved. That monitoring information – ideally combined with latest information from scientific observations – is also utilized by the users (stakeholders) to improve and update the Soil Management Strategy and PoM. Thus, starting the next management cycle.

3.3.3 Common language

Table 3.2 - Objects at the 2nd hierarchy level of the Soil and Land Management ontology.

Object	Described in common language	Source
Healthy soils	Soils that are in good chemical, biological and physical condition and thus are able to continuously provide as many ecosystem services as possible.	EC, 2021a
Soil Management	The application of measures to achieve healthy soils.	This deliverable
Soil Management Strategy	Sets out how users (stakeholders) will work together to achieve healthy soils.	This deliverable
Measure	Action aimed to achieve healthy soils.	This deliverable
Program of Measures	Set of actions aimed to achieve healthy soils.	This deliverable
Ecosystem	A dynamic complex of plant, animal, and micro-organism communities and their non-living environment interacting as a functional unit.	United Nations, 1992
Ecosystem services	Services provided and the benefits people derive from these services, both at the ecosystem and at the landscape scale, including public goods related to the wider ecosystem functioning and society well-being.	Haines-Young & Potschin, 2018 (also in D3.3)
Pressures	Release of substances (emissions), physical and biological agents, the use of resources and the use of land which impacts soil health.	EEA glossary, 2022. Modified version
Users (stakeholders)	Those who are affected in their interest or concern by changes in soil and land management.	SMS D3.3: Actor Engagement guide
Information	Processed, organized and structured data. It provides context for data and enables decision making process.	Diffen, ND

3.4 The 3rd level of hierarchy: achieving of the first six Soil Mission objectives

3.4.1 Objects

This 3rd level provides the highest level of detail regarding the soil and land management ontology. The objects of relevance at the 3rd level of hierarchy relate to the achieving of the first six Soil Mission objectives: 1. reduce desertification, 2. conserve soil organic carbon stocks, 3. stop soil sealing and increase re-use of urban soils, 4. reduce soil pollution and enhance restoration, 5. prevent erosion, and 6. improve soil structure to enhance soil biodiversity. There are simply too many objects to mention them all here, but they are all listed in sections 5.4.3 to 5.4.8, where they are grouped per specific Soil Mission objective.

3.4.2 Conceptual model

A logic conceptual model to be used for achieving of the Soil Mission objectives is the well-known Drivers-Pressures-State-Impact-Response (DPSIR) framework. In Fig. 3.3 this framework is superimposed on the ontology level 2 framework, i.e. the conceptual model for soil management (see Fig. 3.2).

The DPSIR framework was described by Brils (2008) in the following way (slightly adapted to better fit to this document): "The DPSIR framework was developed by the Organisation for Economic Cooperation and Development (OECD) and extensively used by the European Environment Agency (EEA) to provide an insight into environmental processes and the links between human activities and their impact on the environment. Economic activities (**driving forces**, No. 1 in Figure 3.3) such as industry, agriculture, tourism etc., lead to increasing **pressures** (No. 2) on the natural environment as these activities result in land-use change, population growth, over-use of natural resources and emissions (accidental or controlled) of waste to (ground) water, soil and sediment. The over-use of resources and the emissions will change the **state** (No. 3) of these environments in quantity and quality: soil, sediment and water, and resources are depleted (erosion) and are loaded (contaminated) with hazardous substances originating from the economic activities. Above a certain level of depletion and contamination the environment will be **impacted** (No. 4), i.e., loss of biodiversity, vulnerability to floods and landslides, decreased chemical and ecological water, soil and sediment quality and health and a shortage of these resources. Several **response** (No. 5) measures prevent this from happening or mitigate impacts to a level deemed acceptable or tolerable by society. For example, by optimization of industrial manufacturing processes less resources will be used, and less waste may be produced. Through stricter permits for emission of wastewater the pollution of surface water may be reduced. The setting of environmental quality standards (EQS) may help prevent the environment being overloaded with specific hazardous substances. And through mitigation and remediation measures the state may be improved and the impacted environment may be restored."

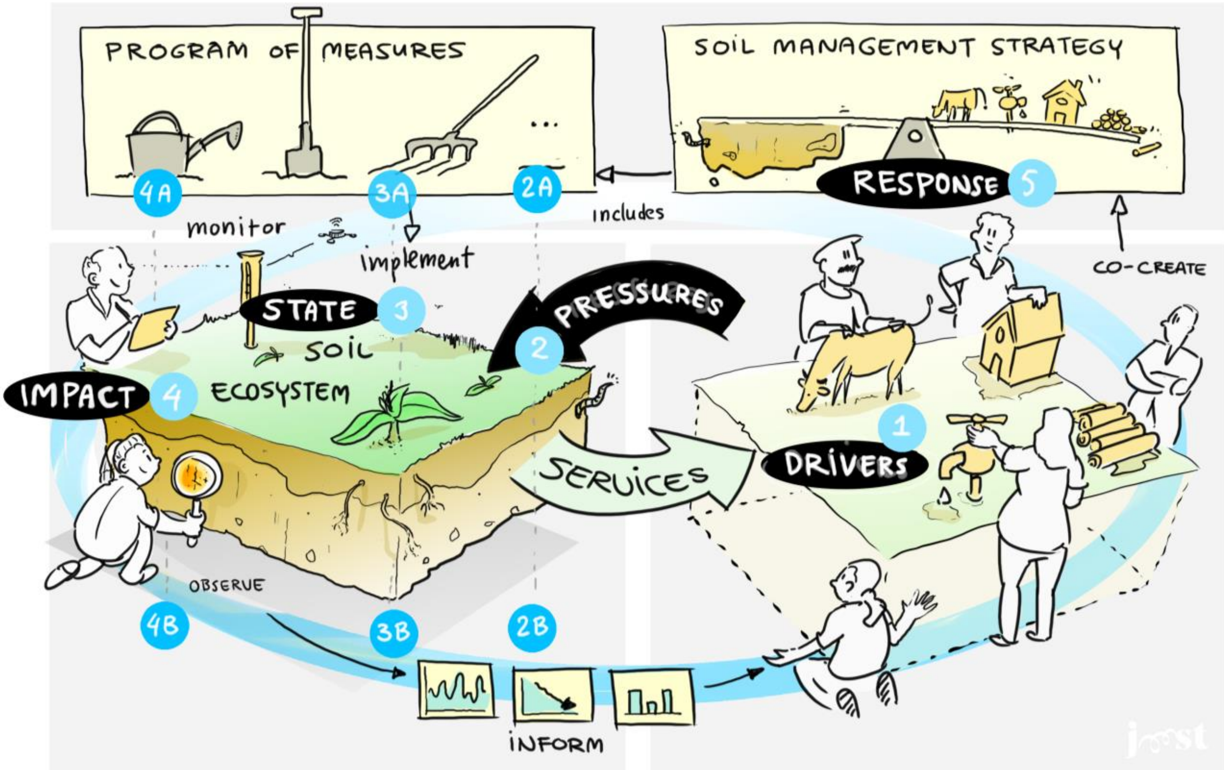

Figure 3.3 – The DPSIR framework superimposed on the conceptual model for soil management (Drawings: Joost Fluitsma).

In Figure 3.3, each step in the DPSIR Framework is given a number so that the objects defined in the following sections can be pinpointed to a specific location in the conceptual soil management model. Apart from the five DPSIR steps, extra positions have been numbered, namely three positions within the program of measures step (2A, 3A and 4A) and three positions within the informing step (2B, 3B and 4B). These locations are used when objects in either the program of measures step or the informing step are directly related to either pressures (2A or 2B), state (3A or 3B) or impact (4A or 4B).

3.4.3 Common language for reducing desertification (objective 1)

Table 3.3 - Objects at the 3rd hierarchy level of the Soil and Land Management ontology related to the reducing of desertification (For DPSIR position see Fig. 3.3).

DPSIR position	Object	Described in common language	Source
1	Land suitability	Land suitability is the fitness of a given type of land for a defined use. The land may be considered in its present condition or after improvements.	FAO, 1976
1	Intensive farming	A system of raising crops and animals, usually on small parcels of land, where a comparatively large amount of production inputs or labour are used per acre.	FAO AGROVOC, 2022c
1 & 2	Deforestation	The removal of forest and undergrowth to increase the surface of arable land or to use the timber for construction or industrial purposes. Forest and its undergrowth possess a very high water-retaining capacity, inhibiting runoff of rainwater.	EEA glossary, 2022
1 & 2	Wind erosion	Wind erosion is a natural process that moves soil from one location to another by wind power. It can cause significant economic and environmental damage.	NSW, 2020
1 & 2	Forest fire	Uncontrolled fire occurring in vegetation more than 1.8 metres in height. It spreads rapidly through the topmost branches of the trees before involving undergrowth or the forest floor.	Kane, 2022
1 & 2	Groundwater overexploitation	Groundwater is surface water which has filtered through permeable soils and rocks until stopped by impermeable layers below, being cleaned in the process. It accumulates as aquifers, which may be thousands and millions or years old and slowly seep to the surface as springs or flow underground and feed rivers and lakes. The depletion of groundwater in excess of its recharge rate leads to overexploitation.	UIA, 2020
1 & 2	Overgrazing	Intensive grazing by livestock that exceeds the environmental carrying capacity of a given piece of land. It can lead to impoverishment of the sward, dominance of certain unpalatable species, soil erosion, soil compaction and even a (complete) loss of vegetation.	Adapted from EEA glossary, 2022
1 & 2	Overtourism	Overtourism indicates the overcrowding of tourists at a holiday destination. When it comes to natural tourist destinations, tourism must respect flora, fauna, and microclimate. When the destination is a city, tourism must primarily respect residents, as well as local culture and archaeological sites	Framba, 2020
1 & 2	Population pressure	The sum of the factors (as increase in numbers or excessive food consumption) within a population that reduce the ability of an environment to support the population and that therefore tend to result in migration and expansion of range or in extinction or decline of the population.	Merriam Webster, 2022
2	Drought	A period of abnormally dry weather sufficiently prolonged so that the lack of water causes a serious hydrologic imbalance (such as crop damage, water supply shortage) in the affected area.	EEA glossary, 2022
2	Climatic change	The long-term fluctuations in temperature, precipitation, wind, and all other aspects of the Earth's climate. External processes, such as solar-irradiance variations, variations of the Earth's orbital parameters (eccentricity, precession, and inclination), lithosphere	EEA glossary, 2022

		motions, and volcanic activity, are factors in climatic variation. Internal variations of the climate system, e.g., changes in the abundance of greenhouse gases (GHG), also may produce fluctuations of sufficient magnitude and variability to explain observed climate change through the feedback processes interrelating the components of the climate system.	
2	Desertification	Degraded land in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic fluctuations and human activities.	UNDDD, 2010
3	Soil organic carbon content	Soil organic carbon, the major component of soil organic matter, is extremely important in all soil processes. Organic material in the soil is essentially derived from residual plant and animal material, synthesised by microbes and decomposed under the influence of temperature, moisture and ambient soil conditions. The annual rate of loss of organic matter can vary greatly, depending on cultivation practices, the type of plant/crop cover, drainage status of the soil and weather conditions. There are two groups of factors that influence inherent organic matter content: natural factors (climate, soil parent material, land cover and/or vegetation and topography), and human-induced factors (land use, management and degradation).	ESDAC, 2022
3	Soil moisture deficit	This indicator shows the annual deviation in soil moisture content of each 500-m grid cell from the long-term (1995-2019) average. Negative soil moisture anomalies indicate that the annual average availability of soil moisture to plants drops to such a level that it has the potential to affect terrestrial vegetation and, hence, cause persistent changes in ecosystem condition. Negative long-term averages and negative trends in the annual data indicate increasing pressures on vegetation and ecosystems, and thus represent a climatic driver that should be considered in EU nature restoration plans. Therefore, the indicator can inform policy action on ecosystem restoration in the EU but also on adaptation to climate change.	EEA glossary, 2022
3	Degraded land	The result of human-induced actions which exploit land, causing its utility, biodiversity, soil fertility, and overall health to decline.	UNDDD, 2010
3	Arid land	Lands characterized by low annual rainfall of less than 250 mm, by evaporation exceeding precipitation and a sparse vegetation.	EEA glossary, 2022
3	Semi-arid land ecosystem	The interacting system of a biological community and its non-living environmental surroundings in regions that have between 10 to 20 inches of rainfall and are capable of sustaining some grasses and shrubs but not woodland.	EEA glossary, 2022
3	Erosion vulnerability	The erosion vulnerability index is calculated by combining soil loss potential, the stream power index and internally drained areas. Areas with high soil loss and a high stream power index will have high erosion vulnerability. Areas that are internally draining are excluded from the vulnerability assessment.	University of Wisconsin-Stevens Point, 2016
3	Soil water availability	Soil water availability is the capacity of a soil to hold water that is available for plant use.	Kolb, 2019

3	Soil salinization	Salt-affected soils consist of saline and sodic soils, occur in all continents and under almost all climatic conditions, but their distribution is relatively more extensive in the arid and semi-arid regions compared to the humid regions. Soil salinization is a major process of land degradation that decreases soil fertility and is a significant component of desertification processes in the world's drylands.	FAO, 2022a
3	Vulnerable area	Area that is subject to threatening processes and is likely to become endangered unless the threatening factors cease to operate.	EEA glossary, 2022
4	Loss of soil-biodiversity	The reduction of forms of life living in soils (both in terms of quantity and variety) and of related functions, causing a deterioration of one or more soil functions or ecosystem services.	Bispo et al., 2009
4	Field damage	A decline in the productivity of an area of land or in its ability to support natural ecosystems or types of agriculture. Degradation may be caused by a variety of factors, including inappropriate land management techniques, soil erosion, salinity, flooding, clearing, pests, pollution, climatic factors, or progressive urbanization.	EEA glossary, 2022
4	Flooding of low land	Inundation of land beside a watercourse, as a result of an excessive water table. This may incur addition of sediment onto the land surface as well as water.	Soilcare glossary, 2022
4	Surface runoff	The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called groundwater runoff or seepage flow from groundwater.	Soilcare glossary, 2022
4	Dam sedimentation	Deposition of material of varying size, both mineral and organic, away from its site of origin by the action of water, wind, gravity or ice. This sediment builds and steadily decreases the storage capacity of the reservoir. Ultimately all dams fill with sediment or are destroyed by natural floods.	EEA glossary, 2022
5	Land degradation neutrality	A state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase within specified temporal and spatial scales and ecosystems.	UNCCD, 2015
5	Terracing	Terracing is an agricultural practice that suggests rearranging farmlands or turning hills into farmlands by constructing specific ridged platforms. These platforms are called terraces which stop erosion and contribute to soil and water conservation.	EOS, 2021
5	Soil restoration	Soil restoration refers to actions to regenerate natural soil cycles through revegetation with shrub and creeper species, reforestation with native arboreal species and containment work with stakes. The aim is to stabilize the soil and increase the supply of organic matter, which promotes restoration.	CTCN, 2022
5	Climate change mitigation	Refers to efforts to reduce or prevent emission of GHGs. Mitigation can mean using new technologies and renewable energies, making older equipment more energy efficient, or changing management practices or consumer behaviour.	Soilcare glossary, 2022

5	Sustainable agriculture	Use for the practice of agriculture which supports sustained economic profitability, sustained quality and well-being of the environment, efficient use of natural resources, and the overall quality and availability of food and fibre for mankind.	FAO AGROVOC, 2022c
5	Wetland protection	Areas that are inundated by surface or ground water with frequency sufficient to support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth or reproduction.	EEA glossary, 2022
5	Forest protection	Branch of forestry concerned with the prevention and control of damage to forests arising from the action of people or livestock, of pests and abiotic agents.	EEA glossary, 2022
5	Demesnial water	A body of water that is owned and maintained by a national governmental body or agency.	EEA glossary, 2022
5	Agricultural policy	A course of action adopted by government or some other organization that determines how to deal with matters involving the cultivation of land; raising crops; feeding, breeding and raising livestock or poultry; and other farming issues.	EEA glossary, 2022
5	Environmental protection	Measures and controls to prevent damage and degradation of the environment, including the sustainability of its living resources.	EEA glossary, 2022
5	Water desalinization	Any mechanical procedure or process where some, or all, of the salt is removed from water.	EEA glossary, 2022
5	Water policy	Collection of legislation, legal interpretations, governmental decisions, agency rules and regulations, and cultural responses which guide a country's actions concerning the quantity and quality of water.	EEA glossary, 2022
5	Touristic activity management	The administration, promotion, organization and planning for the business or industry of providing information, transportation, entertainment, accommodations and other services to travellers or visitors.	EEA glossary, 2022
5	Water governance	The range of political, organizational and administrative processes through which communities articulate their interests, their input is absorbed, decisions are made and implemented, and decision makers are held accountable in the development and management of water resources and delivery of water services at different levels of society.	EEA glossary, 2022
5	Groundwater dam	Structures that intercept or obstruct the natural flow of groundwater and provide storage for water underground.	EEA glossary, 2022
5	Hydrologic balance	An accounting of the inflow to, outflow from, and storage in a hydrologic unit such as a drainage basin, aquifer, soil zone, lake or reservoir; the relationship between evaporation, precipitation, runoff, and the change in water storage.	EEA glossary, 2022
5	Water transfer	Artificial conveyance of water from one area to another one.	EEA glossary, 2022
5	Desertification control	Any remedial and preventive actions adopted against desertification including improved irrigation management, planting of trees and grasses, the erection of fences to secure sand dunes, and a careful management of water resources.	EEA glossary, 2022

2a & 2b 3a & 3b 4a & 4b	Living labs (LL)	Spaces for co-innovation through participatory, trans-disciplinary and systemic research	D2.2 LL & LH
2a & 2b 3a & 3b 4a & 4b	Lighthouses (LH)	Places for demonstration of solutions, training and communication. They are best practice examples (technologies, cooperation, governance, trainings) that have already been developed and applied in practice.	D2.2 LL & LH
2a,3a & 4a	Citizen science	Participation of citizens in the generation of new knowledge and/or data.	Buytaert et al., 2014 (also in D3.3)
2a,3a & 4a	Co-creating / co-production / joint-fact finding	Process in which stakeholders with differing viewpoints and interests work together to develop data and information, analyse facts and forecasts, develop common assumptions and informed opinion, finally, use the information they have developed to reach decisions together.	Ehrmann & Stinson, 1999 (also in D3.3)

3.4.4 Common language for conserving soil organic carbon stocks (objective 2)

Table 3.4 - Objects at the 3rd hierarchy level of the Soil and Land Management ontology related to the conserving of soil organic carbon stocks (For DPSIR position see Fig. 3.3).

DPSIR position	Object	Described in common language	Source
1	Monoculture	The growing of a single arable crop species on a field year after year, for at least 10 years.	Soilcare glossary, 2022
1	Carbon farming	Carbon farming refers to anthropogenic interference with carbon pools, flows and GHG fluxes at farm-level with the purpose of minimising climate change. Farmers and foresters manage vast carbon stocks and significant GHG fluxes. There is a provision of incentives to adopt practices/management that promotes carbon conservation and carbon sequestration.	COWI, Ecologic Institute & IEEP, 2020
1	EU Emissions trading system (ETS)	The EU ETS is a “cap and trade” scheme where a limit (the cap) is placed on the right to emit specified pollutants over a geographic area and companies can trade emission rights within that area.	EPA, 2022
2	Soil poaching	Soil that has been broken down under the weight of animals. It causes direct physical damage to the crop and the soil, leading to bare patches, there is also an increased risk of erosion, leaching and invasive weeds.	Soil Association, 2022
2	Soil leaching	Removal of soluble materials from one zone in soil to another via water downward movement in the profile.	Soilcare glossary, 2022
2, 2a & 3a	Pedoclimatic zones	Zones that are relatively homogeneous concerning climate and soil.	Soilcare glossary, 2022
2a & 2b	Fire risk zone	Forest fire risk zones are areas more likely to start a fire, before spreading to other locations.	Enoh, Okeke & Narinau, 2021
2a & 3	Inorganic carbon	Soil inorganic carbon mainly refers to the parent rock soil carbonate formed in the weathering process of silicate carbon, which has very high accumulation rate, and easily affected by atmosphere, water, rocks, etc, is the main form of soil carbon pool in arid and semi-arid region.	Bai et al., 2017
2a, 3a & 4a	Soil carbon flux	The movement of any material from one place to another is called a flux. We typically think of a carbon flux as a transfer of carbon from one pool to another.	University of New Hampshire, 2008

2a, 3a & 4a	Remote sensing	The measurement or acquisition of information of some property of an object or phenomena, by a recording device that is not in physical or intimate contact with the object or phenomenon under study, e.g., the utilization at a distance.	Jafarbiglu & Pourreza, 2022
3	Carbon Sink	Forests and other ecosystems that absorb carbon, thereby removing it from the atmosphere and offsetting CO_2 emissions.	EEA glossary, 2022
3	Permanent pasture	Land used permanently (five years or more) for herbaceous forage crops, either cultivated or growing wild (wild prairie or grazing land).	EEA glossary, 2022
3	Recalcitrance	Resistance to decomposition – humus is highly recalcitrant and therefore remains in soil for a long time.	Ontl et al., 2021
3a	Soil profile	A column of soil extending through all its horizons and into the parent material and large enough to be used to characterise the soil condition at a particular place.	Soilcare glossary, 2022
3a	Carbon cycle	Sequence of transformations whereby carbon dioxide is converted to organic forms by photosynthesis or chemosynthesis, recycled through the biosphere (with partial incorporation into sediments), and ultimately returned to its original state through respiration or combustion.	Soilcare glossary, 2022
3a	Edaphon	The community of soil organisms (microbes, fungi, nematodes, worms, insects, protozoa, etc.).	Soilcare glossary, 2022
3 & 3a	Bulk density	Ratio of the mass of a quantity of material (or one phase) and the total volume occupied by this material (including other phases). Monitoring/measuring bulk density can inform on the state of soil compaction.	ISO 11074, 2015 This deliverable
3 & 3a	Soil organic matter	The organic fraction of the soil exclusive of undecayed plant and animal residues.	Soilcare glossary, 2022
3 & 3a	Humus	The well decomposed, amorphous, stable fraction of the organic matter in mineral soils with a low specific weight and high surface area; usually composed of many organic compounds of high molecular weight and dark colour. A term often used synonymously with soil organic matter. Humus is important for soil fertility, and helps to bind soil particles and aggregates together.	Soilcare glossary, 2022
3b	Species diversity	The number and variety of species found in a given area in a region.	EEA glossary, 2022
3a & 4a	Soil Organic Carbon (SOC) sequestration potential	The potential of soils to absorb carbon. This can be increased through conservational agricultural practices.	Zomer et al., 2017
3a & 4a	Carbon carrying capacity (CCC)	The mass of carbon stored in an ecosystem in a state of dynamic equilibrium under prevailing environmental conditions and natural disturbance regimes, but excluding anthropogenic disturbance. CCC provides a baseline against which current carbon stocks (CCS) can be compared, with the difference between CCC and CCS giving the carbon sequestration potential.	Keith et al., 2010
3a & 4a	Respiration rate	Soil respiration consists of heterotrophic respiration, mainly through the mineralization of soil organic C and decomposition of litters of leaves, branches and roots by soil microorganisms, and autotrophic respiration, generally via plant root and microbial respiration in the rhizosphere. Soil respiration has been generally considered to be the second greatest C exchange between the atmosphere and terrestrial ecosystem.	Huang et al., 2021

3b & 4	Climate regulation	The capacity of a soil to reduce the negative impact of increased GHG (i.e., CO_2, CH_4, and N_2O) emissions on climate, among which is its capacity to store carbon.	Soilcare glossary, 2022
3b & 4b	Paludiculture	The productive land use of wet and rewetted peatlands that preserves the peat soil and thereby minimizes CO_2 emissions and subsidence.	EU Peatlands & CAP Network, 2021
3b & 4b	Nitrogen fixation	Conversion of molecular nitrogen (N_2) to ammonia and subsequently to organic nitrogen utilizable in biological processes.	SSSA, 2022
3 & 5	Green Manures	Non-harvested crop grown in between two main crop seasons, intended to improve the soil fertility, generally not growing under N limitation due to the use of fertilizers and manures, or the ability to fix atmospheric N, OR Young and succulent plant material turned into the soil to improve its organic matter and nutrient content.	Soilcare glossary, 2022
3 & 5	Cover crops	Cover crops, catch crops or green manure crops are normally grown between successive production crops to provide ground cover, to capture soil nutrients and to improve soil characteristics or benefit the following crop. Using deep rooting crops provides crop induced wetting and drying cycles that crack the soil and breaks up impermeable layers of soil by root penetration.	Teagasc, 2022
3 & 5	Crop residue	Crop residues can be defined as biomass remaining on the soil's surface after harvest. In some systems, linear increases in soil organic carbon stocks can be observed with increasing rates of residue addition.	Page, Dang & Dalal, 2020
3, 3b & 5	Multi-species sward	Multi-species mixtures are a combination of diverse forage species with specific characteristics. An advantage of multi-species swards is the maintenance of a steady plant growth rate at reduced fertiliser application compared to grass only swards.	Teagasc, 2020
3b & 5	Agroforestry	Land-use system in which woody perennials are maintained or planted, in some form of spatial arrangement or temporal sequence, on the same land as agricultural crops and/or livestock.	EEA glossary, 2022
4a & 4b	Measurement, reporting, verification (MRV) System	The practice of "MRV," which involves three processes of measurement or monitoring (M), reporting (R), and verification (V) to obtain a clear understanding of GHG emissions.	United Nations Climate Change Secretariat, 2014
4b	Carbon Sequestration	The uptake and storage of carbon. Trees and plants, for example, absorb carbon dioxide, release the oxygen and store the carbon. Soils benefit from an increased rate of carbon sequestration or net carbon storage.	EEA glossary, 2022
5	Agri-environmental Scheme	Agri-environment schemes are Government programmes set up to help farmers manage their land in an environmentally-friendly way. Schemes which incentivise farmers to adopt or carry out favourable practices / management of their land and soil resources to reach a target objective.	EEA glossary, 2022
5	Organic fertiliser	Organic fertilisers are materials of animal origin used to maintain or improve plant nutrition and the physical and chemical properties and biological activity of soils, either separately or together, they may include manure, digestive tract content, compost and digestion residues.	EEA glossary, 2022

5	No tillage (NT)	An agronomic practice in conservation agriculture (CA) for annual crops, and is defined as a way to farm without disturbing the soil through tillage. NT must leave at least 30% of area covered by plant residues right after crop establishment, and crops are sown using machinery which is able to place seeds through plant residues from previous crops. Also, in arid climates it enhances water retention in soils through decreasing evaporation losses from the soil surface which is usually enhanced by tillage involving soil invert.	Soilcare glossary, 2022
5	Afforestation	The establishment of a forest, stand or tree crop on an area not previously forested, or on land from which forest cover has very long been absent.	EEA glossary, 2022
5	Urban organic waste	These wastes include sewage, wastewater and vegetable waste.	Schroder et al., 2021
5	Direct drill seeding	Planting crops in a non-inverted soil without seedbed preparation.	Soilcare glossary, 2022
5	Strip tillage	The process in which only a narrow strip of land needed for the crop row is tilled.	Soilcare glossary, 2022
5	Biochar	Biochar is a charcoal-like substance that's made by burning organic material from agricultural and forestry wastes in a controlled process called pyrolysis. The energy or heat created during pyrolysis can be captured and used as a form of clean energy. Biochar is also found to be beneficial for composting, since it reduces GHG emissions and prevents the loss of nutrients in the compost material.	Spears, 2018
2a & 2b 3a & 3b 4a & 4b	Living labs (LL)	Spaces for co-innovation through participatory, transdisciplinary and systemic research.	D2.2 LL & LH
2a & 2b 3a & 3b 4a & 4b	Lighthouses (LH)	Places for demonstration of solutions, training and communication. They are best practice examples (technologies, cooperation, governance, trainings) that have already been developed and applied in practice.	D2.2 LL & LH
2a,3a & 4a	Citizen science	Participation of citizens in the generation of new knowledge and/or data.	Buytaert et al., 2014 (also in D3.3)
2a,3a & 4a	Co-creating / co-production / joint-fact finding	Process in which stakeholders with differing viewpoints and interests work together to develop data and information, analyse facts and forecasts, develop common assumptions and informed opinion, finally, use the information they have developed to reach decisions together.	Ehrmann & Stinson, 1999 (also in D3.3)

3.4.5 Common language for stopping soil sealing and increasing re-use of urban soils (objective 3)

Table 3.5 - Objects at the 3rd hierarchy level of the Soil and Land Management ontology related to the stopping of soil sealing and increasing of the re-use of urban soils (For DPSIR position see Fig. 3.3).

DPSIR position	Object	Described in common language	Source
2	Land take	The area of land that is "taken" by infrastructure itself and other facilities that necessarily go along with the infrastructure, such as filling stations on roads and railway stations.	EEA glossary, 2022

2	Artificial surface	The continuous and discontinuous urban fabric (housing areas), industrial, commercial and transport units, road and rail networks, dump sites and extraction sites, but also green urban areas.	Prokop et al., 2012
2a	Measuring land take	Measuring the change in the area of agricultural, forest and other semi-natural land taken for urban and other artificial land development.	EEA glossary, 2022
2b	Circular land use	Circular land use is a process in which neglected land in urban areas is put to better uses. CircUse as a concept aims to be integrated with existing structures and uses, and is put into practice on a broad scale. The concept also looks to reduce the consumption of un-built land through prioritizing inner development over outer development.	HOMBRE, D2.3
2b	Land recycling	The reuse of abandoned, vacant, or underused properties for redevelopment.	Centre of Creative Land Recycling, 2021
2b	Brownfield regeneration or revitalization	Regeneration or revitalization involves the process of turning around deprived communities and lands in decaying neighbourhoods. It consists of two specific processes: one is the decontamination or remediation of a specific site and the other is the social, economic or cultural redevelopment of the site in view of future uses.	TIMBRE Glossary, 2022
2b	Brownfield redevelopment	Recycling of brownfields instead of developing greenfield land outside the built environment reduces land take and further soil sealing. Some but not the majority of brownfield sites are contaminated to differing extents and these require risk assessment.	Prokop et al., 2012
2b	Interim / temporary land use	Interim, non-permanent use is a step-by-step regeneration approach to smoothen the transition from traditional to future use in a given area. It can buy more time to plan and realise new long-term use, meanwhile not “wasting” the land resource altogether. Interim uses specifically considered are those that in themselves may contribute to a more sustainable society and societal ambitions, such as production of biomass for sustainable energy, city farms and allotments, or the creation of outdoor amenities and open space for human well-being and health.	HOMBRE, D2.2
2b	Soft land use / re-use	Innovative strategies, techniques and appraisal methods to improve the value of brownfield regeneration into "soft re-use" (i.e. non-sealed land uses) on an interim or long-term basis.	HOMBRE outcomes
3	Sealed soils	Sealed soils can be defined as the destruction or covering of soils by buildings, constructions and layers of completely or partly impermeable artificial material (asphalt, concrete, etc.). It is the most intense form of land take and is essentially an irreversible process. Sealed land is a subset of the above mentioned category; i.e. land consumed by development of settlements, infrastructure, and commercial and industrial areas. An indicator of the intensity of land take is the proportion of the total built-up land area which is sealed.	Prokop et al., 2012
3	Brownfields	Sites that have been affected by the former use of the site and surrounding land, are derelict or underused, may have real or perceived contamination problems, are mainly in developed urban areas and require intervention to bring them back to beneficial use.	Ferber et al., 2006

3	Greenfields	A site, usually suburban or rural, that has never been used for development.	Centre of Creative Land Recycling, 2021
4a	Measuring soil functions	Measuring the performance of the ecological processes (provided by soils) that result in the supply of ecosystem services (different indicators).	Van der Meulen & Maring, 2018
4b	Permeable surfaces	Permeable surfaces reduce soil sealing and increase the water drainage capacity of surfaces. However, permeable surfaces cannot be considered as a soil protection measure, since all techniques require removal of the upper soil layer of at least 30 cm. In some cases, the original soil can be replaced to some extent, as in the case of gravel turf.	Prokop et al., 2012
5	Net land take	Changes of non-artificial areas into artificial areas, which are not compensated by the restoration of the same amount of artificial areas into non-artificial areas.	SURFACE, 2019
2a & 2b 3a & 3b 4a & 4b	Living labs (LL)	Spaces for co-innovation through participatory, transdisciplinary and systemic research.	D2.2 LL & LH
2a & 2b 3a & 3b 4a & 4b	Lighthouses (LH)	Places for demonstration of solutions, training and communication. They are best practice examples (technologies, cooperation, governance, trainings) that have already been developed and applied in practice.	D2.2 LL & LH
2a,3a & 4a	Citizen science	Participation of citizens in the generation of new knowledge and/or data.	Buytaert et al., 2014 (also in D3.3)
2a,3a & 4a	Co-creating / co-production / joint-fact finding	Process in which stakeholders with differing viewpoints and interests work together to develop data and information, analyse facts and forecasts, develop common assumptions and informed opinion, finally, use the information they have developed to reach decisions together.	Ehrmann & Stinson, 1999 (also in D3.3)

3.4.6 Common language for reducing soil pollution and enhancing restoration (objective 4)

Table 3.6 - Objects at the 3rd hierarchy level of the Soil and Land Management ontology related to the reducing of soil pollution and enhancing of restoration (For DPSIR position see Fig. 3.3).

DPSIR position	Object	Described in common language	Source
1	Uses with a heavy environmental impact	Socioeconomic use of land with a heavy environmental impact including mining and quarrying; energy production; industry; water and waste treatment; and construction.	LUCAS, 2021
1, 2, 3 & 4	Source-Pathway-Receptor (SPR)	Causal chain linking the origin of a hazard or pressure (e.g. an identified or estimated loading of a polluting substance) along an environmental pathway to consequences for human health or the environment (using concepts such as vulnerability, exposure and impact assessment). It should also provide some assessment of the probability of, and confidence in, such a forecast.	EC, 2010b
1, 2, 3 & 4	Megasite	Expression used for a large area with multiple contaminant sources related to (former) industrial activities, with a considerable impact on the environment, through groundwater, surface water and/or air migration. The dimensions of the area for which the megasite management strategy needs to be determined by the sphere of influence of contaminant	IMS, ND

		migration through these different pathways. In general these vary between 1-10 km.	
2	Atmospheric deposition	Transfer of substances in air to surfaces, including soil, vegetation, surface water, or indoor surfaces, by dry or wet processes.	EEA glossary, 2022
2	Point source	Stationary locations or fixed facilities from which pollutants are discharged.	EEA glossary, 2022
2	Diffuse pollution	Pollution from widespread activities with no one discrete source, e.g. acid rain, pesticides, urban run-off, etc.	EEA glossary, 2022
2	Pollution	Direct or indirect introduction, as a result of human activity, of substances, vibrations, heat or noise into air, water or land which may be harmful to human health or the quality of the environment, result in damage to material property, or impair or interfere with amenities and other legitimate uses of the environment.	EC, 2010a
2	Contamination	Introduction into or onto water, air, soil or other media of microorganisms, chemicals, toxic substances, wastes, wastewater or other pollutants in a concentration that makes the medium unfit for its next intended use.	EEA glossary, 2022
2	Emerging contaminants / contaminants of concern	Chemicals that are not currently (or have been only recently) regulated by the environmental regulatory bodies and about which there are concerns regarding their impact on human or ecological health.	Ghangrekar et al., 2020
2	Microplastics	Solid plastic particles <5 mm composed of mixtures of polymers and functional additives. They may also contain residual impurities. Microplastics can be unintentionally formed when larger pieces of plastic, like car tyres or synthetic textiles, wear and tear. But they are also deliberately manufactured and added to products for specific purposes, such as exfoliating beads in facial or body scrubs.	ECHA, ND
2b & 3b	Remedial measures	Any action, or combination of actions, including mitigating or interim measures to restore, rehabilitate or replace damaged natural resources and/or impaired services, or to provide an equivalent alternative to those resources or services as foreseen in Annex II (of the Environmental Liability Directive).	EC, 2004
2b & 3b	Remediation	Actions aimed at the removal, control, containment or reduction of contaminants or exposure pathways so that the site, taking account of its current use or approved future use, no longer poses a significant risk to human health or the environment. Remediation actions may involve monitored natural recovery. It can be done onsite (in situ) or off site (ex-situ).	EC, 2006
2b & 3b	Gentle soil remediation options	Using plants, associated microbes and soil amendments may serve as an environmentally friendly and cost-efficient alternative.	GREENLAND, 2014
2b & 3b	Decontamination	The removing of chemical, biological, or radiological contamination from, or the neutralizing of it on a person, object, or area.	EEA glossary, 2022
2b & 3b	Brownfield regeneration or revitalization	Regeneration or revitalization involves the process of turning around deprived communities and lands in decaying neighbourhoods. It consists of two specific processes: one is the decontamination or remediation of a specific site and the other is the social, economic or cultural redevelopment of the site in view of future uses.	TIMBRE Glossary, 2022
2b & 3b	In-situ chemical oxidation	This technique inserts a strong oxidant into the soil. When the oxidant comes into contact with the	SOILECTION, 2008

		pollution, it is broken down chemically (oxidized). This produces harmless compounds. The oxidator (for example ozone or Fenton's reagens) is produced in the right concentrations in a special unit and is injected into the soil by the use of filters. If the injection is discontinuous after the injection period, the filters are flushed with an acidic solution to prevent clogging.	
2b & 3b	Enhanced natural attenuation (aerobic)	The principle of aerobic biological remediation is stimulation of the biological activity by improving the limiting factor for biological activity. Limiting factors for aerobic biological activity can be: lack of oxygen, the lack of nutrients or the lack of micro-organisms that degrade the contamination. The clue of this technology is to find out what is the limiting factor and subsequently improving this factor by injection, extraction, heating or a combination.	SOILECTION, 2008
2b & 3b	Enhanced natural attenuation (anaerobic)	Natural soil bacteria can anaerobically degrade contaminants by biological processes. During the treatment of the soil, the soil conditions for the bacteria are improved by injecting substrate and nutrients. Also a bio screen can be applied. In the laboratory soil samples are examined to know how much the concentration of contaminants is decreased and how the biodegradation is proceeding. It is an anaerobic process which is very sensitive to redox conditions.	SOILECTION, 2008
2b & 3b	Soil vapor extraction	Refreshes the soil vapor in the unsaturated zone by lowering the atmospheric pressure. This causes vaporization of the contaminant which is extracted from the soil. The extracted soil vapor is cleaned with the use of an activated carbon filter, biofilter or catalyst. Soil Vapor Extraction also causes an increase of the oxygen level which stimulates natural attenuation (bioventing). Lowering the concentration of the contaminant in the vapor phase causes a new equilibrium between the vapor phase and the soil. Therefore, the concentration in the soil decreases too.	SOILECTION, 2008
2b & 3b	Pump & Treat	Polluted groundwater is pumped to the surface where it is cleaned or discharged. Once the groundwater is cleaned, it can infiltrate the soil again. The extraction of groundwater can be performed in the horizontal or vertical direction with the use of drains driven by a vacuum pump or by gravitational flow.	SOILECTION, 2008
2b & 3b	Multi-Phase Extraction	Combines the extraction of groundwater and/or soil vapor and/or pure product. The extracted phases are separated aboveground where the phases are treated or discharged. Usually removing the floating layer and groundwater are meant by multiple-phase extraction or two-phase extraction.	SOILECTION, 2008
2b & 3b	Steam Injection	Heathens up the soil including the capillary zone, floating layer and groundwater. Because of the heating the mobility of the contaminant will increase as well as the evaporation and the concentration of the dissolved contaminant. With the use of extraction filters the phase mixture (steam, vapor, pure product and water) is extracted from the soil and treated aboveground.	SOILECTION, 2008
2b & 3b	Electro-reclamation	Charged particles and ions are transported through the soil by an electrical field. The charged particles are moving towards the electrodes and are being removed by the electrode fluids which circulate around the	SOILECTION, 2008

		electrodes. The use of alternating current heathens the soil which increases the availability of the contaminant. The biological activity can also be stimulated due to the heating.	
2b & 3b	(Bio)sparging	Compressed air is transported into the soil. This causes decomposition of the contaminant (In Situ Air Sparging) and stimulates aerobic attenuation.	SOILECTION, 2008
2b & 3b	Co-solvent/ Surfactant flushing	These are two comparable in situ techniques using a different principal. Both techniques inject enriched water into the soil and extract groundwater with the mobilized contaminant. Co-solvent flushing: Injection of a fluid or mixture of fluids (mostly alcohol) to dissolve the pure product. The mixture of water, alcohol and the contaminant is now extracted. Surfactant flushing: Injection of a molecule with a water-soluble head and water insoluble tail which increases the solvability of contaminants in water. Because of the increased solvability, the contaminant can be pumped out of the soil via the water phase.	SOILECTION, 2008
2b & 3b	In-situ Chemical reduction	In situ chemical reduction is based on the addition of reducing compounds to the soil. This technique is mostly applied as a permeable reactive barrier (PRB). The reducing compound commonly used is zero-valent iron (Fe0).	SOILECTION, 2008
2b & 3b	In-situ Metal Precipitation	The most applied in situ metal precipitation method is the stimulation of microbiological sulphate to sulphide conversion. The conversion takes place because of the addition of a carbon source and (if needed) nutrients to the soil. The sulphide being formed can fixate metals. There are also other methods which stimulate sorption, precipitation and cation exchange with the addition of certain compounds.	SOILECTION, 2008
3	Soil quality	The capacity of a soil to function for specific land uses or within ecosystem boundaries. This capacity is an inherent characteristic of a soil and varies from soil to soil. Such indicators as organic-matter content, salinity, tilth, compaction, available nutrients, and rooting depth help measure the health or condition of the soil-its quality-in any given place.	USDA, 2015
3	Groundwater quality	Comprises the physical, chemical, and biological qualities of ground water. Temperature, turbidity, colour, taste, and odour make up the list of physical water quality parameters.	Harter, 2003
3b	Land restoration	Reversing land degradation processes by applying soil amendments to enhance land resilience and restoring soil functions and ecosystem services.	UNCCD, 2012
3 & 4	Brownfields (BFs)	Sites that have been affected by the former use of the site and surrounding land, are derelict or underused, may have real or perceived contamination problems, are mainly in developed urban areas and require intervention to bring them back to beneficial use.	Ferber et al., 2006
3 & 4	Contaminated site	Location where, as a result of human activity an unacceptable, hazard to human health and ecosystems exists. Local contamination (contaminated sites) is a problem in restricted areas (or sites) around the source, where there is a direct link to the source of contamination.	EEA glossary, 2022
4	Ecological risk	Risks posed by the presence of substances released to the environment by man, in theory, on all living	EEA glossary, 2022

		organisms in the variety of ecosystems which make up the environment.	
2a & 2b 3a & 3b 4a & 4b	Living labs (LL)	Spaces for co-innovation through participatory, trans-disciplinary and systemic research.	D2.2 LL & LH
2a & 2b 3a & 3b 4a & 4b	Lighthouses (LH)	Places for demonstration of solutions, training and communication. They are best practice examples (technologies, cooperation, governance, trainings) that have already been developed and applied in practice.	D2.2 LL & LH
2a,3a & 4a	Citizen science	Participation of citizens in the generation of new knowledge and/or data.	Buytaert et al., 2014 (also in D3.3)
2a,3a & 4a	Co-creating / co-production / joint-fact finding	Process in which stakeholders with differing viewpoints and interests work together to develop data and information, analyse facts and forecasts, develop common assumptions and informed opinion, finally, use the information they have developed to reach decisions together.	Ehrmann & Stinson, 1999 (also in D3.3)

3.4.7 Common language for preventing erosion (objective 5)

Table 3.7 - Objects at the 3rd hierarchy level of the Soil and Land Management ontology related to the preventing of erosion (For DPSIR position see Fig. 3.3).

DPSIR position	Object	Described in common language	Source
1	Erosion	The wearing away of the land surface by water, wind, ice, gravity or other natural or anthropogenic agents that abrade, detach and remove soil particles or rock material from one point on the earth's surface, for deposition elsewhere, including gravitational creep and so-called tillage erosion.	Soilcare glossary, 2022
1	Accelerated erosion	The erosion that exceeds the normal geologic erosion and becomes destructive. It occurs when people disturb the soil or the natural vegetation by cutting forests, overgrazing, ploughing hillsides, recreational activity, indiscriminate (arbitrary) burning, or construction of roads and buildings.	Soilcare glossary, 2022
1	Common Agricultural Policy (CAP)	The Common Agricultural Policy (CAP) is the agricultural policy of the European Union. It is a set of laws adopted by the EU to provide a common, unified policy on agriculture.	European Council, ND. Modified version
1	Fertilization	Application of mainly mineral compounds, in order to increase soil fertility. In some cases, (e.g. liming) the purpose of fertilization is also to improve specific soil properties (pH, stability of soil structure).	Soilcare glossary, 2022
1 & 2	Agronomic management techniques	Techniques used to manage soil, water, nutrients and pests.	Soilcare glossary, 2022
1 & 4	Connectivity	The interdependence of hydrological processes with other elements of the landscape as soil, highlighting the strong relationship among them.	Keesstra et al., 2018
2	Drip irrigation	Drip irrigation is sometimes called trickle irrigation and involves dripping water onto the soil at very low rates from a system of small diameter plastic pipes fitted with outlets called emitters or drippers. Water is applied close to plants so that only part of the soil in which the roots grow is wetted, unlike surface and sprinkler irrigation, which involves wetting the whole soil profile.	Brouwer et al., 1990

2	Conventional tillage	Full width tillage that disturbs the entire soil surface which is generally performed prior to planting. It usually involves a primary operation by depth ploughing or chiselling (commonly to 20-30 cm depth), followed by secondary operation such as rotavating or harrowing that pulverizes, flattens, and firms the surface. Depending on climate and soil type, tillage may be the cause of compaction but may also help in improving soil structure through the mechanical destruction of compacted layers.	Soilcare glossary, 2022
2 & 5	Conservation agriculture	A farming method including minimum soil disturbance (no tillage, minimum tillage, reduced tillage, strip tillage, direct drill), crop rotation, and permanent soil cover.	Soilcare glossary, 2022
2 & 5	No tillage (NT)	An agronomic practice in conservation agriculture (CA) for annual crops, and is defined as a way to farm without disturbing the soil through tillage. NT must leave at least 30% of area covered by plant residues right after crop establishment, and crops are sown using machinery which is able to place seeds through plant residues from previous crops. Also, in arid climates it enhances water retention in soils through decreasing evaporation losses from the soil surface which is usually enhanced by tillage involving soil invert.	Soilcare glossary, 2022
3	Aggregates	Soil aggregate consisting of two or more soil particles bound together by various forces.	Soilcare glossary, 2022
3	Aggregation	Process whereby primary soil particles (sand, silt, clay) are bound together, usually by natural forces and substances derived from root exudates and microbial activity. Soil aggregates are arranged to form soil peds, units of soil structure, classified by size, shape (platy, prismatic, columnar, angular, subangular, blocky, granular…) and grade (single-grain, massive, weak, moderate, strong). From an agronomical point of view, the most important soil aggregates are in range 3 - 1 mm.	Soilcare glossary, 2022
3	Gully	Channel resulting from erosion and caused by the concentrated but intermittent flow of water during and immediately following heavy rainfall; gullies are deep enough (usually >0.5 m) to interfere with, but not obliterated by, normal tillage operations.	Soilcare glossary, 2022
3	Arable land	Agricultural land that is cultivated by ploughing, usually to 20 or 30 cm depth. More than 30 cm represents deep ploughing.	Soilcare glossary, 2022
3b	Cultural ecosystem services	The non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience, including, e.g., knowledge systems, social relations, and aesthetic values.	Soilcare glossary, 2022
3 & 4	Infiltration	The movement of water passing the soil surface into the soil (as contrasted with percolation, which is movement of water through soil layers moving down to the aquifers, or out to rivers).	Soilcare glossary, 2022
3 & 4	Preferential flow	Water flow through macro-pores (e.g., cracks, root channels) in the unsaturated/ vadose zone.	Soilcare glossary, 2022
3 & 4	Surface runoff	The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface	Soilcare glossary, 2022

		streams is called groundwater runoff or seepage flow from groundwater.	
3 & 5	Compost	The material used to supply organic matter or plant nutrients to a soil, resulting from composting.	Soilcare glossary, 2022
4	Soil resilience	The capacity of a soil to recover its functional capacity after a disturbance.	Soilcare glossary, 2022
5	Contour ploughing	Ploughing in a direction that follows the contour, maintaining the same elevation.	Soilcare glossary, 2022
5	Strip cropping	Growing crops in strips that follow the contour line. Strips of grass or close-growing crops alternate with strips of clean-tilled crops or summer fallow.	Soilcare glossary, 2022
5	Reduced tillage	A tillage without inversion at a reduced depth (about 30% crop residues remaining on the surface), with specific machines (often with grubber/cultivator), more than once a year.	Soilcare glossary, 2022
5	Organic farming	Agricultural production which typically places a higher emphasis on environmental and wildlife protection and, with regard to livestock production, on measures that are supposedly animal welfare friendly. Organic production aims at more holistic production management systems for crops and livestock, emphasizing on-farm management practices over off-farm inputs. This involves avoiding, or largely reducing, the use of synthetic chemicals such as inorganic fertilizers, pesticides, medicinal products, replacing them, wherever possible, with cultural, biological and mechanical methods. Organic producers explicitly aim to develop an allegedly healthier, fertile soil by growing and rotating a mixture of crops and using clover to fix nitrogen from the atmosphere. The production of genetically-modified (GM) crops and their use in animal feed is banned.	Soilcare glossary, 2022
5	Precision farming (precision agriculture)	A management strategy that utilizes site-specific information to precisely and economically manage and optimize production inputs.	Soilcare glossary, 2022
5	Sustainable land management	The use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions.	Soilcare glossary, 2022
5	Water management	The way in which water availability (irrigation; water harvesting) and discharge (drainage) is regulated.	Soilcare glossary, 2022
2a & 2b 3a & 3b 4a & 4b	Living labs (LL)	Spaces for co-innovation through participatory, transdisciplinary and systemic research.	D2.2 LL & LH
2a & 2b 3a & 3b 4a & 4b	Lighthouses (LH)	Places for demonstration of solutions, training and communication. They are best practice examples (technologies, cooperation, governance, trainings) that have already been developed and applied in practice.	D2.2 LL & LH
2a,3a & 4a	Citizen science	Participation of citizens in the generation of new knowledge and/or data.	Buytaert et al., 2014 (also in D3.3)
2a,3a & 4a	Co-creating / co-production / joint-fact finding	Process in which stakeholders with differing viewpoints and interests work together to develop data and information, analyse facts and forecasts, develop common assumptions and informed opinion, finally, use the information they have developed to reach decisions together.	Ehrmann & Stinson, 1999 (also in D3.3)

3.4.8 Common language for improving soil structure to enhance soil biodiversity (objective 6)

Table 3.8 - Objects at the 3rd hierarchy level of the Soil and Land Management ontology related to the improving of soil structure to enhance soil biodiversity (For DPSIR position see Fig. 3.3).

DPSIR position	Object	Described in common language	Source
1	Agricultural economics	Study of the allocation, distribution, and utilization of the resources used, along with the commodities produced, by farming.	Britannica, 2022
1	Agronomic management techniques	Techniques used to manage soil, water, nutrients and pests.	Soilcare glossary, 2022
2	Machinery	Equipment used for managing soil and biomass production as tractors, skidding machine or harvester (to minimize costs, progressively larger and more efficient machinery is used in the field).	Schjonning et al., 2015
2	Grazing intensity	The cumulative effects grazing animals have on rangelands during a particular time period.	Holechek et al., 1998
2	Overgrazing	Intensive grazing by livestock that exceeds the environmental carrying capacity of a given piece of land. It can lead to impoverishment of the sward, dominance of certain unpalatable species, soil erosion, soil compaction and even a (complete) loss of vegetation.	Adapted from EEA glossary, 2022
2	Compaction	Changing the nature of the soil such that there is a decrease in the volume of voids between soil particles or aggregates; it is manifested as an increase in bulk density and a severely compacted soil can become significantly less permeable and less aerated. Manmade compaction is caused by poaching (trampling of animal hooves repeatedly) or by the passage of heavy machinery	Soilcare glossary, 2022
2, 2b & 5	Conventional tillage	Full width tillage that disturbs the entire soil surface which is generally performed prior to planting. It usually involves a primary operation by depth ploughing or chiselling (commonly to 20-30 cm depth), followed by secondary operation such as rotavating or harrowing that pulverizes, flattens, and firms the surface. Depending on climate and soil type, tillage may be the cause of compaction but may also help in improving soil structure through the mechanical destruction of compacted layers.	Soilcare glossary, 2022
2, 2b & 5	No tillage (NT)	An agronomic practice in conservation agriculture (CA) for annual crops, and is defined as a way to farm without disturbing the soil through tillage. NT must leave at least 30% of area covered by plant residues right after crop establishment, and crops are sown using machinery which is able to place seeds through plant residues from previous crops. Also, in arid climates it enhances water retention in soils through decreasing evaporation losses from the soil surface which is usually enhanced by tillage involving soil invert. Depending on climate and soil type, NT may be the cause of compaction but may also help in improving soil structure due to biological processes linked to the use cover crops or to the activity of soil engineers as earthworms.	Soilcare glossary, 2022
2,2b & 5	Sustainable soil management	Soil management is sustainable if the supporting, provisioning, regulating, and cultural services provided by	FAO,2017

		soil are maintained or enhanced without significantly impairing either the soil functions that enable those services or biodiversity.	
2, 2b & 5	Cover crops	Cover crops, catch crops or green manures are normally grown between successive production crops to provide ground cover, to capture soil nutrients and to improve soil characteristics or benefit the following crop. Using deep rooting crops provides crop induced wetting and drying cycles that crack the soil and breaks up impermeable layers of soil by root penetration.	Teagasc, 2022
2b & 5	Reduction of pressure on soils	Compaction depends on machinery tractor size/weight, on soil texture, and soil water content. Those characteristics need to be considered to reduce pressure on soils. Note that low tire inflation pressures it is possible to reduce the soil stresses, at least in the upper subsoil.	Van-Camp et al., 2004
3	Soil structure	Arrangement of particles and organic matter to form aggregates which produce macro structures and micro structures in the soil.	ISO 11074, 2015
3	Soil habitat	Ability of soil/soil materials to serve as a habitat for micro-organisms, plants, soil living animals, and their interactions (biocenosis).	ISO 11074, 2015
3 & 3a	Soil porosity	Volume of pores in a soil sample (non-solid volume) divided by the bulk volume of the sample. Monitoring/measuring soil porosity can inform on the state of soil compaction.	ISO 11074, 2015
3 & 3a	Bulk density	Ratio of the mass of a quantity of material (or one phase) and the total volume occupied by this material (including other phases). Monitoring/measuring bulk density can inform on the state of soil compaction.	ISO 11074, 2015
3 & 3a	Soil biodiversity	Variability among living organisms on the earth, including the variability within and between species, and within and between ecosystems. This is also often used as the number and variety of organisms found within a specified geographic region. Soil biodiversity may be measured and monitored by collecting soil samples and extracting soil animals (or DNA) to identify the different groups of organisms. It is also possible to monitor biological activities (e.g. enzymatic measurements, organic matter degradation).	ISO 11074, 2015
4	Compacted soil	Densification and distortion in which total and air-filled porosity and permeability are reduced, strength is increased, soil structure partly destroyed and many changes are induced in the soil fabric and in various behaviour characteristics. Soil biological activity and soil productivity for agricultural and forest cropping is reduced and which results in a decreased water infiltration capacity and increased erosion risk. Note that the subsoil compaction is a hidden form of soil degradation that affects all the agricultural area and results in gradually decreasing yields and yield security and gradually increasing problems with waterlogging. Note that a reduced aeration of the soil matrix between vertical macropores increases the risk of anaerobic conditions. Denitrification of nitrate is one of the potential	Van-Camp et al., 2004 Schjonning et al., 2015

		undesirable side effects, since it removes plant-available nitrogen from the soil and potentially adds to the atmospheric concentration of the potent GHG N_2O.	
2a & 2b 3a & 3b 4a & 4b	Living labs (LL)	Spaces for co-innovation through participatory, transdisciplinary and systemic research.	D2.2 LL & LH
2a & 2b 3a & 3b 4a & 4b	Lighthouses (LH)	Places for demonstration of solutions, training and communication. They are best practice examples (technologies, cooperation, governance, trainings) that have already been developed and applied in practice.	D2.2 LL & LH
2a,3a & 4a	Citizen science	Participation of citizens in the generation of new knowledge and/or data.	Buytaert et al., 2014 (also in D3.3)
2a,3a & 4a	Co-creating / co-production / joint-fact finding	Process in which stakeholders with differing viewpoints and interests work together to develop data and information, analyse facts and forecasts, develop common assumptions and informed opinion, finally, use the information they have developed to reach decisions together.	Ehrmann & Stinson, 1999 (also in D3.3)

3.5 Soil Mission objectives 7 and 8

3.5.1 Introducing remarks

The remaining two Soil Mission objectives, i.e. 7. reduce the EU global footprint on soils and 8. improve soil literacy in society, do not directly relate to the actual management of soil and land. However, also for these mission objectives some important objects have been selected and defined in a common language.

3.5.2 Common language for reducing the EU global footprint on soils (objective 7)

Table 3.9 - Objects related to reducing the EU global footprint on soils (objective 7).

Object	Described in common language	Source
Ecological footprint	The only metric that compares the resource demand of individuals, governments, and businesses against Earth's capacity for biological regeneration. Ecological Footprint accounting measures the demand on and supply of nature. On the demand side, the Ecological Footprint adds up all the productive areas for which a population, a person or a product competes. It measures the ecological assets that a given population or product requires to produce the natural resources it consumes (including plant-based food and fiber products, livestock and fish products, timber and other forest products, space for urban infrastructure) and to absorb its waste, especially carbon emissions. The Ecological Footprint tracks the use of productive surface areas. Typically, these areas are: cropland, grazing land, fishing grounds, built-up land, forest area, and carbon demand on land. On the supply side, a city, state or nation's biocapacity represents the productivity of its ecological assets (including cropland, grazing land, forest land, fishing grounds, and built-up land). These areas, especially if left unharvested, can also serve to absorb the waste we generate, especially our carbon emissions from burning fossil fuel. Both the Ecological Footprint and biocapacity are expressed in global hectares (gha).	GFN, ND

Global hectares (gha)	Globally comparable, standardized hectares with world average productivity.	GFN, ND
Biocapacity	The goods and services that a regions land and seas can provide (fruits and vegetables, meat, fish, wood, cotton for clothing, and carbon dioxide absorption).	GFN, ND
Biocapacity deficit	A population's Ecological Footprint exceeds the region's biocapacity.	GFN, ND
EU Global footprint	EU's Ecological Footprint compared to that of the world.	This deliverable & GFN, ND
Overshoot Day	Marks the date when humanity has exhausted nature's budget for the year. For the rest of the year, we are maintaining our ecological deficit by drawing down local resource stocks and accumulating carbon dioxide in the atmosphere. We are operating in overshoot.	GFN, ND

3.5.3 Common language for improving soil literacy in society (objective 8)

Table 3.10 - Objects related to improving soil literacy in society (objective 8).

Object	Described in common language	Source
Soil literacy	The state of knowing about or being familiar with soil. It concerns both a popular awareness about the importance of soil, and specialised and practice-oriented knowledge related to achieving soil health.	EC, 2021b and Cambridge, 2022
Know	Aware of the importance of soil and of how to achieve soil health.	EC, 2021b and Cambridge, 2022
Knowledge	Awareness, understanding, or information that has been obtained by experience or study, and that is either in a person's mind or possessed by people generally.	Cambridge, 2022
Explicit knowledge	Knowledge that can be expressed in words, numbers, and symbols and stored in books, computers, etc. Explicit knowledge can be articulated and easily communicated between individuals and organizations.	Cambridge, 2022
Implicit knowledge	Knowledge that you do not get from being taught, or from books, etc. but get from personal experience, for example when working in a particular organization (= same as tacit knowledge).	Cambridge, 2022
Tacit knowledge	Knowledge that you do not get from being taught, or from books, etc. but get from personal experience, for example when working in a particular organization (= same as implicit knowledge).	Cambridge, 2022
Knowledge transfer	Knowledge transfer is the sharing of knowledge, skills and technologies between research and enterprises for collective benefit.	IUA, ND
Science – policy interface	Science–policy interfaces are defined as social processes which encompass relations between scientists and other actors in the policy process, and which allow for exchanges, co-evolution, and joint construction of knowledge with the aim of enriching decision-making.	Watson, 2005
Agriculture Knowledge and Innovation Systems (AKIS)	The term Agricultural Knowledge and Innovation Systems (AKIS) is used to describe the whole knowledge exchange system: the ways people and organisations interact within a country or a region. AKIS can include farming practice, businesses, authorities, research, etc. and can vary a lot, depending on the country or sector.	EC, 2018b

4 RECOMMENTDATIONS AND WAY FORWARDS

4.1 Recommendations

This report was written in collaboration with different SMS partners and is based on their knowledge and expertise. Due to these areas of expertise, or rather lack of areas of expertise, the concepts defined for Soil Mission Objectives 7 and 8 merely scratch the surface of the full content of these objectives. We propose elaborating these two sections with experts in global soil footprints and soil literacy. Further, we recommend sharing this document with policy makers and regulatory bodies as well as with landowners and land users to get a more extensive outlook into which concepts are important, and currently missing in the report, when talking about soil and land management.

4.2 Way forwards

As stated in section 1.3, this document is a first attempt at a soil and land management ontology and should be regarded as a living document that matures by interaction with stakeholders. In follow-up projects that aim to support the Soil Mission, we recommend that partners use this document and build on it whenever the need arises.

This document will firstly be published on the SMS website. Further, SMS partners that will be involved in follow-up projects will share this document with each consortium so that the knowledge collected in this Ontology report is not lost or forgotten. Finally, we suggest that partners share this document with any stakeholder that is being engaged during the lifetime of future projects. This will hopefully result in smooth communication between all involved stakeholders.

5 GLOSSARY

In this final section, a list with all concepts defined in the Ontology report can be found.

Object	Definition	Table
Accelerated erosion	The erosion that exceeds the normal geologic erosion and becomes destructive. It occurs when people disturb the soil or the natural vegetation by cutting forests, overgrazing, ploughing hillsides, recreational activity, indiscriminate (arbitrary) burning, or construction of roads and buildings.	3.7
Afforestation	The establishment of a forest, stand or tree crop on an area not previously forested, or on land from which forest cover has very long been absent.	3.4
Aggregates	Soil aggregate consisting of two or more soil particles bound together by various forces.	3.7
Aggregation	Process whereby primary soil particles (sand, silt, clay) are bound together, usually by natural forces and substances derived from root exudates and microbial activity. Soil aggregates are arranged to form soil peds, units of soil structure, classified by size, shape (platy, prismatic, columnar, angular, subangular, blocky, granular…) and grade (single-grain, massive, weak, moderate, strong). From an agronomical point of view, the most important soil aggregates are in range 3 - 1 mm.	3.7
Agricultural economics	Study of the allocation, distribution, and utilization of the resources used, along with the commodities produced, by farming.	3.8
Agricultural policy	A course of action adopted by government or some other organization that determines how to deal with matters involving the cultivation of land; raising crops; feeding, breeding and raising livestock or poultry; and other farming issues.	3.3
Agriculture	Farmland, agricultural land use: arable land, grassland, rise, orchard, vineyard and others, semi-natural land.	3.1
Agriculture Knowledge and Innovation Systems (AKIS)	The term Agricultural Knowledge and Innovation Systems (AKIS) is used to describe the whole knowledge exchange system: the ways people and organisations interact within a country or a region. AKIS can include farming practice, businesses, authorities, research, etc. and can vary a lot, depending on the country or sector.	3.10
Agri-environmental Scheme	Agri-environment schemes are Government programmes set up to help farmers manage their land in an environmentally-friendly way. Schemes which incentivise farmers to adopt or carry out favourable practices / management of their land and soil resources to reach a target objective.	3.4
Agroforestry	Land-use system in which woody perennials are maintained or planted, in some form of spatial arrangement or temporal sequence, on the same land as agricultural crops and/or livestock.	3.4
Agronomic management techniques	Techniques used to manage soil, water, nutrients and pests.	3.7 & 3.8
Arable land	Agricultural land that is cultivated by ploughing, usually to 20 or 30 cm depth. More than 30 cm represents deep ploughing.	3.7
Arid land	Lands characterized by low annual rainfall of less than 250 mm, by evaporation exceeding precipitation and a sparse vegetation.	3.3
Artificial surface	The continuous and discontinuous urban fabric (housing areas), industrial, commercial and transport units, road and rail networks, dump sites and extraction sites, but also green urban areas.	3.5
Atmospheric deposition	Transfer of substances in air to surfaces, including soil, vegetation, surface water, or indoor surfaces, by dry or wet processes.	3.6
Biocapacity	The goods and services that a regions land and seas can provide (fruits and vegetables, meat, fish, wood, cotton for clothing, and carbon dioxide absorption).	3.9
Biocapacity deficit	A population's Ecological Footprint exceeds the region's biocapacity.	3.9
Biochar	Biochar is a charcoal-like substance that's made by burning organic material from agricultural and forestry wastes in a controlled process called pyrolysis. The energy or heat created during pyrolysis can be captured and used as a form of clean energy. Biochar is also found to be beneficial for composting, since it reduces GHG emissions and prevents the loss of nutrients in the compost material.	3.4
(Bio)sparging	Compressed air is transported into the soil. This causes decomposition of the contaminant (In Situ Air Sparging) and stimulates aerobic attenuation.	3.6
Brownfield redevelopment	Recycling of brownfields instead of developing greenfield land outside the built environment reduces land take and further soil sealing. Some but not the majority of brownfield sites are contaminated to differing extents and these require risk assessment.	3.5

Brownfield regeneration or revitalization	Regeneration or revitalization involves the process of turning around deprived communities and lands in decaying neighbourhoods. It consists of two specific processes: one is the decontamination or remediation of a specific site and the other is the social, economic or cultural redevelopment of the site in view of future uses.	3.5 & 3.6
Brownfields	Sites that have been affected by the former use of the site and surrounding land, are derelict or underused, may have real or perceived contamination problems, are mainly in developed urban areas and require intervention to bring them back to beneficial use.	3.5 & 3.6
Bulk density	Ratio of the mass of a quantity of material (or one phase) and the total volume occupied by this material (including other phases). Monitoring/measuring bulk density can inform on the state of soil compaction.	3.4 & 3.8
Carbon carrying capacity (CCC)	The mass of carbon stored in an ecosystem in a state of dynamic equilibrium under prevailing environmental conditions and natural disturbance regimes, but excluding anthropogenic disturbance. CCC provides a baseline against which current carbon stocks (CCS) can be compared, with the difference between CCC and CCS giving the carbon sequestration potential.	3.4
Carbon cycle	Sequence of transformations whereby carbon dioxide is converted to organic forms by photosynthesis or chemosynthesis, recycled through the biosphere (with partial incorporation into sediments), and ultimately returned to its original state through respiration or combustion.	3.4
Carbon farming	Carbon farming refers to anthropogenic interference with carbon pools, flows and GHG fluxes at farm-level with the purpose of minimising climate change. Farmers and foresters manage vast carbon stocks and significant GHG fluxes. There is a provision of incentives to adopt practices/management that promotes carbon conservation and carbon sequestration.	3.4
Carbon Sequestration	The uptake and storage of carbon. Trees and plants, for example, absorb carbon dioxide, release the oxygen and store the carbon. Soils benefit from an increased rate of carbon sequestration or net carbon storage.	3.4
Carbon Sink	Forests and other ecosystems that absorb carbon, thereby removing it from the atmosphere and offsetting CO_2 emissions.	3.4
Circular land use	Circular land use is a process in which neglected land in urban areas is put to better uses. CircUse as a concept aims to be integrated with existing structures and uses, and is put into practice on a broad scale. The concept also looks to reduce the consumption of un-built land through prioritizing inner development over outer development.	3.5
Citizen science	Participation of citizens in the generation of new knowledge and/or data.	3.3 – 3.8
Climate change mitigation	Refers to efforts to reduce or prevent emission of GHGs. Mitigation can mean using new technologies and renewable energies, making older equipment more energy efficient, or changing management practices or consumer behaviour.	3.3
Climate regulation	The capacity of a soil to reduce the negative impact of increased GHG (i.e., CO_2, CH_4, and N_2O) emissions on climate, among which is its capacity to store carbon.	3.4
Climatic change	The long-term fluctuations in temperature, precipitation, wind, and all other aspects of the Earth's climate. External processes, such as solar-irradiance variations, variations of the Earth's orbital parameters (eccentricity, precession, and inclination), lithosphere motions, and volcanic activity, are factors in climatic variation. Internal variations of the climate system, e.g., changes in the abundance of greenhouse gases (GHG), also may produce fluctuations of sufficient magnitude and variability to explain observed climate change through the feedback processes interrelating the components of the climate system.	3.3
Co-creating / co-production / joint-fact finding	Process in which stakeholders with differing viewpoints and interests work together to develop data and information, analyse facts and forecasts, develop common assumptions and informed opinion, finally, use the information they have developed to reach decisions together.	3.3 – 3.8
Common Agricultural Policy (CAP)	The Common Agricultural Policy (CAP) is the agricultural policy of the European Union. It is a set of laws adopted by the EU to provide a common, unified policy on agriculture.	3.7
Compacted soil	Densification and distortion in which total and air-filled porosity and permeability are reduced, strength is increased, soil structure partly destroyed and many changes are induced in the soil fabric and in various behaviour characteristics. Soil biological activity and soil productivity for agricultural and forest cropping is reduced and which results in a decreased water infiltration capacity and increased erosion risk.	3.8

	Note that the subsoil compaction is a hidden form of soil degradation that affects all the agricultural area and results in gradually decreasing yields and yield security and gradually increasing problems with waterlogging. Note that a reduced aeration of the soil matrix between vertical macropores increases the risk of anaerobic conditions. Denitrification of nitrate is one of the potential undesirable side effects, since it removes plant-available nitrogen from the soil and potentially adds to the atmospheric concentration of the potent GHG N_2O.	
Compaction	Changing the nature of the soil such that there is a decrease in the volume of voids between soil particles or aggregates; it is manifested as an increase in bulk density and a severely compacted soil can become significantly less permeable and less aerated. Manmade compaction is caused by poaching (trampling of animal hooves repeatedly) or by the passage of heavy machinery	3.8
Compost	The material used to supply organic matter or plant nutrients to a soil, resulting from composting.	3.7
Connectivity	The interdependence of hydrological processes with other elements of the landscape as soil, highlighting the strong relationship among them.	3.7
Conservation agriculture	A farming method including minimum soil disturbance (no tillage, minimum tillage, reduced tillage, strip tillage, direct drill), crop rotation, and permanent soil cover.	3.7
Contaminated site	Location where, as a result of human activity an unacceptable, hazard to human health and ecosystems exists. Local contamination (contaminated sites) is a problem in restricted areas (or sites) around the source, where there is a direct link to the source of contamination.	3.6
Contamination	Introduction into or onto water, air, soil or other media of microorganisms, chemicals, toxic substances, wastes, wastewater or other pollutants in a concentration that makes the medium unfit for its next intended use.	3.6
Contour ploughing	Ploughing in a direction that follows the contour, maintaining the same elevation.	3.7
Conventional tillage	Full width tillage that disturbs the entire soil surface which is generally performed prior to planting. It usually involves a primary operation by depth ploughing or chiselling (commonly to 20-30 cm depth), followed by secondary operation such as rotavating or harrowing that pulverizes, flattens, and firms the surface. Depending on climate and soil type, tillage may be the cause of compaction but may also help in improving soil structure through the mechanical destruction of compacted layers.	3.7 & 3.8
Co-solvent/ Surfactant flushing	These are two comparable in situ techniques using a different principal. Both techniques inject enriched water into the soil and extract groundwater with the mobilized contaminant. Co-solvent flushing: Injection of a fluid or mixture of fluids (mostly alcohol) to dissolve the pure product. The mixture of water, alcohol and the contaminant is now extracted. Surfactant flushing: Injection of a molecule with a water-soluble head and water insoluble tail which increases the solvability of contaminants in water. Because of the increased solvability, the contaminant can be pumped out of the soil via the water phase.	3.6
Cover crops	Cover crops, catch crops or green manures are normally grown between successive production crops to provide ground cover, to capture soil nutrients and to improve soil characteristics or benefit the following crop. Using deep rooting crops provides crop induced wetting and drying cycles that crack the soil and breaks up impermeable layers of soil by root penetration.	3.4 & 3.8
Crop residue	Crop residues can be defined as biomass remaining on the soil's surface after harvest. In some systems, linear increases in soil organic carbon stocks can be observed with increasing rates of residue addition.	3.4
Cultural ecosystem services	The non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience, including, e.g., knowledge systems, social relations, and aesthetic values.	3.7
Dam sedimentation	Deposition of material of varying size, both mineral and organic, away from its site of origin by the action of water, wind, gravity or ice. This sediment builds and steadily decreases the storage capacity of the reservoir. Ultimately all dams fill with sediment or are destroyed by natural floods.	3.3
Decontamination	The removing of chemical, biological, or radiological contamination from, or the neutralizing of it on a person, object, or area.	3.6
Deforestation	The removal of forest and undergrowth to increase the surface of arable land or to use the timber for construction or industrial purposes. Forest and its undergrowth possess a very high water-retaining capacity, inhibiting runoff of rainwater.	3.3

Degraded land	The result of human-induced actions which exploit land, causing its utility, biodiversity, soil fertility, and overall health to decline.	3.3
Demesnial water	A body of water that is owned and maintained by a national governmental body or agency.	3.3
Desertification	Degraded land in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic fluctuations and human activities.	3.3
Desertification control	Any remedial and preventive actions adopted against desertification including improved irrigation management, planting of trees and grasses, the erection of fences to secure sand dunes, and a careful management of water resources.	3.3
Diffuse pollution	Pollution from widespread activities with no one discrete source, e.g. acid rain, pesticides, urban run-off, etc.	3.6
Direct drill seeding	Planting crops in a non-inverted soil without seedbed preparation.	3.4
Drip irrigation	Drip irrigation is sometimes called trickle irrigation and involves dripping water onto the soil at very low rates from a system of small diameter plastic pipes fitted with outlets called emitters or drippers. Water is applied close to plants so that only part of the soil in which the roots grow is wetted, unlike surface and sprinkler irrigation, which involves wetting the whole soil profile.	3.7
Drought	A period of abnormally dry weather sufficiently prolonged so that the lack of water causes a serious hydrologic imbalance (such as crop damage, water supply shortage) in the affected area.	3.3
Ecological footprint	The only metric that compares the resource demand of individuals, governments, and businesses against Earth's capacity for biological regeneration. Ecological Footprint accounting measures the demand on and supply of nature. On the demand side, the Ecological Footprint adds up all the productive areas for which a population, a person or a product competes. It measures the ecological assets that a given population or product requires to produce the natural resources it consumes (including plant-based food and fiber products, livestock and fish products, timber and other forest products, space for urban infrastructure) and to absorb its waste, especially carbon emissions. The Ecological Footprint tracks the use of productive surface areas. Typically, these areas are: cropland, grazing land, fishing grounds, built-up land, forest area, and carbon demand on land. On the supply side, a city, state or nation’s biocapacity represents the productivity of its ecological assets (including cropland, grazing land, forest land, fishing grounds, and built-up land). These areas, especially if left unharvested, can also serve to absorb the waste we generate, especially our carbon emissions from burning fossil fuel. Both the Ecological Footprint and biocapacity are expressed in global hectares (gha).	3.9
Ecological risk	Risks posed by the presence of substances released to the environment by man, in theory, on all living organisms in the variety of ecosystems which make up the environment.	3.6
Ecosystem	A dynamic complex of plant, animal, and micro-organism communities and their non-living environment interacting as a functional unit.	3.2
Ecosystem services	Services provided and the benefits people derive from these services, both at the ecosystem and at the landscape scale, including public goods related to the wider ecosystem functioning and society well-being.	3.2
Edaphon	The community of soil organisms (microbes, fungi, nematodes, worms, insects, protozoa, etc.).	3.4
Electro-reclamation	Charged particles and ions are transported through the soil by an electrical field. The charged particles are moving towards the electrodes and are being removed by the electrode fluids which circulate around the electrodes. The use of alternating current heathens the soil which increases the availability of the contaminant. The biological activity can also be stimulated due to the heating.	3.6
Emerging contaminants / contaminants of concern	Chemicals that are not currently (or have been only recently) regulated by the environmental regulatory bodies and about which there are concerns regarding their impact on human or ecological health.	3.6
Enhanced natural attenuation (aerobic)	The principle of aerobic biological remediation is stimulation of the biological activity by improving the limiting factor for biological activity. Limiting factors for aerobic biological activity can be: lack of oxygen, the lack of nutrients or the lack	3.6

	of micro-organisms that degrade the contamination. The clue of this technology is to find out what is the limiting factor and subsequently improving this factor by injection, extraction, heating or a combination.	
Enhanced natural attenuation (anaerobic)	Natural soil bacteria can anaerobically degrade contaminants by biological processes. During the treatment of the soil, the soil conditions for the bacteria are improved by injecting substrate and nutrients. Also a bio screen can be applied. In the laboratory soil samples are examined to know how much the concentration of contaminants is decreased and how the biodegradation is proceeding. It is an anaerobic process which is very sensitive to redox conditions.	3.6
Environmental protection	Measures and controls to prevent damage and degradation of the environment, including the sustainability of its living resources.	3.3
Erosion	The wearing away of the land surface by water, wind, ice, gravity or other natural or anthropogenic agents that abrade, detach and remove soil particles or rock material from one point on the earth's surface, for deposition elsewhere, including gravitational creep and so-called tillage erosion.	3.7
Erosion vulnerability	The erosion vulnerability index is calculated by combining soil loss potential, the stream power index and internally drained areas. Areas with high soil loss and a high stream power index will have high erosion vulnerability. Areas that are internally draining are excluded from the vulnerability assessment.	3.3
EU Emissions trading system (ETS)	The EU ETS is a “cap and trade” scheme where a limit (the cap) is placed on the right to emit specified pollutants over a geographic area and companies can trade emission rights within that area.	3.4
EU Global footprint	EU’s Ecological Footprint compared to that of the world.	3.9
Explicit knowledge	Knowledge that can be expressed in words, numbers, and symbols and stored in books, computers, etc. Explicit knowledge can be articulated and easily communicated between individuals and organizations.	3.10
Fertilization	Application of mainly mineral compounds, in order to increase soil fertility. In some cases, (e.g. liming) the purpose of fertilization is also to improve specific soil properties (pH, stability of soil structure).	3.7
Field damage	A decline in the productivity of an area of land or in its ability to support natural ecosystems or types of agriculture. Degradation may be caused by a variety of factors, including inappropriate land management techniques, soil erosion, salinity, flooding, clearing, pests, pollution, climatic factors, or progressive urbanization.	3.3
Fire risk zone	Forest fire risk zones are areas more likely to start a fire, before spreading to other locations.	3.4
Flooding of low land	Inundation of land beside a watercourse, as a result of an excessive water table. This may incur addition of sediment onto the land surface as well as water.	3.3
Forest fire	Uncontrolled fire occurring in vegetation more than 1.8 metres in height. It spreads rapidly through the topmost branches of the trees before involving undergrowth or the forest floor.	3.3
Forest protection	Branch of forestry concerned with the prevention and control of damage to forests arising from the action of people or livestock, of pests and abiotic agents.	3.3
Forestry	Forest, afforestation, deforestation.	3.1
Gentle soil remediation options	Using plants, associated microbes and soil amendments may serve as an environmentally friendly and cost-efficient alternative.	3.6
Global hectares (gha)	Globally comparable, standardized hectares with world average productivity.	3.9
Grazing intensity	The cumulative effects grazing animals have on rangelands during a particular time period.	3.8
Green Manures	Non-harvested crop grown in between two main crop seasons, intended to improve the soil fertility, generally not growing under N limitation due to the use of fertilizers and manures, or the ability to fix atmospheric N, OR Young and succulent plant material turned into the soil to improve its organic matter and nutrient content.	3.4
Greenfields	A site, usually suburban or rural, that has never been used for development.	3.5
Groundwater dam	Structures that intercept or obstruct the natural flow of groundwater and provide storage for water underground.	3.3
Groundwater overexploitation	Groundwater is surface water which has filtered through permeable soils and rocks until stopped by impermeable layers below, being cleaned in the process. It accumulates as aquifers, which may be thousands and millions or years old and slowly seep to the surface as springs or flow underground and feed rivers and lakes. The depletion of groundwater in excess of its recharge rate leads to overexploitation.	3.3

Groundwater quality	Comprises the physical, chemical, and biological qualities of ground water. Temperature, turbidity, colour, taste, and odour make up the list of physical water quality parameters.	3.6
Gully	Channel resulting from erosion and caused by the concentrated but intermittent flow of water during and immediately following heavy rainfall; gullies are deep enough (usually >0.5 m) to interfere with, but not obliterated by, normal tillage operations.	3.7
Healthy (soils)	Having the continued capacity to support ecosystem services in line with the Sustainable Development Goals and the European Green Deal.	3.2
Humus	The well decomposed, amorphous, stable fraction of the organic matter in mineral soils with a low specific weight and high surface area; usually composed of many organic compounds of high molecular weight and dark colour. A term often used synonymously with soil organic matter. Humus is important for soil fertility, and helps to bind soil particles and aggregates together.	3.4
Hydrologic balance	An accounting of the inflow to, outflow from, and storage in a hydrologic unit such as a drainage basin, aquifer, soil zone, lake or reservoir; the relationship between evaporation, precipitation, runoff, and the change in water storage.	3.3
Implicit knowledge	Knowledge that you do not get from being taught, or from books, etc. but get from personal experience, for example when working in a particular organization (= same as tacit knowledge).	3.10
Industry	Commercial and industrial sites (factories, industrial halls), mine, contaminated land, recultivated areas.	3.1
Infiltration	The movement of water passing the soil surface into the soil (as contrasted with percolation, which is movement of water through soil layers moving down to the aquifers, or out to rivers).	3.7
Information	Processed, organized and structured data. It provides context for data and enables decision making process.	3.2
Inorganic carbon	Soil inorganic carbon mainly refers to the parent rock soil carbonate formed in the weathering process of silicate carbon, which has very high accumulation rate, and easily affected by atmosphere, water, rocks, etc, is the main form of soil carbon pool in arid and semi-arid region.	3.4
In-situ chemical oxidation	This technique inserts a strong oxidant into the soil. When the oxidant comes into contact with the pollution, it is broken down chemically (oxidized). This produces harmless compounds. The oxidator (for example ozone or Fenton's reagens) is produced in the right concentrations in a special unit and is injected into the soil by the use of filters. If the injection is discontinuous after the injection period, the filters are flushed with an acidic solution to prevent clogging.	3.6
In-situ Chemical reduction	In situ chemical reduction is based on the addition of reducing compounds to the soil. This technique is mostly applied as a permeable reactive barrier (PRB). The reducing compound commonly used is zero-valent iron (Fe0).	3.6
In-situ Metal Precipitation	The most applied in situ metal precipitation method is the stimulation of microbiological sulphate to sulphide conversion. The conversion takes place because of the addition of a carbon source and (if needed) nutrients to the soil. The sulphide being formed can fixate metals. There are also other methods which stimulate sorption, precipitation and cation exchange with the addition of certain compounds.	3.6
Intensive farming	A system of raising crops and animals, usually on small parcels of land, where a comparatively large amount of production inputs or labour are used per acre.	3.3
Interim / temporary land use	Interim, non-permanent use is a step-by-step regeneration approach to smoothen the transition from traditional to future use in a given area. It can buy more time to plan and realise new long-term use, meanwhile not "wasting" the land resource altogether. Interim uses specifically considered are those that in themselves may contribute to a more sustainable society and societal ambitions, such as production of biomass for sustainable energy, city farms and allotments, or the creation of outdoor amenities and open space for human well-being and health.	3.5
Know	Aware of the importance of soil and of how to achieve soil health.	3.10
Knowledge	Awareness, understanding, or information that has been obtained by experience or study, and that is either in a person's mind or possessed by people generally.	3.10
Knowledge transfer	Knowledge transfer is the sharing of knowledge, skills and technologies between research and enterprises for collective benefit.	3.10
Land	The ground, including the soil covering and any associated surface waters, over which ownership rights are enforced.	3.1
Land cover	Observed (bio)physical cover of the Earth's surface.	3.1

Land degradation neutrality	A state whereby the amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase within specified temporal and spatial scales and ecosystems.	3.3
Land recycling	The reuse of abandoned, vacant, or underused properties for redevelopment.	3.5
Land restoration	Reversing land degradation processes by applying soil amendments to enhance land resilience and restoring soil functions and ecosystem services.	3.6
Land suitability	Land suitability is the fitness of a given type of land for a defined use. The land may be considered in its present condition or after improvements.	3.3
Land take	The area of land that is “taken” by infrastructure itself and other facilities that necessarily go along with the infrastructure, such as filling stations on roads and railway stations.	3.5
Land-use	Arrangements, activities and inputs people undertake in a certain land cover type to maintain it or produce change.	3.1
Lighthouses (LH)	Places for demonstration of solutions, training and communication. They are best practice examples (technologies, cooperation, governance, trainings) that have already been developed and applied in practice.	3.3 – 3.8
Living labs (LL)	Spaces for co-innovation through participatory, transdisciplinary and systemic research	3.3 – 3.8
Loss of soil-biodiversity	The reduction of forms of life living in soils (both in terms of quantity and variety) and of related functions, causing a deterioration of one or more soil functions or ecosystem services.	3.3
Machinery	Equipment used for managing soil and biomass production as tractors, skidding machine or harvester (to minimize costs, progressively larger and more efficient machinery is used in the field).	3.8
Measure	Action aimed to achieve healthy soils.	3.2
Measurement, reporting, verification (MRV) System	The practice of “MRV,” which involves three processes of measurement or monitoring (M), reporting (R), and verification (V) to obtain a clear understanding of GHG emissions.	3.4
Measuring land take	Measuring the change in the area of agricultural, forest and other semi-natural land taken for urban and other artificial land development.	3.5
Measuring soil functions	Measuring the performance of the ecological processes (provided by soils) that result in the supply of ecosystem services (different indicators).	3.5
Megasite	Expression used for a large area with multiple contaminant sources related to (former) industrial activities, with a considerable impact on the environment, through groundwater, surface water and/or air migration. The dimensions of the area for which the megasite management strategy needs to be developed is determined by the sphere of influence of contaminant migration through these different pathways. In general these vary between 1-10 km.	3.6
Microplastics	Solid plastic particles <5 mm composed of mixtures of polymers and functional additives. They may also contain residual impurities. Microplastics can be unintentionally formed when larger pieces of plastic, like car tyres or synthetic textiles, wear and tear. But they are also deliberately manufactured and added to products for specific purposes, such as exfoliating beads in facial or body scrubs.	3.6
Monoculture	The growing of a single arable crop species on a field year after year, for at least 10 years.	3.4
Multi-Phase Extraction	Combines the extraction of groundwater and/or soil vapor and/or pure product. The extracted phases are separated aboveground where the phases are treated or discharged. Usually removing the floating layer and groundwater are meant by multiple-phase extraction or two-phase extraction.	3.6
Multi-species sward	Multi-species mixtures are a combination of diverse forage species with specific characteristics. An advantage of multi-species swards is the maintenance of a steady plant growth rate at reduced fertiliser application compared to grass only swards.	3.4
Nature	Natural and cultural heritage (National parks, archaeological sites, cemeteries).	3.1
Net land take	Changes of non-artificial areas into artificial areas, which are not compensated by the restoration of the same amount of artificial areas into non-artificial areas.	3.5
Nitrogen fixation	Conversion of molecular nitrogen (N_2) to ammonia and subsequently to organic nitrogen utilizable in biological processes.	3.4
No tillage (NT)	An agronomic practice in conservation agriculture (CA) for annual crops, and is defined as a way to farm without disturbing the soil through tillage. NT must leave at least 30% of area covered by plant residues right after crop establishment, and crops are sown using machinery which is able to place seeds through plant residues from previous crops. Also, in arid climates it enhances water retention in soils through decreasing evaporation losses from the soil surface which is usually enhanced by tillage involving soil invert.	3.4, 3.7 & 3.8

Organic farming	Agricultural production which typically places a higher emphasis on environmental and wildlife protection and, with regard to livestock production, on measures that are supposedly animal welfare friendly. Organic production aims at more holistic production management systems for crops and livestock, emphasizing on-farm management practices over off-farm inputs. This involves avoiding, or largely reducing, the use of synthetic chemicals such as inorganic fertilizers, pesticides, medicinal products, replacing them, wherever possible, with cultural, biological and mechanical methods. Organic producers explicitly aim to develop an allegedly healthier, fertile soil by growing and rotating a mixture of crops and using clover to fix nitrogen from the atmosphere. The production of genetically-modified (GM) crops and their use in animal feed is banned.	3.7
Organic fertiliser	Organic fertilisers are materials of animal origin used to maintain or improve plant nutrition and the physical and chemical properties and biological activity of soils, either separately or together, they may include manure, digestive tract content, compost and digestion residues.	3.4
Overgrazing	Intensive grazing by livestock that exceeds the environmental carrying capacity of a given piece of land. It can lead to impoverishment of the sward, dominance of certain unpalatable species, soil erosion, soil compaction and even a (complete) loss of vegetation.	3.3 & 3.8
Overshoot Day	Marks the date when humanity has exhausted nature's budget for the year. For the rest of the year, we are maintaining our ecological deficit by drawing down local resource stocks and accumulating carbon dioxide in the atmosphere. We are operating in overshoot.	3.9
Overtourism	Overtourism indicates the overcrowding of tourists at a holiday destination. When it comes to natural tourist destinations, tourism must respect flora, fauna, and microclimate. When the destination is a city, tourism must primarily respect residents, as well as local culture and archaeological sites	3.3
Paludiculture	The productive land use of wet and rewetted peatlands that preserves the peat soil and thereby minimizes CO_2 emissions and subsidence.	3.4
Pedoclimatic zones	Zones that are relatively homogeneous concerning climate and soil.	3.4
Permanent pasture	Land used permanently (five years or more) for herbaceous forage crops, either cultivated or growing wild (wild prairie or grazing land).	3.4
Permeable surfaces	Permeable surfaces reduce soil sealing and increase the water drainage capacity of surfaces. However, permeable surfaces cannot be considered as a soil protection measure, since all techniques require removal of the upper soil layer of at least 30 cm. In some cases, the original soil can be replaced to some extent, as in the case of gravel turf.	3.5
Point source	Stationary locations or fixed facilities from which pollutants are discharged.	3.6
Pollution	Direct or indirect introduction, as a result of human activity, of substances, vibrations, heat or noise into air, water or land which may be harmful to human health or the quality of the environment, result in damage to material property, or impair or interfere with amenities and other legitimate uses of the environment.	3.6
Population pressure	The sum of the factors (as increase in numbers or excessive food consumption) within a population that reduce the ability of an environment to support the population and that therefore tend to result in migration and expansion of range or in extinction or decline of the population.	3.3
Precision farming (precision agriculture)	A management strategy that utilizes site-specific information to precisely and economically manage and optimize production inputs.	3.7
Preferential flow	Water flow through macro-pores (e.g., cracks, root channels) in the unsaturated/ vadose zone.	3.7
Pressures	Release of substances (emissions), physical and biological agents, the use of resources and the use of land which impacts soil health.	3.2
Program of Measures	Set of actions aimed to achieve healthy soils.	3.2
Pump & Treat	Polluted groundwater is pumped to the surface where it is cleaned or discharged. Once the groundwater is cleaned, it can infiltrate the soil again. The extraction of groundwater can be performed in the horizontal or vertical direction with the use of drains driven by a vacuum pump or by gravitational flow.	3.6
Recalcitrance	Resistance to decomposition – humus is highly recalcitrant and therefore remains in soil for a long time.	3.4
Reduced tillage	A tillage without inversion at a reduced depth (about 30% crop residues remaining on the surface), with specific machines (often with grubber/cultivator), more than once a year.	3.7

Reduction of pressure on soils	Compaction depends on machinery tractor size/weight, on soil texture, and soil water content. Those characteristics need to be considered to reduce pressure on soils. Note that low tire inflation pressures it is possible to reduce the soil stresses, at least in the upper subsoil.	3.8
Remedial measures	Any action, or combination of actions, including mitigating or interim measures to restore, rehabilitate or replace damaged natural resources and/or impaired services, or to provide an equivalent alternative to those resources or services as foreseen in Annex II (of the Environmental Liability Directive).	3.6
Remediation	Actions aimed at the removal, control, containment or reduction of contaminants or exposure pathways so that the site, taking account of its current use or approved future use, no longer poses a significant risk to human health or the environment. Remediation actions may involve monitored natural recovery. It can be done onsite (in situ) or off site (ex-situ).	3.6
Remote sensing	The measurement or acquisition of information of some property of an object or phenomena, by a recording device that is not in physical or intimate contact with the object or phenomenon under study, e.g., the utilization at a distance.	3.4
Respiration rate	Soil respiration consists of heterotrophic respiration, mainly through the mineralization of soil organic C and decomposition of litters of leaves, branches and roots by soil microorganisms, and autotrophic respiration, generally via plant root and microbial respiration in the rhizosphere. Soil respiration has been generally considered to be the second greatest C exchange between the atmosphere and terrestrial ecosystem.	3.4
Science – policy interface	Science–policy interfaces are defined as social processes which encompass relations between scientists and other actors in the policy process, and which allow for exchanges, co-evolution, and joint construction of knowledge with the aim of enriching decision-making.	3.10
Sealed soils	Sealed soils can be defined as the destruction or covering of soils by buildings, constructions and layers of completely or partly impermeable artificial material (asphalt, concrete, etc.). It is the most intense form of land take and is essentially an irreversible process. Sealed land is a subset of the above mentioned category; i.e. land consumed by development of settlements, infrastructure, and commercial and industrial areas. An indicator of the intensity of land take is the proportion of the total built-up land area which is sealed.	3.5
Semi-arid land ecosystem	The interacting system of a biological community and its non-living environmental surroundings in regions that have between 10 to 20 inches of rainfall and are capable of sustaining some grasses and shrubs but not woodland.	3.3
Soft land use / reuse	Innovative strategies, techniques and appraisal methods to improve the value of brownfield regeneration into "soft re-use" (i.e. non-sealed land uses) on an interim or long-term basis.	3.5
Soil	Upper layer of the earth in which plants grow.	3.1
Soil biodiversity	Variability among living organisms on the earth, including the variability within and between species, and within and between ecosystems. This is also often used as the number and variety of organisms found within a specified geographic region. Soil biodiversity may be measured and monitored by collecting soil samples and extracting soil animals (or DNA) to identify the different groups of organisms. It is also possible to monitor biological activities (e.g. enzymatic measurements, organic matter degradation).	3.8
Soil carbon flux	The movement of any material from one place to another is called a flux. We typically think of a carbon flux as a transfer of carbon from one pool to another.	3.4
Soil habitat	Ability of soil/soil materials to serve as a habitat for micro-organisms, plants, soil living animals, and their interactions (biocenosis).	3.8
Soil leaching	Removal of soluble materials from one zone in soil to another via water downward movement in the profile.	3.4
Soil literacy	The state of knowing about or being familiar with soil. It concerns both a popular awareness about the importance of soil, and specialised and practice-oriented knowledge related to achieving soil health.	3.10
Soil Management	The application of measures to achieve healthy soils.	3.2
Soil Management Strategy	Sets out how users (stakeholders) will work together to achieve healthy soils.	3.2
Soil moisture deficit	This indicator shows the annual deviation in soil moisture content of each 500-m grid cell from the long-term (1995-2019) average. Negative soil moisture anomalies indicate that the annual average availability of soil moisture to plants drops to such a level that it has the potential to affect terrestrial vegetation and, hence, cause persistent changes in ecosystem condition. Negative long-term averages	3.3

	and negative trends in the annual data indicate increasing pressures on vegetation and ecosystems, and thus represent a climatic driver that should be considered in EU nature restoration plans. Therefore, the indicator can inform policy action on ecosystem restoration in the EU but also on adaptation to climate change.	
Soil Organic Carbon (SOC) sequestration potential	The potential of soils to absorb carbon. This can be increased through conservational agricultural practices.	3.4
Soil organic carbon content	Soil organic carbon, the major component of soil organic matter, is extremely important in all soil processes. Organic material in the soil is essentially derived from residual plant and animal material, synthesised by microbes and decomposed under the influence of temperature, moisture and ambient soil conditions. The annual rate of loss of organic matter can vary greatly, depending on cultivation practices, the type of plant/crop cover, drainage status of the soil and weather conditions. There are two groups of factors that influence inherent organic matter content: natural factors (climate, soil parent material, land cover and/or vegetation and topography), and human-induced factors (land use, management and degradation).	3.3
Soil organic matter	The organic fraction of the soil exclusive of undecayed plant and animal residues.	3.4
Soil poaching	Soil that has been broken down under the weight of animals. It causes direct physical damage to the crop and the soil, leading to bare patches, there is also an increased risk of erosion, leaching and invasive weeds.	3.4
Soil porosity	Volume of pores in a soil sample (non-solid volume) divided by the bulk volume of the sample. Monitoring/measuring soil porosity can inform on the state of soil compaction.	3.8
Soil profile	A column of soil extending through all its horizons and into the parent material and large enough to be used to characterise the soil condition at a particular place.	3.4
Soil quality	The capacity of a soil to function for specific land uses or within ecosystem boundaries. This capacity is an inherent characteristic of a soil and varies from soil to soil. Such indicators as organic-matter content, salinity, tilth, compaction, available nutrients, and rooting depth help measure the health or condition of the soil-its quality-in any given place.	3.6
Soil resilience	The capacity of a soil to recover its functional capacity after a disturbance.	3.7
Soil restoration	Soil restoration refers to actions to regenerate natural soil cycles through revegetation with shrub and creeper species, reforestation with native arboreal species and containment work with stakes. The aim is to stabilize the soil and increase the supply of organic matter, which promotes restoration.	3.3
Soil salinization	Salt-affected soils consist of saline and sodic soils, occur in all continents and under almost all climatic conditions, but their distribution is relatively more extensive in the arid and semi-arid regions compared to the humid regions. Soil salinization is a major process of land degradation that decreases soil fertility and is a significant component of desertification processes in the world's drylands.	3.3
Soil structure	Arrangement of particles and organic matter to form aggregates which produce macro structures and micro structures in the soil.	3.8
Soil vapor extraction	Refreshes the soil vapor in the unsaturated zone by lowering the atmospheric pressure. This causes vaporization of the contaminant which is extracted from the soil. The extracted soil vapor is cleaned with the use of an activated carbon filter, biofilter or catalyst. Soil Vapor Extraction also causes an increase of the oxygen level which stimulates natural attenuation (bioventing). Lowering the concentration of the contaminant in the vapor phase causes a new equilibrium between the vapor phase and the soil. Therefore, the concentration in the soil decreases too.	3.6
Soil water availability	Soil water availability is the capacity of a soil to hold water that is available for plant use.	3.3
Source-Pathway-Receptor (SPR)	Causal chain linking the origin of a hazard or pressure (e.g. an identified or estimated loading of a polluting substance) along an environmental pathway to consequences for human health or the environment (using concepts such as vulnerability, exposure and impact assessment). It should also provide some assessment of the probability of, and confidence in, such a forecast.	3.6
Species diversity	The number and variety of species found in a given area in a region.	3.4
Steam Injection	Heathens up the soil including the capillary zone, floating layer and groundwater. Because of the heating the mobility of the contaminant will increase as well as the evaporation and the concentration of the dissolved contaminant. With the	3.6

	use of extraction filters the phase mixture (steam, vapor, pure product and water) is extracted from the soil and treated aboveground.	
Strip cropping	Growing crops in strips that follow the contour line. Strips of grass or close-growing crops alternate with strips of clean-tilled crops or summer fallow.	3.7
Strip tillage	The process in which only a narrow strip of land needed for the crop row is tilled.	3.4
Surface runoff	The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called groundwater runoff or seepage flow from groundwater.	3.3 & 3.7
Sustainable agriculture	Use for the practice of agriculture which supports sustained economic profitability, sustained quality and well-being of the environment, efficient use of natural resources, and the overall quality and availability of food and fibre for mankind.	3.3
Sustainable land management	The use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions.	3.7
Sustainable soil management	Soil management is sustainable if the supporting, provisioning, regulating, and cultural services provided by soil are maintained or enhanced without significantly impairing either the soil functions that enable those services or biodiversity.	3.8
Tacit knowledge	Knowledge that you do not get from being taught, or from books, etc. but get from personal experience, for example when working in a particular organization (= same as implicit knowledge).	3.10
Terracing	Terracing is an agricultural practice that suggests rearranging farmlands or turning hills into farmlands by constructing specific ridged platforms. These platforms are called terraces which stop erosion and contribute to soil and water conservation.	3.3
Touristic activity management	The administration, promotion, organization and planning for the business or industry of providing information, transportation, entertainment, accommodations and other services to travellers or visitors.	3.3
Urban	Cities, parks, urban ecosystem, household and wastewater treatment.	3.1
Urban organic waste	These wastes include sewage, wastewater and vegetable waste.	3.4
Users (stakeholders)	Those who are affected in their interest or concern by changes in soil and land management.	3.2
Uses with a heavy environmental impact	Socioeconomic use of land with a heavy environmental impact including mining and quarrying; energy production; industry; water and waste treatment; and construction.	3.6
Vulnerable area	Area that is subject to threatening processes and is likely to become endangered unless the threatening factors cease to operate.	3.3
Water desalinization	Any mechanical procedure or process where some, or all, of the salt is removed from water.	3.3
Water governance	The range of political, organizational and administrative processes through which communities articulate their interests, their input is absorbed, decisions are made and implemented, and decision makers are held accountable in the development and management of water resources and delivery of water services at different levels of society.	3.3
Water management	The way in which water availability (irrigation; water harvesting) and discharge (drainage) is regulated.	3.7
Water policy	Collection of legislation, legal interpretations, governmental decisions, agency rules and regulations, and cultural responses which guide a country's actions concerning the quantity and quality of water.	3.3
Water transfer	Artificial conveyance of water from one area to another one.	3.3
Wetland protection	Areas that are inundated by surface or ground water with frequency sufficient to support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth or reproduction.	3.3
Wind erosion	Wind erosion is a natural process that moves soil from one location to another by wind power. It can cause significant economic and environmental damage.	3.3

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