SocEnv
Society for the Environment

Soils and Stones Report

Sustaining Our Future by Influencing Change in the UK and Beyond

SocEnv Soils and Stones Task Group

socenv.org.uk

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About Society for the Environment:

Society for the Environment (SocEnv) are an umbrella body tasked with championing and registering the expertise of environmental professionals. SocEnv are the custodian of the Chartered Environmentalist (CEnv), Registered Environmental Practitioner (REnvP) and Registered Environmental Technician (REnvTech) registers.

Working as a partnership with 24 Member Bodies, we ensure the quality, relevance and awareness of our registrations and enable our partners and registrants to work together. We are in a unique position, bringing together a range of disciplines and sectors to reflect the multi-disciplinary practice of environmental professionals.

Find out more via our website: socenv.org.uk

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UK Soils

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This report is the result of a joint effort of staff from the Society for the Environment (SocEnv) and Chartered Environmentalists from several of the SocEnv Licensed Members, each contributing to the content and presentation.

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Foreword

I am delighted and honoured to introduce to you our Soils and Stones report, the product of voluntary cross-sector collaboration of professionals enabling sustainable action in their everyday work.

This report reinforces the importance of soils and stones as essential to our everyday lives and the health of our planet, identifying the issues that currently hamper the work of environmental professionals in developing and applying good practices. Such practices are necessary to address soil quality and health issues, unlocking the opportunities to implement at scale the necessary and urgent action for change.

We highlight the need to achieve a marked shift towards recognition of soils and stones as valuable resources and materials, rather than to be discarded as waste or mistreated. Added to that is the requirement for better regulation and guidance, supported by monitoring and enforcement to ensure consistent adoption of good practices. To achieve the scale of change required, we must facilitate greater cross-sector collaboration, ensuring improved access to knowledge platforms, existing online tools, and shared good practice.

The report provides a limited but illustrative resource, with web links to regulations, guidance, standards, case studies, best practice, tools, data sources and supporting reference sources. Our Call for Action sets out thirty-two key action points, each linked to nine associated UN Sustainable Development Goals, with many more supporting actions within the report. These are intended to influence and assist multisector Chartered Environmentalist (CEnv) led assessments and advice, ensuring compliant services, and supporting the adoption of good practices for their employers and clients. We would advocate collaboration between sectors and professions to this end. Key actions include the use of carbon intensity and sequestration criteria in the land-use planning system, in order to provide long-term security to the government's largest natural carbon store and resource for biodiversity.

If we are to tackle the Climate and Environmental Emergencies in front of us, we must achieve these changes – and urgently. 2021 is a crucial year for the UK and beyond, with the eyes of the world on Glasgow for the UN Climate Change Conference (COP26), and the UK must also deliver swiftly on its environmental commitments, among them The Ten Point Plan for a Green Industrial Revolution and Defra's Twenty-Five Year Plan. Now is the time to Build Back Better, with soils and stones at the centre of this transformation.

Dr Emma Wilcox
Chief Executive, Society for the Environment

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Executive Summary

According to the United Nations Convention to Combat Desertification[1], "Every 5 seconds the equivalent of one football field of soil is eroded, it can take up to 1,000 years to produce 2 to 3 cm of soil with over 33% of the earth's soil already degraded". Soils and stones are **essential** as topsoil for **food production** and as **materials** used in industry, agriculture, and land-use developments. The challenges in sustainably managing these resources and habitats of the biodiverse flora and fauna species that rely on the land are stark. **Action to provide protection** of these resources from poor human practices and the increasingly extreme impacts of climate change **is needed urgently**.

As an umbrella body, Society for the Environment (SocEnv) is a partnership of 24 professional bodies from across a wide range of sectors. This makes SocEnv excellently placed to facilitate cross-sector collaboration and, in August 2019, SocEnv sought to establish a specialist task group composed of interested Chartered Environmentalists (CEnvs) from working professionals and members of SocEnv Licensed Members to report on these issues.

The task group provided **focus by sharing experiences and developing consensus** on common risks, issues and opportunities. Bringing together environmental professionals from sectors including engineering, construction, forestry, and agricultural management, the group was tasked with producing a report within an 18-month time frame, enabling fellow professionals to take on these challenges by **identifying links to guidance and resources** that could aid the development and **improvement of best environmental practice** for those working with soil and stones in the UK and beyond.

The task group was split into four sub-groups, made up of volunteer members and led by a Chairperson, to take on four identified themes:

- Engineering, Construction and Landscaping
- Land Management: Agriculture, Forestry and Conservation
- Healthy Soils, Natural Capital, and Carbon Management
- Climate Change and Soil Water Dynamics.

The report was developed through online periodic meetings of the sub-group Chairs and from time-to-time subgroup and full group meetings, reaching a first draft in December 2020. This was followed by a pre-publication review by identified key stakeholders, leading to approval by the SocEnv Board and online publication in April 2021. **The report provides a limited but illustrative resource** supported by 101 footnotes with mainly active web links to regulations, guidance, standards, case studies, best practice, tools, and data sources as well as open access links to many of the 54 supporting reference sources. **32 key action points linked to United Nations (UN) Sustainable Development Goals,** with many more in the themed sections, **are provided.** These are **intended to influence and assist** multisector CEnv-led assessments and advice in providing compliant services and supporting the adoption of best practices for their employers and clients.

[1] See: https://twitter.com/i/status/1334905210016292866 Viewed 4/12/2020

A debate initiated from the words of **former UK Environment Secretary Michael Gove in 2017**, on the loss of soil fertility in the UK within the next 30 to 40 years, provided an **initial focus on intensive farming, changing land use, adopting best practices**, maintaining healthy soils, and improving habitat protections, and increasing soil biodiversity.

One of the many outcomes of this discussion relates to **professionals being exposed to decisions** on land-use changes that may represent **unpalatable future choices**, perhaps between food production and biomass cultivation. This may require a **predetermined hierarchy of land-use** classification based on soil type, quality, and health, with preference for planning approval given to the most sustainable options. **Soil quality and soil health baselines** should be developed for a range of land-use criteria for the management of soil, against which soil remediation, restoration and conservation practices can be measured, targeted, and monitored.

Reducing pressure on land and water use, the **emerging technology of hydroponics**, a system of growing food without soil with other emerging non-soil food production technologies, may in the future provide a **strategic food contingency** that would in a limited way reduce the UK's dependency on imported supplies and free up land for other uses, such as **biodiversity gains**.

Changes made to the land-use classification system should also be employed for the **mandatory protection** and maintenance of wetlands, **degraded peatlands** and forestry representing the **UK's largest natural carbon storage** opportunity and biodiversity protection programme. Furthermore, it was decided that all land-use needs to be assessed by adopting the joint principle of **decreasing land carbon intensity** and **increasing the sequestration** contribution to all land-use development, aiming to increase and make effective future **natural UK carbon storage capacity.**

Building off the **successful construction consolidation centre business model** tested at the London Construction Consolidation Centre, Chartered Environmentalists are likely to be involved with work to develop this supply chain model within regional hubs to **significantly increase the reuse and recycling** of soil and stones, working with and extending the **CL:AIRE DoWCoP approach** with a data management, tracking and logistics platform. This will enable demonstratable **compliance for self-regulation**, increasing efficiency and decreasing costs. It was recognised that inter-sector inconsistencies in **waste classification, regulation and 'End of Waste' criteria** needed to be harmonised, enabling seamless implementation across all sectors.

Across all themes and sectors, there was a consensus that **digital platforms provide** valuable support to share and collaborate on areas of mutual interest for soil. Four were highlighted:

1. A **soils platform** sharing information to enable collaboration in areas of mutual interest.
2. An **extended DoWCoP platform** for self-regulation for compliant operators.
3. A **platform to monitor land use and land-use changes** in relation to soil health, carbon intensity and sequestration.
4. A **platform to support agricultural crop selection and irrigation** based on international best practice, particularly in increasingly drought-prone areas.

This report sets out to influence **urgent policy and practical action** in relation to soil and stones issues that need and can be taken now within a time frame of 1 to 3 years. This will support the UK Government's **Ten Point Plan for a Green industrial Revolution** and Defra's 25 Year Plan, fundamentally underpinning and supporting **the UK's position to COP26** in 2021. SocEnv has a pivotal role in coordinating response and reiteration of the objectives set out by CEnv professionals from all sectors represented in the task group. In addition to this report, SocEnv believes good practice is vital – but it must be recognised that there is a lot of excellent information, advice, and guidance already out there, yet awareness of these resources needs to improve.

A greater involvement between soil scientists and the construction sector has the potential to improve project sustainability, and the diverse SocEnv registrant base has the potential to deliver this relationship. Therefore, we will:

- **Collaborate and partner with organisations** to raise profile for soils and stones protection, supporting the UKSoils Platform (see: https://uksoils.org/) launched on World Soils Day 2020 to signpost knowledge and like-minded bodies.
- **Secure and coordinate resources** to enable us to support our Licensed Members and Chartered Environmentalists in fostering training and education that reflects best practice, including informing and influencing school curricula, skills training, university courses, research, standards, and tools – linking environmental professional practice with education.

Strawberries grown in polytunnels, occupying agricultural land perhaps unnecessarily?
(Photo: ©Robert Earl)

Introduction

Soils and stones are the fundamental building blocks for the built environment and natural environmental cycles – carbon, nitrogen, water; we all rely on soil structures to capture, retain, and return elements to sustain our lives. Soil is the plaything for children in learning, the essential ingredient for gardeners and our food producers, as well as rich habitat for nature, the soil type forging each ecosystem. **How we use and care for soil dictates our future**. Soil is created over many thousands of years to become established as topsoil[2] and in geological eons to form stones and subsoils; but both can be **destroyed in a moment's indiscipline,** poor practice or gradually through persistent and unintended action. **Science is pre-warning us of urgent challenges** we need to face as the global climate warms, accelerating damage to this precious resource.

Common standards and good practice within agriculture, land development, engineering, and management, including timber or stone resources, estate management and recreational uses exist, but can be **inconsistently applied**. Each face similar challenges, **risks and liabilities** that impact on themselves and each other. Collaboration based on the **common opportunities between each sector** is often limited and discrete, **preventing coordinated action** needed to provide scale, with a dim spotlight on soils and stones. This can be **taken for granted or considered too complex** to address, or too great a challenge to bring together stakeholders with the necessary resources to make sustainable change.

These sectors employ or contract the services of **Chartered Environmentalists** of the 24 SocEnv Licensed Members that are focused on improving environmental standards and best practice. **SocEnv acts as a professional umbrella**, representing sectors across the environmental profession, with connections to associated organisations with mutual interests.

Origin and Consensus of Purpose

Building on feedback from Chartered Environmentalists with working experience in agricultural, wastewater and construction development roles, **SocEnv recognised the challenges** relating to soils and stones issues in early 2019 and was committing to determining if there were common liabilities across the disciplines of the environmental profession. In November 2019, the SocEnv Board accepted the proposal of a Soils and Stones task group, authorising consent for an invitation to be made to CEnvs to join the task group. Many CEnvs volunteered and met in December 2019 to share concerns of risk, issues, and opportunities.

SocEnv was accepted as the ideal facilitator for this group, given the professional, cross-sector expertise that was required. In order to achieve its aims, the task group was set up to report on these issues in a 12–18 month time frame, chaired by Martin Ballard CEnv of Willmott Dixon.

The first meeting facilitated a consensus on the common perspectives, identifying **key opportunities and challenges faced by professionals** working with soil and stones across sectors. Scientific knowledge, monitoring and custodial guardianship is considered to remain disparate, with the prime but limited focus of soil care for farming or specialist groups. Whilst there is an extensive range of air

[2] See: https://twitter.com/i/status/1334905210016292866

and water legislation, **dislocated regulation and exemption for use of soils and stone** has evolved by activity, rather than within an agreed framework for its protection from use between sectors.

There is a consensus of the need for people to see **soil and stones as a resource** and not as a waste. Important sub areas **that need to be addressed** include **biodiversity** on and within soil, **soil health** (recognised within both the Agriculture and Environment Bills), **resources** and the **circular economy,** for careful custodianship and sustainable reuse. Significantly, the overlap of **common issues and opportunities between sectors** was recognised, within **a disparate regulatory structure.** Key opportunities to achieve this shift were considered, including:

- **Positioning of soil & stones:** Develop a harmonised stakeholder and sector approach to accessible guidance with clear definitions and better language that avoids dismissive terminology, such as 'muck away' or 'dirt', as opposed to recognition of soil and stone as a valuable and reusable resource.
- **Monitoring & Enforcement**: Review policy and legislative framework to gain cross-sector alignment and regulatory review, and to use digital tracking and monitoring.
- **Good Practice:** Make Codes and Protocols, such as the Definition of Waste Code of Practice (DoWCoP), more understandable and consistent across all sectors, alongside professional training, and competence for all management roles, with clearer responsibilities between sectors and across value chains.

Building Perspective for Common Risks and Opportunities

From consensus, the task group built on the perspective of how to improve soil and stone management across sectors, reflecting on positions presented by regulators, planners, land users, material reuse auditors, remediation contractors and consultants: the need to **collaborate** and **share good practice**, to **create better understanding**, and help professionals better to protect soil and stones. It was envisaged that the report outcomes would be led by **professional calls for action to policymakers, regulators, researchers and peers,** by summarising known issues and opportunities which include:

- **The need for good materials tracking** – this is not evident at the moment and good practice is essential to standard success. Industry and regulators need to work together, better understand risk, and overcome the resource challenge. Particularly important are the roles of development industry, remediation and earthworks contractors, and the soils treatment industry, to protect soil quality and manage reuse between built and natural environs.
- **Recognising limited inert landfill capacity** – there is a need for planning policy to recognise this where regional volume of infrastructure and built environment spatial needs are identified, with the onus on creating space for recycling and reusing inert waste and managing excavated soils and stones as materials rather than waste. In addition, there needs to be a priority on restoring mineral workings and managing tensions for municipal wastes and material recovery, including for soil/stones.
- **An auditing process for soil and stone reuse –** this is needed across all sectors, with due rigour and regulatory assurance, as well as consistency of standards, discipline and action if needed.
- **Addressing confusion over the number of regulations and guidelines** that apply (e.g., environmental permitting; HM Revenue and Customs (HMRC) tax rules; contaminated land

legislation; industry best practice; exemptions, etc.), with inevitable challenges for contractors, including potential misclassification of waste or multiple deployment of exemptions in/between sectors.

- **Soil fertility and health** – the importance of having broad focus and relative consideration of soil fertility, soil loss, and the potential that soil offers to tackle climate change (carbon sink, mitigation, or impact from weather extremes), given the interrelated challenges between sectors/biomes.

The overriding concern expressed by the professionals and sectors represented was for a better recognition of soil and stones and the urgency to take action by protecting soils within a 1–3-year time frame. This could only be achieved by influencing necessary legislative and practical collaborative action, to deliver meaningful change and address key climate change impacts. To assess these issues, the task group focused on four identified sub-themes:

- Engineering, Construction and Landscaping
- Land Management: Agriculture, Forestry and Conservation
- Healthy Soils, Natural Capital and Carbon Management
- Climate Change and Soil Water Dynamics.

The purpose of this report is therefore to recognise these risks and opportunities, identified by CEnvs from across sectors, with urgency of action to protect and improve the quality of soils and stones needed for food production, landscape, habitat and engineering resource. The report's aim is to provide the 'Calls to Action' from each theme that, with cross-sector and disciplined collaboration, will bring consistent practice and appreciation. The intended audience is those in policy leadership, those sectors with direct or indirect impact on or from soil and stone quality, as well as other professionals, organisations, and groups with an interest in soils and stones, in the UK and beyond.

Zero tillage in a Controlled Traffic Farming system *(Photo: ©Vaughan Redfern)*

Engineering, Construction and Landscaping

Construction minerals are made up of aggregates, brick clay and extracted raw materials used in cement production. UK aggregates are sourced from crushed rock, sand, and gravel from land-and marine-dredging activities. Extraction can disturb or displace the overlying soil profile (topsoil and subsoil) which can damage the soil and habitats if poorly managed or lead to the loss of the soil as a resource. In 2017, 66% of primary aggregates were produced in England, 14% in Scotland, 12% in Northern Ireland and 8% in Wales. Licensed dredging of UK waters managed by The Crown Estates[3] covered 1,057 km^2 of which 91 km^2 was used, with 90% of the extraction effort in an area of 38 km^2.

However, only about 40% of the global infrastructure necessary to support urbanisation and an expected 10 billion people by 2050 exists. This will affect UK and international supply chains with increasing demand for stone and soils. Global housing and infrastructure development constitute 44% of the current 82.1 (26.7 in 1970) billion tonnes of materials extracted in 2015, with only 9.1% recycled (UNEP 2019).

The UK aggregates industry in 2018 produced 180 million tonnes of primary aggregates made up of crushed rock, sand and gravel. Industry has adopted sustainable practice over the previous decade, making use of 72 million tonnes of recycled and secondary aggregates. Industrial minerals extracted include gypsum used to make plaster board (1.2 million tonnes in 2017), industrial and agricultural carbonates (9 million tonnes in 2014), Silica sands essential for glass making, industrial and horticultural applications (4.5 million tonnes in 2017), potash with 90% used in agricultural fertilisers (215,000 tonnes in 2017) and tungsten (although not currently mined, Devon has 10% of the world's tungsten reserves)[4].

To address future urbanisation and growth challenges and improve best practice, environmental professionals need to provide advice in making greater use of recycled soil and stones and in reducing extraction of minerals from the land. As soil and subsoils are often removed in the land clearance stage of development and construction projects, they are treated as waste, despite options for reuse in civil engineering applications used to prepare the land or for providing an amenity option with landscaping features.

Developing Frameworks for Action

The activities within these sectors may simultaneously present soil and stones, either as a valuable resource or a problematic waste. To address this dichotomy, a working group composed of regulators and representatives from these industry sectors has developed the necessary regulations, supported by working practices and guidance documents, to enable the beneficial reuse of the waste as a resource and compliant disposal where waste is above permitted contaminant levels. The focus of this working group was to identify:

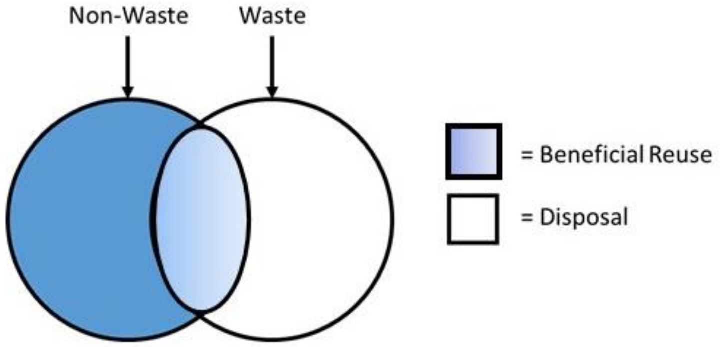
- The existing pitfalls or disadvantages of the current system(s).
- Working practices that are effective and where working practices have been accepted or adopted.

[3] See: https://www.gov.uk/government/publications/extractive-industries-transparency-initiative-payments-report-2018/mining-and-quarrying-in-the-uk Viewed 20/11/2020

[4] See: Footnote 2.

- Simplifications or improvements that could be made.

So, what are the existing options for beneficial use or compliant disposal of soil and stones? The infographic below illustrates the overlap where soil and stones may be either waste or non-waste, indicating how much of this could be beneficially reused:



Graphic: Joe Jackson

Disposal of (Waste) Soil and Stones

The legislative framework governing the suitable classification and disposal of soil and stones is provided by the Waste Regulations[5], with similar regulations in the devolved regions of Scotland and Northern Ireland. The classification of soil and stones is a detailed process beyond the scope of this document, but very usefully summarised by the Association of Geotechnical and Geo-environmental Specialists (AGS) in their 'Waste Classification for Soils – A Practitioners Guide'[6]. The output of these assessments identifies waste soil and stones as either Hazardous or Non-Hazardous[7]. Suitable receiving facilities must be appropriately permitted (or exempt) to receive the waste soil and stones as set out in the Environmental Permitting Regulations[8]. The Civil Engineering Contractor Association (CECA) also produce a waste soil classification and permitting guide[9]. The receiving facilities may be either a treatment, transfer, or disposal facility. A further complication to disposal lies in the classification of active and inactive waste, which qualify for a higher or lower landfill tax rate applied by HMRC. Inactive waste is defined in the Landfill Tax (Qualifying Material) Order 2011 (SI 2011 No 1017) as amended, which includes stones and materials such as concrete and ceramics[10].

[5] See: The Waste (England and Wales) (Amendment) Regulations 2012. Viewed 17/11/2020 at https://www.legislation.gov.uk/uksi/2012/1889/contents/made

[6] See: Association of Geotechnical and Geo-environmental Specialists 'Waste Classification for Soils – A Practitioners Guide, 2019. Viewed 17/11/2020 at https://www.ags.org.uk/item/ags-guidance-on-waste-classification-for-soils-a-practitioners-guide/

[7] Some Non-Hazardous soil and stones may be suitable for disposal at a landfill as inert waste, subject to meeting the appropriate waste acceptance criteria, however 'Inert' waste is not a third category of waste under the Waste Framework Directive.

[8] See: The Environmental Permitting (England and Wales) Regulations 2016. Viewed 17/11/2020 at https://www.legislation.gov.uk/uksi/2016/1154/contents/made

[9] See: https://www.ceca.co.uk/wp-content/uploads/legacy-media/300067/ceca-waste-classification-and-permitting-in-construction-february-2018.pdf Viewed 25/1/2021

[10] See: Excise Notice LFT1: a general guide to Landfill Tax - GOV.UK (www.gov.uk) Viewed 7/12/2020

Anything that is not included in this definition is active waste, which can include non-hazardous soil and stone wastes, and is charged at the higher rate. Additionally, cover material such as topsoil, fines, and grits, separated at waste treatment facilities, that are used to protect the outer layers of waste prior to clay capping of a landfill, no longer benefit from the lower landfill tax rate, having previously been defined as engineering material.

Beneficial Reuse of (Waste and Non-Waste) Soil and Stones

Beneficial reuse is an aspect of physical site reuse regulated under pertinent permit or exemption conditions. The key criteria for beneficial reuse of soil and stones are described in *Table 1* below:

Table 1: Beneficial reuse of soil and site conditions

Reuse Mechanism	Site of Reuse	Off-Site Recycling Soil and Stones
Unrestricted use of Non-Waste or 'Product'	No restrictions or requirements.	Must have met 'End of Waste' i.e. Quality Protocol or similar.
DoWCoP (v2) Materials Management Plan[11]	Must have a proven need for the soils and stones. Must be suitable to receive the soil and stones on a risk-assessment basis.	Must have an identified use at the point of production. Excluded as a material requiring a permitted activity[12]. Must be suitable for use on a risk-assessment basis and not introduce new contaminants to the site.
U1 Exemption[13]	Applied once at any specific site only relating to a specific use at that site of reuse.	Applies to limited tonnages of waste soil and stones (specific European List of Waste (LoW)[14] codes only).
Recovery / Landspreading Permits[15]	Must hold a suitable Permit.	Waste soil and stones. Specific LoW codes and subject to import criteria.
Regulatory Position Statement 190[16]	Applied once at any specific site only relating to a specific use at that site of reuse.	Must be certified Topsoil.
Regulatory position statement (exceptional agreement with EA)	Possible in unique scenarios. Allows a risk-based and 'public interest' approach.	

[11] See: https://www.claire.co.uk/projects-and-initiatives/dow-cop/28-framework-and-guidance/111-dow-cop-main-document Viewed 17/11/2020
[12] Unless part of a 'Hub and Cluster' whereby the soil and stones may travel as a waste to a permitted treatment facility beyond which they may become a non-waste and reused under DoWCoP.
[13] See: https://www.gov.uk/guidance/u1-waste-exemption-use-of-waste-in-construction Viewed 13/11/2020
[14] See: The List of Wastes (England) Regulations 2005 at https://www.legislation.gov.uk/uksi/2005/895/contents/made Viewed 15/11/2020
[15] See: https://www.gov.uk/guidance/waste-recovery-plans-and-permits Viewed 15/11/2020
[16] See: https://www.gov.uk/government/publications/use-of-manufactured-topsoil-rps-190/use-of-manufactured-topsoil-rps-190 Viewed 15/11/2020

The Institute of Environmental Management and Assessment (IEMA), in guidance to be published and distributed to their membership, define "t*ypes of land use change as "hard" or "soft" development, depending on the degree to which soils are displaced and whether they can be retained for beneficial uses on-site".* This is where it is necessary to apply the distinction more fully between "land" and "soil" at construction sites, and not just in respect of the restoration of surface mineral sites. Whereas land can be lost, the soils displaced both temporarily and permanently must be conserved to achieve sustainable development. Where soils are permanently displaced by hard development, a beneficial use should be found for these soils and where such soils are re-used for soft development, the soils must be able to support the proposed soft use.

What Are the Existing Pitfalls or Disadvantages of the Current System(s)?

For the day-to-day management of soil and stones the CL:AIRE DoWCoP system is a particularly useful tool; however, it has its drawbacks due to:

- No mandated central database of donors and receivers
- Whilst suitable for large scale projects, it may be overly complex for 'mid-sized' projects (say 1,000 to 10,000 tonnes)
- Regulators, Consultants and Qualified Persons have a highly inconsistent approach to Material Management Plans (MMPs) with regard to suitability, production, sign-off and a wide-ranging fee basis
- It is a form of 'self-regulation', and due to a lack of resources there is no suitable deterrent from the regulator to ensure compliance.

Other anomalies arise. Often the layperson's expectation is that topsoil should be excavated, transported, and reused without regulation. The existing rules do not allow this; furthermore, waste topsoil cannot be disposed to landfill without treatment or attracting the higher rate of landfill tax.

Lack of soil framework across different sectors

Management of soil and stones touches upon the Waste Regulations (for disposal or 'End of Waste' where the material is no longer waste and can be used freely in the supply chain). Contaminated Land Regulations are defined as high-, medium- and low-risk activities, with soil reuse defined by contamination levels after treatment and by land use with, for example, industrial development permitting higher levels of contamination for soil reuse or the site's ability to accept or transfer soil of lower contamination from and to other development sites. However, if there is no reuse or recycling option and the after-treatment waste classified for reuse is sent for disposal, HMRC could charge any applicable landfill tax, based on its own established rules, which requires a dynamic assessment that must consider the characterisation of the soil and stones, specifically:

- Hazardous Properties (chemical, physical and biological);
- Contamination potential; and
- Active vs. Non-Active[17] status.

[17] See: https://www.gov.uk/government/publications/excise-notice-lft1-a-general-guide-to-landfill-tax/excise-notice-lft1-a-general-guide-to-landfill-tax Viewed 16/11/2020

There is a specific and prevalent issue where low-risk asbestos fragments in soil and stones (typically in pile mats constructed of recycled aggregate) is preferentially treated over higher risk (i.e. more friable) microscopic asbestos contamination because the former attracts the 'hazardous waste' classification. This issue is currently covered under a Health and Safety risk assessment protocol arising from the Control of Asbestos Regulations 2012[18] with an active working group developing a Quality Protocol that defines reuse of inert aggregate wastes[19, 20]. There is a good practice guide available for the construction sector from CIRIA[21].

Classification as a waste may prevent reuse and land spreading permits that require a "benefit statement", although this benefit is limited to the immediate benefit such as complying with a soil standard rather than diverting waste from landfill.

Working with soils contaminated with Asbestos *(Photo: ©Michael Longman, VertaseFLI)*

[18] See: https://www.legislation.gov.uk/uksi/2012/632/contents/made Viewed 9/12/2020
[19] See: https://www.claire.co.uk/index.php?option=com_content&view=article&id=1417:waste-quality-protocols-review-aggregates-from-inert-waste-quality-protocol-call-for-evidence&catid=14&idU=2&acm=_123 Viewed 9/12/2020
[20] See: https://www.gov.uk/government/publications/quality-protocol-production-of-aggregates-from-inert-waste Viewed 4/2/2021
[21] Asbestos in soil and made ground good practice site guide (C765) at https://www.ciria.org/ItemDetail?iProductcode=C765&Category=BOOK

The 'Rules' are not followed

In addition to the DoWCoP anomalies, the industry witnesses frequent non-compliance[22] in relation to:

- Waste characterisation;
- Application of Quality Protocols;
- Sale of 'Products' that have not achieved the necessary 'End of Waste' criteria;
- Sham recovery activities such as unplanned landscaping works; and
- Misuse of Exemptions.

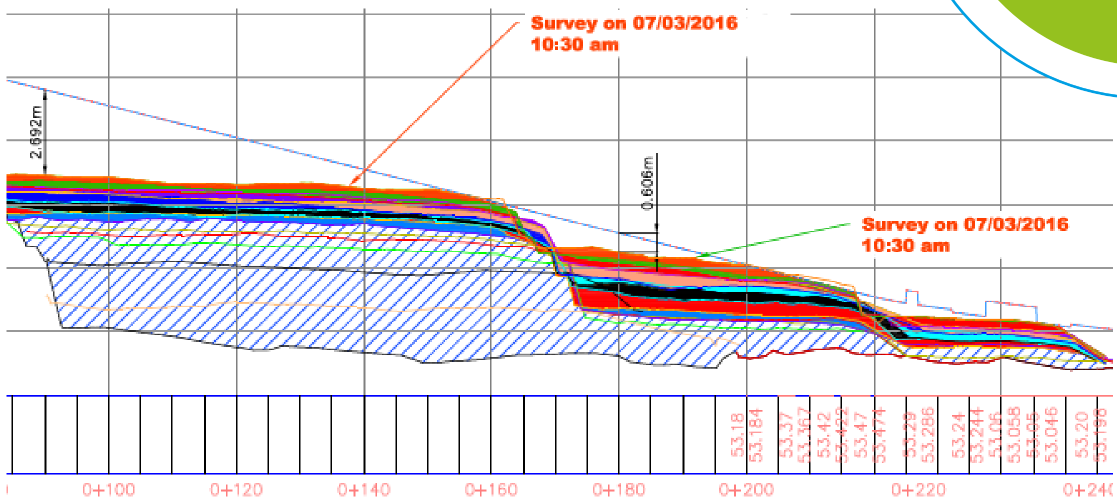
What Working Practices are Effective and Why Have they Been Accepted or Adopted?

The use of DoWCoP has been broadly accepted by the larger players in the industry, being particularly effective for larger-scale projects of over 10,000 m^3 and with the simplest reuse scenarios being that of reuse on site of origin and direct transfer with single donor and single receiver. Improvements for efficient use on smaller projects as well as broader land use sectors are proposed below.

[22] See for example news report: https://www.bristolpost.co.uk/news/bristol-news/bristol-recycling-bosses-exposed-workers-573341 Viewed 7/12/2020

Case Study

Watford Health Campus Road Embankment



The project required construction of a new 'link road' which comprised a 1.4 km length of single carriage road incorporating a rail line crossing embankment. To achieve this the project required the placement of 38,200 m^3 of contaminated made ground and soils (1A and 2C material) that were processed and treated on site, employing a stabilisation and solidification technique to affect their safe reuse on site that also met the geotechnical requirements.

Surplus contaminated soils were excavated and transported as waste to the material treatment permit area, where they were treated to be chemically and geotechnically suitable and beneficially reused as non-waste under the MMPs, being placed in the new embankment. The works (and MMPs) were fully validated.

(Photos and survey chart: Courtesy of ©Keltbray Remediation)

Beneficial reuse

Genuine restoration projects such as landfill restoration and quarry restoration[23] have been real success stories, allowing beneficial reuse and diverting of soils from landfill, often resulting in significant amenity value. In smaller projects, when appropriately applied, exemptions provide efficient and regulated means of use of limited volumes of selected wastes.

How can existing practices be improved?

The online registration with the CL:AIRE DoWCoP system is a simple and effective tool in helping establish best practice, with the provision of training to assist operators and professionals[24]. More regulatory resources and active enforcement would assist in improving standards and industry compliance. Increasing the likelihood of regulatory sanctions would deter observed bad practices and non-compliance. However, there are many industry operators able to demonstrate good practice and managed risk and compliance systems, so there is scope for voluntary self-regulation. For instance:

- Create a soil legislation framework to enable sustainable use of soils across different sectors.
- Specification for MMPs and validation as a planning condition.
- Certificate of Technical Competence for DoWCoP – attached to companies and individuals undertaking the work.
- DoWCoP 'permit' which includes a subsistence to fund the EA to complete compliance assessment report (CAR) supporting inspections of MMPs.
- UK government advice in the form of Construction Code of Practice for the Sustainable Use of Soils on Construction Sites[25].

To provide further confidence, sustainability benchmarks for investors, governments and regulators can be provided by schemes such as the Building Research Establishment's CEEQUAL platform[26]. This is an evidence-based sustainability assessment, rating and awards scheme for civil engineering, infrastructure, landscaping, and public sector projects.

Call for Action – Engineering, Construction and Landscaping

- **A review to remove barriers to achieving 'zero waste'** and material optimisation through cross-sector harmonisation of regulation and guidance. This would establish the framework for an Approved Code of Practice (ACoP) which could be led by an appropriate independent body.
- **A review of the CL:AIRE DoWCoP** system for small-scale projects subject to conditions such as soil reuse on site. This would allow a 'light touch' DoWCoP scheme for 'trusted'

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[23] See for example: https://www.rbquarryproducts.co.uk/restoration/ and https://www.agg-net.com/resources/articles/legislation-regulation/quarry-restoration-and-waste-recovery Viewed 11/11/2020
[24] See: https://www.claire.co.uk/events-training Viewed 4/2/2021
[25] See: https://www.gov.uk/government/publications/code-of-practice-for-the-sustainable-use-of-soils-on-construction-sites Viewed 16/11/2020
[26] See: https://www.ceequal.com/ Viewed 28/1/2021

operators based on the operator's track record and risk management systems, to gain assurance of increased sector compliance.

- The 'light touch' scheme should be made **available to operators on projects with medium volume (>10,000 m^3)** and medium to low-risk sites. A site project-specific bond would be surrendered if non-compliant.
- **A review of the European 'Gronde Bank Scheme'[27]** would be beneficial as this is widely viewed by practitioners as a 'best in class' solution supported by:
    - **Regional hubs or temporary permits to store (where space allows) for longer-term stockpiling or 'banking' of soils and stones,** making beneficial reuse less reliant on 'the perfect storm' of conditions, including reuse and recycling availability, space for storage, and timing.
- **A decision-making system**, available online with an interactive flow chart to enable determination of waste or material for reuse, regulatory compliance, duty of care, documentation and auditing capability.
- **Create a soil legislation framework** to enable sustainable use of soils across different sectors.

Commerciality

The costs involved with the management of soil and stones are significantly more than the associated consultancy fees and administrative charges. Therefore, there would be little resistance to increasing related charges if the system was simplified and less risky, as well as supporting reuse between sectors under one Code of Protocol specifically for material designation and reuse. Some specific recommendations are as follows:

- '**Light touch' DoWCoP** that would require a bond to be surrendered on non-compliance.
- **New landfill tax bracket for Non-Hazardous soils** to avoid confusion over when this material is considered 'Active' or 'Non-Active', and a simple 'one size fits all' approach to Non-Hazardous soil and stones[28].
- **Introduction of a construction waste levy**, which has a tiered approach depending upon reuse and benefits; this would dissuade sham recovery.
- **Working with key stakeholders and regulators** to develop regulatory change or guidance to enable permitting of sites for banking and longer-term storage of End of Waste non-hazardous soil and stone available for reuse.

[27] See: https://www.grondbank.be/ Viewed 4/2/2021
[28] Waste classified as hazardous will still attract the Standard Rate for Landfill Tax.

Case Study

Storage and reuse of waste ballasts on rail network

Disposal of hazardous ballast waste from rail network (Photo: ©Paul Dumble)

Systems are already in use for permitting of regional transfer stations, such as those used on the UK rail network for storage and banking of soils. Such regional facilities would be useful in serving smaller operators so that excavated soil without an available option for site reuse, treatment or disposal (e.g. as hazardous waste) is made available for recycling on other sites.

Network Rail use granite stone in the construction and maintenance of over 20,000 miles of the railway network across England, Scotland and Wales.

Over one million tonnes of ballast waste are removed every year; 95% of this is classified as non-hazardous for reuse and recycling.

The quantities have been higher in recent years with Crossrail and more recently the start of the HS2 project. Hazardous ballast waste may include excessive levels of oil and heavy metals such as arsenic (from the old coal driven steam engines). A typical permit will allow the storage of hazardous waste ballast in contained areas for transfer to permitted hazardous waste disposal sites and the storage and transfer of non-hazardous waste to other sites (Dumble 2006).

Case Study

Gypsum recycling

For construction sector fit-out phase and maintenance activities, plaster made from gypsum rock is fully recyclable due to a reversible hydration reaction with a best case modelled zero landfilled gypsum waste with no net lifecycle energy changes.

The recycled gypsum replaces 18.7% of the processed gypsum rock in plasterboard (Rivero, Sathre and Navarroa 2016)

Remediation and soil recovery *(Photo: ©Martin Ballard)*

Land Management: Agriculture, Forestry and Conservation

Coppiced bluebell woodland: forestry in harmony with conservation *(Photo: ©Robert Earl)*

A typical soil profile comprises three horizons that develop over time because of physical weathering, and chemical and biological processes. The A horizon, often referred to as 'topsoil', contains the highest levels of organic matter and plant-available nutrients. It is the most biologically active layer. Below this, the B horizon contains fewer nutrients, organic matter, or biological activity, but is important for holding plant-available water and provides anchorage for plant roots. The C horizon is the weathered parent material from which the soil is formed.

There is a wide range of issues of concern relating to the management of soils for agriculture, forestry, and conservation, including compaction, soil erosion, and organic matter decline. Such issues lead to land degradation and a decline of the economic and biological productivity of land[29]. The overall aim for any land use should be sustainability, i.e., maintaining the land use and its required output whilst protecting and potentially enhancing soil quality and avoiding land degradation. Sustainability also means ensuring that land retains its capability for multiple uses; for example, land converted from agriculture to recreation should be capable of being returned to farming.

[29] UNCCD. (1994). United Nations convention to combat desertification in countries experiencing serious drought and/or desertification, particularly in Africa. Paris: United Nations Convention to Combat Desertification, UNCCD. https://legal.un.org/avl/ha/unccd/unccd.html Viewed 17/11/2020

Each of these land-use sectors has a wide range of land management requirements, reflecting the diversity of use within each sector; for example, agriculture produces not only food but also fibre and fuel. The following are broad descriptions of the sectors:

Agriculture

- **Arable** – land cultivated for crop production, including combinable crops, root crops, crops grown for animal feed.
- **Permanent Grassland** – land used to grow grasses or other herbaceous forage for 5 years or more.
- **Permanent crops**[30] – crops occupying land for 5 years or more, including short rotation coppice and multi-annual crops.

Forestry

- **Establishment, cultivation and management of forests, woodlands, and trees** for a range of purposes. Species and cultivation methods will vary with purpose of land use and location.

Conservation – Amenity and recreation[31]

- **Maintaining undisturbed or semi-natural ecosystems** and natural capital reserves or creating them, e.g., wildflower meadows, and more generally conserving habitats of biodiverse flora and fauna.
- **Agriculture** – resting land and incentivising putting aside land for wilding.
- **Golf courses, amenity and parkland** offer opportunity for protecting soils and natural capital; maintaining and managing amenity spaces and public parks present Sustainable Urban Drainage Schemes (SUDS) and habitat for invertebrates if managed sensitively, for wildlife and people. Rewilding public areas and semi-natural ecosystems in and around the built environment as well as providing corridors between isolated natural ecosystems.

Poor soil management in the construction of an amenity area *(Photo: ©Vaughan Redfern)*

[30] See: Defined in the Basic Payment Scheme Rules at www.gov.uk/rpa/bps2020 Viewed 10/2/2021
[31] See: Section on Engineering, Construction and Landscaping

Land Management

A report by The European Commission[32] concluded that the diversity of soils and their services needs to be valued and considered in all actions at different scales. This diversity calls for tools and mechanisms that are adapted to the local context and to allow for wider societal involvement. fundamental indicators for soil health were proposed:

- Presence of soil pollutants
- Excess nutrients and salts
- Vegetation cover
- Soil organic carbon
- Soil structure including soil bulk density and absence of soil sealing and erosion
- Soil biodiversity
- Soil nutrients and acidity (pH).

These indicators have informed current advice on land management in UK.

Guidance that encourages best practice in land management

UK guidance that encourages best practice in land management is set out in:

- Protecting our Water, Soil and Air: A Code of Good Agricultural Practice for farmers, growers, and land managers
- Safeguarding our Soils: A Strategy for England[33]
- Construction Code of Practice for the Sustainable Use of Soils on Construction Sites[34]
- UK Forestry Standard: The governments' approach to sustainable forestry[35].

Consequences of poor land management

Poor land management leads to land degradation. Degraded land is less productive (e.g. lower crop yields), less resilient and less able to provide ecosystem services like fresh water or clean air. The financial costs of degraded land include the cost of restoring land; for instance, habitats; loss of biodiversity finance, such as carbon credits; the cash flow risks for agriculture, forestry or tourism; and the loss of recreational value[36]. Defra reported in 2009 that soil erosion due to wind and rainfall results in the annual loss of around 2.2 million tonnes of topsoil in the UK, costing British farmers £9m a year in lost production. A consequence of soil erosion is eutrophication because of soil nutrients such as nitrogen and phosphorus being deposited in water bodies. This has potential negative impacts on water quality and a cost associated with clean-up.

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[32] Caring for soil is caring for life – Ensure 75% of soils are healthy by 2030 for healthy food, people, nature and climate. European Commission Directorate-General for Research and Innovation and Directorate-General for Agriculture and Rural Development. May 2020. https://op.europa.eu/en/publication-detail/-/publication/32d5d312-b689-11ea-bb7a-01aa75ed71a1 Viewed 17/11/2020

[33] See: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/268691/pb13558-cogap-131223.pdf Viewed 16/11/2020

[34] See: https://www.gov.uk/government/publications/code-of-practice-for-the-sustainable-use-of-soils-on-construction-sites Viewed 16/11/2020

[35] https://www.gov.uk/government/publications/the-uk-forestry-standard Viewed 5/10/2020

[36] University of Cambridge Institute for Sustainability Leadership (CISL 2020). Biodiversity Loss and Land Degradation: An Overview of the Financial Materiality. https://www.cisl.cam.ac.uk/resources/publication-pdfs/biodiversity-loss-and-land-degradation-overview.pdf Viewed 5/10/2020

Degraded agricultural land resulting from poor restoration following minerals extraction *(Photo: ©Vaughan Redfern)*

In the minerals industry the MAFF Good Practice Guide for Handling Soils[37] provides comprehensive advice on soil handling good practice to operators, soil moving contractors, and consultants. It is also used by mineral planning authorities to inform restoration planning conditions that will protect soil resources for future use, whether the site is to be returned to agriculture or a biodiverse site such as grassland or woodland. The preservation of soils on mineral extraction sites is critical to successful land restoration. All soil making material is stored on site in areas where it will not be contaminated with other quarry or mining material. The topsoil and subsoil are lifted and stored separately and used to reinstate the site once the mineral working is completed. Successful land restoration requires soils to be handled in such a way that damage to their structure is minimised, thus the Guide describes the machinery to be used, the working practices and the soil moisture conditions under which work should take place. The Guide is currently being updated by the Institute of Quarrying and Natural England. A Code of Practice for the "Sustainable Use of Soils on Construction Sites" is also available[38].

[37] MAFF (2000), Good Practice Guide for Handling Soils (version 04/00). FRCA, Cambridge. https://webarchive.nationalarchives.gov.uk/20090318025503/http://www.defra.gov.uk/farm/environment/land-use/soilguid/sheet01.pdf Viewed 21/11/20

[38] See: https://www.gov.uk/government/publications/code-of-practice-for-the-sustainable-use-of-soils-on-construction-sites

Deer Grazing on restored quarry site (Photo: ©Graham Stead)

Ability to match soils and land use

Within each of the three land-use sectors there is a wide range of soil requirements. The issue for any land manager is understanding the characteristics and quality of the soil, matching this with intended land use, and applying appropriate management practices to sustain and improve the soil characteristics required for that land use. A lack of understanding of the land and soil and failure to apply appropriate management will lead to land degradation. Whilst most farmers will understand their own land and soil, economic drivers can lead to inappropriate land use to the detriment of long-term soil health, for example, ploughing up chalk grassland to grow cereals. Land capability classification provides a method for classifying land according to its capability to sustain a particular intensity of use, and in Britain there exist systems for both agriculture and forestry. Whilst essentially a land-use planning tool, land capability classification has the potential to be adopted more widely by land users and adapted for a wider range of uses.

There is also a need to understand the drivers on landowners and farmers in relation to making a living off the land, which requires policy change. Landowners need to be incentivised by national fiscal policies that make sustainable soil management (SSM)[39] economically viable in the short term.

Issues with legislation, guidance and good practice

There is a large amount of legislation and guidance, constantly being updated, relating to land management, which applies across a wide range of professional disciplines, including land-use policy, regulation, planning, as well as professional support to practical land-based activities. Some professional advisors and land users, such as farmers, may lack access to the full range of supporting knowledge, competences and data sources that are essential in the development of best practices.

This poses a constraint to promoting good practice and can be a particular issue on projects where a multi-disciplinary approach is needed, such as construction projects and mineral restoration. This multi-disciplinary dialogue could include contractors, soil scientists, landscapers, and ecologists to ensure a consistent approach for soil protection and beneficial reuse as a valuable resource. University of Sheffield research[40] found that whilst a significant number of farmers undertook practices such as manure spreading, minimum tillage and cover cropping, there was little evidence that different SSM practices were being combined in similar ways on different farms. Rather, there seems to be no universal approach to SSM in the UK, with knowledge exchange fragmented. Furthermore, legislation may deter rather than encourage SSM. For example, excavated soils and dredgings are often classified as a "waste" and any use must therefore comply with exemptions or permits.

The legislation and guidance applied to the management of dredging waste[41] often prevents their reuse as a source of soil nutrients and organic matter. Whilst there will be instances when the source of the dredgings means there is a risk to their reuse, the use of inappropriate criteria to

[39] "See: Indicators of SSM at http://www.fao.org/fileadmin/user_upload/GSP/SSM/SSM_Protocol_EN_006.pdf, Viewed 4/3/2021"
[40] See: https://www.sheffield.ac.uk/sustainable-food/research/translational-transformative/achieving-sustainable-soil-management-uk Viewed 17/11/2020
[41] See: https://www.gov.uk/guidance/dredging Viewed 28/1/2021

assess the contaminant levels within sediments and restrictive exemption and permit conditions discourage the use of this resource.

Call for Action – Proposals for Improving Best Practice

The key areas for improving current and best practices are as follows:

- **Develop baselines for soil quality** and health for a range of land-use types. Under the 25-Year Environment Plan[42] the UK Government plans to develop a soil health index that can be used on farms to monitor the implementation of best practices.
- **Demonstrate the benefits** (financial and otherwise) of good soil management through case studies, highlighting best practice via beacon or demonstration schemes.
- **Review current barriers** to the safe and sustainable reuse of soils and dredgings – including a review of waste exemptions, permits and the process for meeting "end of waste" status.
- **Improve training and support:** In line with the aims of the 25-Year Environment Plan, improve training opportunities for farmers, soil and land-use professionals, and advisers by allocating funds for technical advice to support farmers and land managers, but additionally by considering legal and advancing fiscal and financial incentives for SSM.
- **Revise land classification systems**: Revise and update the current land capability classification systems for both agriculture and forestry, including the updating of the meteorological data set, which is used to determine climatic limitations and irrigation for crop growing purposes – encourage their wider use by land managers.
- **Signpost sources of information**, guidance, management options and interventions, for example through a regularly updated website. This should include:
    - Beneficial land use, soil management practices e.g., agroforestry and permaculture, long-term fallow and rewilding, controlled traffic farming, minimum tillage.
    - Information on soil testing: legislative requirements and useful tests. Provide clear guidance on appropriate soil tests e.g., Priority Pollutants BS 3882:2015[43], Sludge Code of Practice. Encourage development of tests common to various disciplines, such as those that exist in the contaminated land industry.
    - Advice on alternative fertilisers such as sewage sludge[44] and paper pulp[45].
    - Provide online access for multi-user legislative guidance.
    - Details of professional bodies and organisations promoting good soil management.

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[42] A Green Future: Our 25 Year Plan to Improve the Environment. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/673492/25-year-environment-plan-annex1.pdf Viewed 5/10/2020

[43] BS 3882:2015, Specification for Topsoil. The British Standards Institution, 2015. https://www.bsigroup.com/en-GB/about-bsi/media-centre/press-releases/2015/may/Newly-revised-topsoil-standard-is-published/ Viewed 17/11/2015

[44] See: https://www.gov.uk/government/publications/sewage-sludge-in-agriculture-code-of-practice/sewage-sludge-in-agriculture-code-of-practice-for-england-wales-and-northern-ireland Viewed 7/2/2021

[45] For England and Wales see: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291514/scho0805bjnj-e-e.pdf Viewed 7/2/2021

Healthy Soils, Natural Capital and Carbon Management

Typically, topsoil is defined as the upper 30–40 cm of the soil profile (Jones et al. 2012). Practically, healthy soils have been linked to the UN Sustainability Development Goals (Lal, Horn and Kosaki 2018; Bouma et al. 2019; Visser et al. 2019) In the UK, Defra's 25-Year Environment Plan[46], the Environmental Audit Committee's Soil Health Inquiry in 2016 and the Natural Capital Committee's Advice on Soil Management[47] all promote the importance of 'healthy soils' and 'soil health' as an essential part of natural capital.

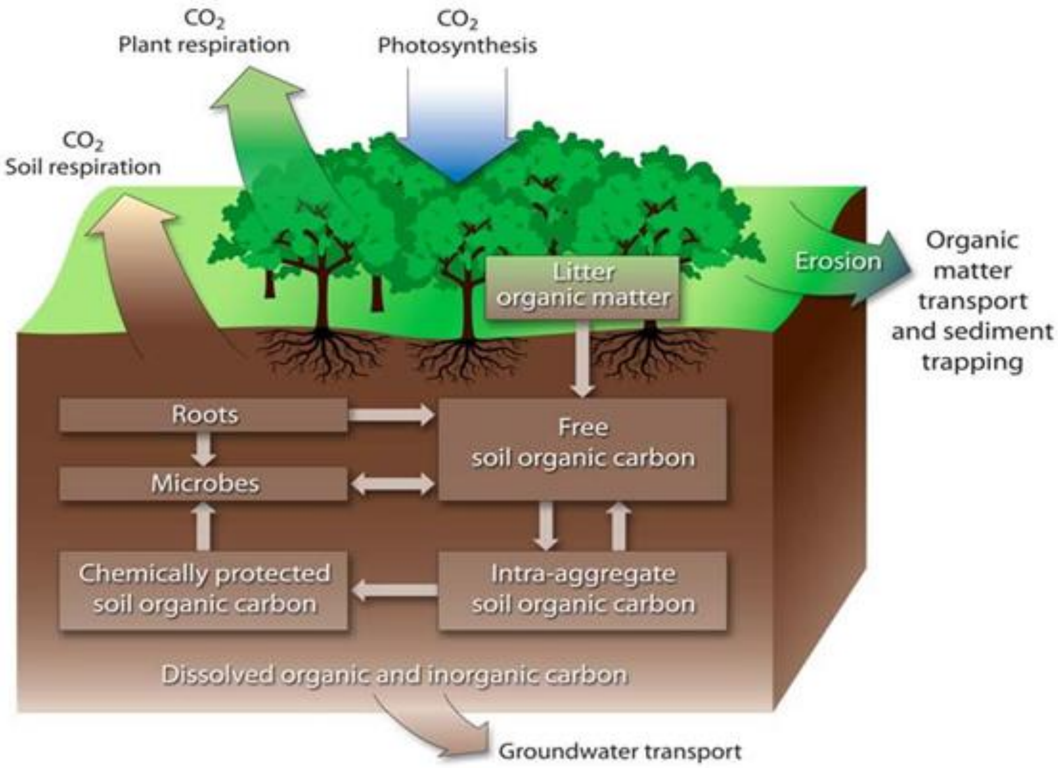

Figure 1. The role of healthy soil in the carbon cycle (Source: U.S. Department of Energy Genomic Science[48])

Carbon management of soil has an important role to play in decarbonising land-based industries such as agriculture, construction, recreation, amenity and forestry by reducing CO_2 emissions, increasing CO_2 sequestration, and by conserving, maintaining and improving land uses for carbon capture and storage.

[46] See: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/693158/25-year-environment-plan.pdf Viewed 16/11/2020

[47] See: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/909069/ncc-advice-soil-management.pdf Viewed 1/10/2020

[48] See: https://genomicscience.energy.gov Viewed: 20/10/2020

The Value, Risks and Issues Associated with 'Healthy Soils, Natural Capital and Carbon Management'

Soil provides essential goods and services to society, including the production of food, fibre and (bio)fuel; the regulation of water and carbon cycles; the protection of heritage, space for infrastructure and economic development; and the support of natural ecosystems as illustrated in *Figure 1*. Soils are a valuable tool for achieving net zero carbon and biodiversity net gain. The ability of soil to deliver these goods and services is reflected in soil health, which is based on the physical, biological and chemical properties of soil and their natural interactions with human activities. Key indicators of soil health include soil organic matter, soil structure, soil biota, air to water ratio, nutrients and pH. Soil health is defined as,

"The continued capacity of soil to function as a vital living system, within ecosystem and land-use boundaries, to sustain biological productivity, promote the quality of air and water environments, and maintain plant, animal and human health" (Karlen, Ditzler and Andrews 2003; Karlen et al. 1997; Kinyangi 2007; Wienhold et al. 2009).

Table 2: Ecosystem goods and services delivered by healthy soils

Ecosystem goods and services	Examples	Benefits to people
Provision of material goods and services	Agricultural production Carbon sequestration Mineral extraction Water supplies Land for development	Food security, rural-based livelihoods, minerals, climate change mitigation, net zero carbon targets, renewable energy, water use
Regulation of ecosystem processes	Water storage (flood and drought control) Erosion control Carbon storage and control of carbon losses Water purification	Flood damage avoidance, Social cost of carbon (net zero carbon targets) Water quality Waste management
Cultural, non-material services	Heritage, Landscape, Amenity, recreation, Aesthetics, Social relations	Heritage sites, Landscape features, Countryside walks, Tourist visits, health and well-being
Supporting processes and services	Soil formation, habitats, Biodiversity	Crop yields, Habitat and species, Net biodiversity gain targets

Adverse impacts of intensive land use aggravated by climate change and extreme weather events can lead to soil degradation, which poses serious threats to the delivery of vital ecosystem goods and services associated with individuals and national health and well-being. Degradation processes include soil erosion, compaction, loss of organic matter, loss of soil biodiversity, surface sealing and contamination (European Commission 2006). Soils are also degraded by excessive applications of fertilisers and agrichemicals (e.g. pesticides and herbicides), which can damage soil micro-organisms and the food chains dependent on them. This brings into conflict producers who are keen to maintain crop productivity with the urgent need to protect pollinators and other species, reduce the carbon intensity and eliminate the soil degradation.

It is important that soils are 'fit for purpose'. So, soil properties required to maximise agricultural production will not be the same as those where the intended end use is restoration of a wildflower meadow for net biodiversity gain or geotechnical stabilisation of a constructed slope. Another issue is that, in the construction industry in particular, soil can be designated as waste or 'muck', something to be treated and/or disposed of, off-site[49, 50].

Severely degraded agricultural land in the UK. *(Photo: ©Rob Simmons)*

[49] CL:AIRE (2011) *The Definition of Waste: Development Industry Code of Practice*. London. Available at: https://www.claire.co.uk/projects-and-initiatives/dow-cop/28-framework-and-guidance/111-dow-cop-main-document Viewed 17/11/2020

[50] See: Section on Engineering, Construction and Landscaping

A better understanding of potential uses and sustainable management of soil would go some way towards addressing the 'waste' issue in this sector. Indeed, current legislation states that when discarded by the producer, good topsoil can become a waste, even if there are options to (re)use the material. Options may be limited in site permit conditions or by lack of available sites for off-site reuse. Even so, soil reuse can bring many potential environmental and economic benefits associated with the delivery of ecosystem goods and services. However, the potential options need to be planned carefully, taking account of soil properties and processes to avoid unintended consequences, including damage to soil health. For example, simply adding layers of topsoil to a site could bring about compaction and anaerobic conditions at depth, as well as changing the drainage properties of the profile. A simple initial assessment of soil physical, biological and chemical properties would indicate whether proposed soil management practices might compromise soil health.

Best Practices to Enhance Soil Health, Natural Capital and Carbon Management

Practitioners from all land-based industries can design and implement practices to improve soil health, natural capital and carbon management. For example, construction and land maintenance techniques are used to mitigate the hydrological and ecological impacts on peatlands and other Groundwater Dependant Terrestrial Ecosystems (GWDTEs), also known as wetlands, that are safeguarded by the Water Framework Directive[51].

Soil has a role to play in decarbonising land-based activities, and the role of soil management in carbon management is an important area of research (Renforth et al. 2011). Carbon losses through atmospheric emissions from the soil can be minimised through less soil disturbance, such as the use of reduced tillage (conservation) agriculture. Soil loss caused by rainfall and run-off erosion processes, with, for example, soil on construction sites, is at greatest risk when vegetation and topsoil is removed, leading to losses of carbon stored in topsoil (Lal 2005). This can be reduced using green infrastructure such as SUDS, porous pavements, swales and green roofs, which reduce run-off generation and associated flooding and soil erosion[52].

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[51] See: Water Framework Directive implementation in England and Wales: new and updated standards to protect the water environment (publishing.service.gov.uk) Viewed 10/2/2021. For Scotland see: https://www.nature.scot/professional-advice/protected-areas-and-species/safeguards-beyond-protected-areas/water-framework-directive Viewed 10/2/2021. For Northern Ireland see: The Water Environment (Water Framework Directive) Regulations (Northern Ireland) 2017 (legislation.gov.uk) Viewed 10/2/2021

[52] See: SUDS website: https://www.susdrain.org/resources/ciria-guidance.html and "Delivering biodiversity benefits through green infrastructure (C711)" https://www.ciria.org/ItemDetail?iProductCode=C711&Category=BOOK&WebsiteKey=3f18c87a-d62b-4eca-8ef4-9b09309c1c91 Viewed 28/1/2021

Soils play a role in decarbonising land-based industries, from the planning stage to breaking ground (increased carbon emissions) to construction of green spaces (swales, green roofs, etc. for carbon sequestration and storage), Cambourne. *(Photo: ©Jane Rickson)*

Avoiding compaction of soil by heavy machinery (especially when the soil is wet) also reduces run-off, but also maintains a soil environment suited to successful vegetation establishment and growth. As well as progressing towards 'net biodiversity gain' targets, plants can bioremediate degraded soils. Root networks improve soil physical properties such as structure and infiltration. Root exudates can stimulate soil biology and nutrient cycling. In phytoremediation, plants can remove contaminants such as organic pollutants and heavy metals from land, so rectifying and re-establishing the natural condition of the soil. This process is described as a "cost-effective, efficient and eco-friendly in-situ remediation technology driven by solar energy" (Dixit et al. 2015).

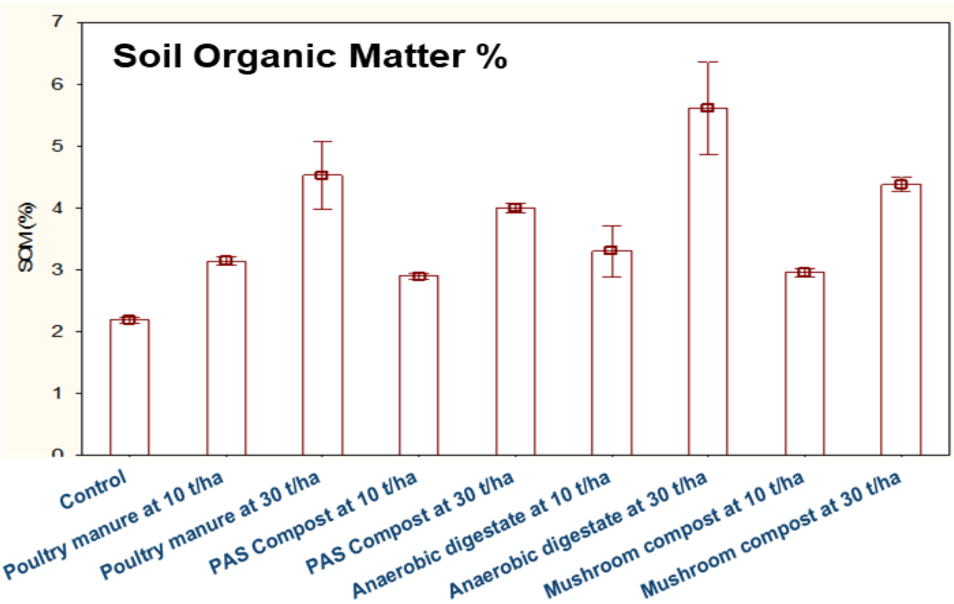

Figure 2. Effect of different soil organic amendments applications on soil organic matter (Source: Unagwu, 2017[53])

[53] Unagwu, B.O. 2017. Application of organic amendments to restore soil health and productivity of a degraded soil. Unpublished PhD thesis, Cranfield University. *Figure 2* with permission.

Vigorous vegetation growth also increases the sequestration of CO_2 from the atmosphere. One of the most promising 'geo-engineering' methods to mitigate climate change is to exploit CO_2 capture by plants and soil, using finely divided silicates applied on the soil to fix the CO_2 as environmentally benign carbonates. However, the necessary conditions for this to work are not well understood, and there are no reliable models with which to predict where such a technology would be successful, which restricts technology development. Practices that increase soil carbon storage also help meet 'net zero' carbon targets. When added to soil, organic matter from both plant material and organic amendments (such as composts, biochar and homogenised food and organic waste matter from anaerobic digesters) help improve soil health and support the ecosystem biome (*Figure 2*).

> All soil management options available to land-based practitioners must be evaluated for their cost-effectiveness in improving soil health, as well as their sustainability, practicality, and likely barriers to adoption.

Call for Action – Healthy Soils, Natural Capital and Carbon Management

In creating the necessary scale and momentum in the future development of 'Sustainable soil use and management', professionals will need to consider commercial interests, the needs in the provision of goods and services, as well as the need to maintain the healthy soils and ecosystems.

To ensure that their actions encourage the:

- **Promotion of the sustainability agenda** (delivering economic, social and environmental benefits) and green recovery in land-based industries.
- **Use of life cycle assessments** for construction projects which include:
    - The goal of CO_2 sequestration gains on land associated with new developments with the support of online tools;
    - Sourcing of materials required for CO_2 sequestration gains from demolition and quarry waste; and
    - Post-construction monitoring of CO_2 sequestration through geo-chemical analysis, (Renforth et al. 2011; Washbourne, Renforth and Manning 2012; Stout, Lal and Monger 2016).

- **Better use of technologies and tools** in the regulatory and planning process, including:
    - Geographical information systems (GIS) and software modelling e.g. the development of 'digital twins' in land management decision making (Bartos and Kerkez 2020). The aim is to reduce negative impacts on soils, restoring healthy soil and bettering functionality at the local, regional and national level.

There needs to be a critical review of the current legislation and regulation landscape regarding healthy soils at national and local levels, to assess:

- **Whether it is fit for purpose**, to ensure the sustainable use and management of soils.
- **Progress towards 'zero waste'**.

Regulatory and sector actions are needed to improve the management of healthy soils, natural capital and carbon management, for example:

- **Environmental permit regulations** to address soil and waste in the post-Brexit period.
- **A new, cross-sectoral ACoP** to be administered by an appropriate independent body.

This could draw on the current DoWCoP, adapted to suit the objective of sustaining healthy soils.

Brownfield site restoration (Photo ©Mike Longman, VertaseFLI)

Climate Change and Soil Water Dynamics

Challenges and Boundaries – Linking to UK Policy and Legislation

Since its formation, the earth's climate has been in constant flux. These changes have typically occurred over hundreds or thousands of years, at rates slow enough to allow life on earth time to evolve or adapt to a changing environment. However, due to human activity vast amounts of greenhouse gases, such as carbon dioxide and methane, have been released into the earth's atmosphere since the Industrial Revolution. This warming is accelerating, with changes now being recorded over decadal timescales (Parker 2007). This is resulting in atypical seasonal changes in weather patterns, punctuated by the increasingly intense extreme weather events, each having a direct impact on soil physical, chemical, and biological properties, including soil water dynamics, which affect water retention, drainage, wildfire events[54], pollution, erosion, and emissions. Visualisation of the many of the ways which the earth's soil and stones may be used to address climate change are explored in Netflix's "Kiss the ground" documentary[55].

Globally, Agriculture, Forestry and Other Land Use activities are thought to account for around 23% of total net anthropogenic (originating from human activity) emissions of greenhouse gases (12.0 ± 2.9 $GtCO_2eq\ yr^{-1}$) between 2007 and 2016, rising to 21–37% when taking into account food production value chains (IPCC 2019). The implications of this are stark, with many areas of the world experiencing changes in water dynamics, ecosystem services and soil erosion (Shukla et al. 2019).

In the UK, this is manifested in the following ways:

- **Agricultural soils are becoming less fertile** and productive, adversely affecting their capacity to grow food for human consumption[56], though it has been already noted (p25) that this is disputed by farmers who rely on intense farming methods to maintain crop productivity.
- **Long periods of drought are:**
    - Creating water stress, affecting water supply for domestic, industrial and agricultural applications, often affecting regions of the UK, more often publicly visible through the adoption of hosepipe bans.
    - Adversely affecting the flora and fauna of natural ecosystems on land and aquatic species from heat stress and the drying out of riverbeds, drainage channels and other surface water features.
    - Drying out surface detritus, creating conditions for wildfires that can be started by human and natural activity such as lightning (Nolan et al. 2019; Vaughan 2019).
- **Flooding**: Sustained periods of rainfall leading to flood events, resulting in damage to property and agricultural land.
- **Storm events leading to infrastructure damage**, destabilising land and with sea level rises accelerating coastal erosion and estuarine floodplain damage.

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[54] See: Michael E Mann, Natural Resources Committee @altNOAA. https://twitter.com/i/status/1304906295510732800 Viewed 28/11/2020
[55] See: https://www.netflix.com/gb/title/81321999 Viewed 22/3/21
[56] Open Access Government (2017). Gove-warns-eradication-of soil-fertility-due-intensive-farming. https://www.openaccessgovernment.org/gove-warns-eradication-soil-fertility-due-intensive-farming/39039/ Viewed 17/11/2020

Globally, material extraction is expected to rise to 184 billion tonnes by 2050, adding 7 to 27 billion tonnes CO_{2eq} (de Wit et al. 2018; de Wit et al. 2019). Cement is made of materials including limestone, chalk, and silica sand, and alone contributes to about 8% of global emissions with 50% of this coming from process fossil fuel burning, providing greenhouse gas mitigation opportunities (Olivier et al 2016). In the UK, the effects of climate change on land and the effects of land usage on climate change are considered in terms of land use in both urban and rural development. This also includes industrial development, where legislation and permitting is interfaced with MMPs within the CL:AIRE DoWCoP guidance[57] used in the preliminary site preparation stages[58,59], which is discussed in the Engineering, Construction and Landscaping section.

Addressing Challenges through Evolving Best Practice

Non-hazardous granite ballast waste unloaded at rail depot for reuse and recycling enabling embedded energy and multimodal (rail, road) transport emission savings *(Photo: ©Paul Dumble)*

Linear economy options leave landfill or mainly ground reuse or recycling options for soil and stone wastes. To increase circularity, the options for reuse and recycling soil and stones must be implemented higher up the waste hierarchy in the design stages of land-use developments.

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[57] CL:AIRE (2020). Definition of Waste: Code of Practice. Viewed 11/8/2020 at https://www.claire.co.uk/projects-and-initiatives/dow-cop

[58] HMG (2011). The Carbon Plan: Delivering our low carbon future. Presented to Parliament pursuant to Sections 12 and 14 of the Climate Change Act 2008. Amended 2nd December 2011 from the version laid before Parliament on 1st December 2011. Viewed 6/8/2020 at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/47613/3702-the-carbon-plan-delivering-our-low-carbon-future.pdf

[59] DEFRA (2018).The National Adaptation Programme and the Third Strategy for Climate Adaptation Reporting, July. Viewed 6/8/2020 at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/727252/national-adaptation-programme-2018.pdf

Although there is a need to address the rejection of waste materials for reuse, many reuse options are from experience often excluded by commercial specifications and engineering quality criteria.

In relation to the design aspects of urban development and the scale of the indirect supply chain impacts of soils and stones, process, transport and distribution emissions have been captured in a recent report by the Royal Academy of Engineering 'Sustainable Living Places'[60]. Bristol University's ICE database and online tools are useful in quantifying embedded soil and stones emissions in the supply chain[61]. Practical guidance is outlined in construction and logistics support systems, such as BREEAM[62]. Multiple developments can be supported using Construction Consolidation Centres by reducing transport emissions and embedded emissions from product and materials that would normally be lost or damaged on site[63]. Research on mineral-based construction materials is being carried out at the UCL Interdisciplinary Circular Economy Centre for Mineral-based Construction Materials[64].

About 26% of UK greenhouse gas emissions are from agriculture, waste management and 'other' (including forestry)[65]. In 2017, former Environment Secretary, Michael Gove, stated that the UK is only 30 to 40 years away from "the fundamental eradication of soil fertility", highlighting contradictory imperatives of policymakers, businesses focused on short-term returns, and long-term land-use planners. The state of the UK's arable soils illustrates this well, with the Minister[66] warning "… no country can withstand the loss of its soil and fertility".

The decommissioning of oil, gas and waste management sites will become more prevalent in the future and will face the challenge of dealing with low-level fugitive methane emissions from ground sources. Soil design and practices to reduce the greenhouse gas potential of the methane are already understood and should be developed to provide long-term mitigation features (IPCC 2001; Spokas et al. 2015).

At a practical level, the land-use planning (master planning) needs be defined in terms of carbon emission intensity limits or intensity reduction within time-framed targets for all rural and urban developments or agricultural activities, at field or land plot level.

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[60] Royal Academy of Engineering (2019) Sustainable living places – a systems perspective on planning, housing and infrastructure. Viewed 11/9/2020 at https://www.raeng.org.uk/publications/reports/sustainable-living-places-(1)
[61] See: Circular ecology. Viewed 30/11/2020 at Circular Ecology - Carbon Footprint, LCA, Embodied Energy and Sustainability Experts - Circular Ecology
[62] BRE (2020). BRE SMARTWaste Membership Scheme. Viewed 13/8/2020 at http://www.smartwaste.co.uk/filelibrary/SWPlan
[63] WRAP (2010). Guidance: Construction Logistics: Using Construction Consolidation Centres to reduce construction waste and carbon emissions. Viewed 7/8/2020 at http://www.wrap.org.uk/sites/files/wrap/CCC%20combined.pdf
[64] Interdisciplinary Circular Economy Centre for Mineral-based Construction Materials. See: https://www.ucl.ac.uk/ioe/news/2020/nov/ucl-leads-research-circular-economy-three-uk-industries Viewed 29/1/2021
[65] BEIS (2018). Greenhouse Gas Emissions. Viewed 13/8/2020 at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/863325/2018-final-emissions-statistics-summary.pdf
[66] See: https://www.openaccessgovernment.org/gove-warns-eradication-soil-fertility-due-intensive-farming/39039/. Viewed 11/8/2020

Case Study

Growing food without soil

In the future, will most of our strawberries grown in soil be produced by hydroponics in the UK? (Photo: ©Robert Earl)

Intensive agriculture practices are rapidly degrading cropland in the UK. There are further problems caused with the rapid decline of pollinators due to the use of pesticides and from the discharge of the run-off of soluble chemical fertilisers from the fields into drainage channels and rivers, a cause of eutrophication.

Hydroponics, one of a number of emerging technologies for growing food without soil, is reported to be a rising profitable method for growing plants and crops without soil, with Europe holding 47.3% of the global market and with the fastest growing market in Africa[67]. The roots of plants are supported by substrates such as gravel, sand, perlite, rice husks, rockwool or other materials that are maintained in an aqueous nutrient solution, which, in a controlled environment, may be pesticide free.

Nutrients for the process can be provided from organic sources including animal manure, bonemeal, fishmeal and dried locust, and bio-ashes such as wood[68]. To reduce the need for land, the processing is carried out with layers of crops arranged vertically, with multiple harvesting of different or similar crops throughout the year. Hydroponics may replace and scale up market produce activities currently carried out in soils in greenhouses, or crops grown under plastic in fields, potentially offering a welcome reduction in agricultural plastic contamination of land.

[67] See: https://www.mordorintelligence.com/industry-reports/hydroponics-market Viewed 23/11/2020
[68] See: https://en.wikipedia.org/wiki/Hydroponics Viewed 23/11/2020

As less water is used than in traditional crops, it is likely that this method will be adopted in harsh environments with high water stress such as Dubai[69] where an industrial-scale park is being planned to provide fresh produce to the Emirates with surpluses exported regionally.

The hydroponic method is developing new practices with distinct environmental benefits[70], including decreased farming intensity and emissions from:

- **Significantly less land area needed**, as new crops can be grown after each one has been harvested, and vertical farming methods can used.
- **Reduced or no pesticide use**, enabling pollinators to be introduced into the controlled hydroponic environments.
- **Nutrients being recycled** and made available from the green wastes left over after harvesting, as well as animal waste from farms such as manure.
- **Significant reduction in water usage** (e.g. 80 to 85% for strawberries and tomatoes).
- **Reduction of agricultural plastic waste** where hydroponics methods substitute crop production on soil that is normally protected by plastic sheeting.

The method is still under development as more crops are adapted; with issues of scale, maintaining nutrient balances and growing conditions, in addition to wastewater discharge, the recycling and disposal of wastes needs consideration.

UK soils currently store about 10 billion tonnes of carbon, roughly equal to 80 years of annual UK greenhouse gas emissions[71]. Carbon storage sites such as forests, wetlands or peatbogs need improved mandatory protection, perhaps in the form of a specific protection status, which includes resourcing of any required active management and maintenance to increase and maintain storage capacity, such as in the UK's degraded peatbogs[72] that have become carbon emission sources (Karhu et al. 2014). Wetlands, particularly peatlands, are the largest carbon store on the planet with up to 1,300 tons of carbon per hectare[73]. Recent estimates by the Committee for Climate Change[74] have suggested that re-wetting and sustainable management of UK peatlands (which cover about 12% of the UK land surface[75]) from the current 25% to 60% by 2050 could not only stem carbon emissions, but could result in annual savings of around 6 $MtCO_2e$ by 2035 and 10 $MtCO_2e$ by 2050.

[69] See: Why hydroponics is perfect for the UAE – and how to use the process to grow plants in your home - The National (thenationalnews.com) Viewed 23/11/2020
[70] See: World Economic Forum https://twitter.com/i/status/1338700930603229184 Viewed 15/12/2020
[71] EA (2019). State of the Environment; Soil, Defra. Viewed 7/9/2020 at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/805926/State_of_the_environment_soil_report.pdf
[72] Harrabin, R. (2020). Climate change: UK peat emissions could cancel forest benefits, BBC News Website. Viewed 6/6/2020 at https://www.bbc.co.uk/news/science-environment-53684047
[73] UNCCD (2015). Pivotal Carbon. Science Policy Brief. UNCCD Science Policy Interface. Viewed 12/8/2020 at https://www.unccd.int/sites/default/files/documents/2015_PolicyBrief_SPI_ENG_0.pdf
[74] See: https://www.theccc.org.uk/publication/sixth-carbon-budget/ Viewed 11/1/2021
[75] See: https://www.ceh.ac.uk/sites/default/files/Peatland%20factsheet.pdf Viewed 10/2/2021

Increasing Soil Organic Carbon Especially for Arable Land

Nutrient rich soil enhancements *(Photo: ©Jane Gilbert)*

Farmers have known for millennia that organic amendments, such as manure and compost, can increase soil productivity[76].

The extent to which quality compost can improve soil organic matter was demonstrated in a number of field experiments and published by WRAP[77], where repeated applications over a 9-year period were shown to increase topsoil organic matter stocks by over 20%. Improved farming methods to incorporate organic amendments into crop cycles can not only increase soil organic carbon stocks and improve soil structure (hence water dynamics) but also reduce inorganic fertiliser demand and the associated environmental emissions associated with its manufacture and use[78]. Organic amendments have been shown to increase soil organic carbon (FAO 2017; Peltre et al. 2017) and contribute towards long-term carbon storage (carbon sequestration, Powlson et al. 2012).

[76] See: For European perspective https://www.compostnetwork.info/download/soil-structure-carbon-storage/ Viewed 10/12/2020.

[77] Bhogal, A., Taylor, M., Nicholson, F., Rollett, A., Williams, J., Newell Price, P., Chambers, B., Litterick, A. and Whittingham, M. (2016). Work Package 1 Final report (2010-2015) DC-Agri; field experiments for quality digestate and compost in agriculture. Waste and Resources Action Programme. Viewed 28/6/2019 at http://www.wrap.org.uk/content/digestate-and-compost-agriculture-dc-agri-reports

[78] Gilbert, J., Ricci-Jürgensen, M. and Ramola, A. (2020). Benefits of Compost and Anaerobic Digestate When Applied to Soil. ISWA. Viewed 30/11/2020 at https://www.iswa.org/media/publications/iswa-soils-project/

Benchmarking in reducing carbon intensity in change of land use from arable to agroforestry

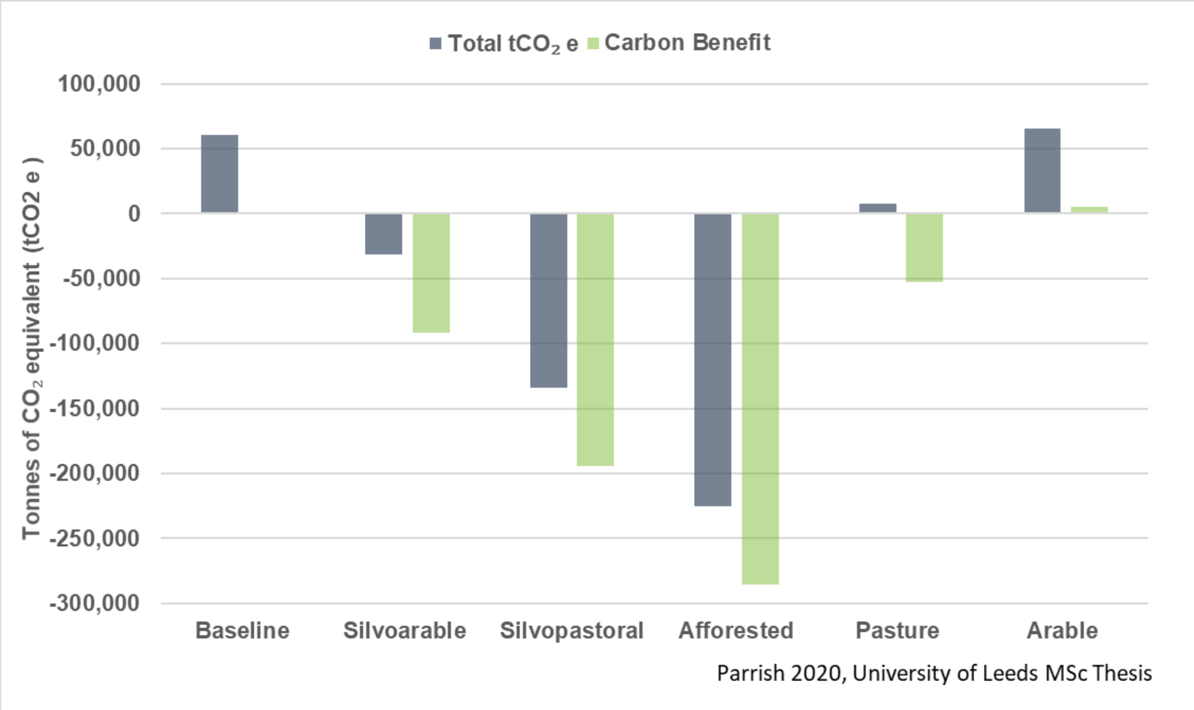

Figure 3. Emissions and carbon benefit from transition from arable to agroforestry (Source: Hayley Parrish)

Agroforestry can be defined as a form of sustainable land management; it integrates woody vegetation within arable crop land, known as silvoarable, or within livestock pastures, known as silvopastoral (Abbas et al. 2017). The results from a recent study assessed the potential carbon benefit from changing land-use management systems, with a particular focus on the conversion of arable and pastoral land management activities to agroforestry systems. The study found that for a large area of farmland (319ha), a silvoarable system sequesters carbon with an estimated carbon benefit of 3.35 tCO_{2e}/ha/yr, and for a silvopastoral system the benefit increases to 14tCO_{2e}/ha/yr. For a smaller farm (37ha) the carbon benefit for a silvopastoral system is 1.64 tCO_{2e}/ha/yr[79]. An online tool for estimation of sequestration and carbon benefits is available at the Carbon Benefits Project (CBP)[80].

Synergistic outcomes with bioenergy are possible; for example, strategic integration of perennial bioenergy crops with conventional crops can provide multiple production and environmental benefits, including management of dryland salinity, enhanced biocontrol and biodiversity, and reduced eutrophication (Davis et al. 2013; Larsen et al. 2018; Cacho et al. 2018). Dryland is defined by the United Nations Convention to Combat Desertification (UNCCD) as areas in which the ratio of annual precipitation to potential evapotranspiration falls within a range of 0.05 to 0.65[81].

[79] Parrish, H. (2020). An assessment of climate change mitigation potential of Agroforestry systems in Yorkshire, MSc Environment and Development Thesis, Leeds University.
[80] See: https://banr.nrel.colostate.edu/CBP/ Viewed 16/11/2020
[81] UNCCD (2017). Global Land Outlook, pp340. Viewed 12/8/2020 at https://knowledge.unccd.int/sites/default/files/2018-06/GLO%20English_Ch12.pdf

The impacts of land-use practices such as logging can affect CO_2 emissions. A recent study by Naturwald Akademie demonstrates that by cutting logging by a third, the amount of CO_2 sequestered could be increased from 245 million tonnes per year to 488 million tonnes, enhancing biodiversity benefits and the resilience of European forests[82].

Soil water dynamics adapting best practices

A typical natural floodplain in the Aire Valley and a managed floodplain on the River Ouse
(Photos: ©Graham Stead)

The UK and Ireland have a normal weather pattern of high precipitation in winter and low in summer, but increases in global temperatures with changes in weather patterns are expected to see extreme conditions becoming more frequent. Climate change and human activities impact on river flows, with reduced precipitation in summer resulting in reduced water supply and concentration of pollutants (Charlton and Arnell 2011; Sanderson, Wiltshire and Betts 2012; Charlton and Arnell 2014; Vicente-Serrano et al. 2019).

The UK is remarkably diverse in terms of its climate, topography, land use and patterns of water exploitation; each of these factors is of relevance to drought vulnerability (Marsh and Lewis 2011). Drought occurs in the UK every 5 to 10 years. In 2018, drought adversely affected agricultural practices across all regions in the UK. These periods of drought are due to the jet stream remaining increasingly largely static for longer periods to the south of the UK (Salmoral, Ababio and Holman 2020). A recent Met Office study[83] found that heat stress in dairy cattle is likely to increase from a few days annually to one and half months in the period of 2050 to 2070, particularly in the southeast of England. In this period, a 70% increase in frequency of blight affecting potatoes grown in east Scotland is expected due to high levels of humidity. The combined impacts from soil loss and erosion from wind shearing or storm run off present further challenges across UK regions.

[82] See: https://www.greenpeace.org/static/planet4-eu-unit-stateless/dc958adf-20201203_greenpeace_future_of_forests_in_the_eu.pdf Viewed 3/12/2019
[83] See: https://www.metoffice.gov.uk/about-us/press-office/news/weather-and-climate/2021/dairy-cattle-and-potato-blight-research Viewed 22/3/2020

Case Study

International best practice monitoring and controlling water usage on agricultural land

The UK only experiences periods of drought occurring at decadal intervals (for details of last period of drought, see: Salmoral, Ababio and Holman 2020), where there is a lack of a nationally cordinated water management management scheme, particularly for arable farmers. The government has recently responded to this with a flood risk and water resource management scheme, to be developed in the forthcoming Environmental Land Management scheme[84]. In the western United States there are may states, such as California, that are subject to severe or ongoing decadal drought with little rainfall and high rates of soil moisture evaporation. This is increasingly referred to as a megadrought event (Lehner et al. 2018; Williams et al. 2020; NIDIS 2020).

International best practice in irrigation management has been established in drought ridden California, with online tools to select the most suitable crops for cultivation. Water demand is controlled in an online service to farmers, based on ongoing daily monitoring data (from 2008) of potential evapotranspiration (ET_o) rates across the state at microclimate level[85].

Projected effects of climate change may affect water quality and soil water dynamics as a result of high sea levels and changes in weather patterns, with increased periods of flood and drought leading to pollution of water courses, loss of land, and changes in the chemical composition of water supplies and soils. Groundwater and aquifer depletion in periods of severe drought can reach a point where they cannot be replenished, and subsidence from groundwater depletion can be irreversible. Aquifers, particularly those nearer the coast, can become contaminated by salts, either by flood or natural sources. Others can become polluted, either by contaminated land or by natural chemicals through oxidation of metals, including arsenic, present in aquifer rocks (Fienen and Arshad 2016).

As more natural floodplains become subject to urban development, more areas become prone to flooding, so there comes a need for a more sustained approach to water retention. In East Yorkshire the Bransholme Storm Water pumping station stores surface water from the drains in an 111,000 m^3

[84] See: Farmers need key role in water management – NFU, 27/1/2021: https://www.fwi.co.uk/news/farm-policy/farmers-need-key-role-in-water-management-nfu Viewed 9/2/2021
[85] See: California Irrigation Management Information System. Viewed 14/7/2020 at https://cimis.water.ca.gov/

capacity lagoon[86]. Flood water and natural run-off can transport a wide range of pollutants into and out of the water system from industrial processes, agriculture, leakages from landfill, mining, and human waste. The Water Quality Archive produced by the Environment Agency (EA) shows the extent of pollution in water courses throughout the UK[87] and much of this can be traced to human activities on the land through drainage and run-off with the deteriorating quality of soils. The rapid urbanisation, industrialisation and intensifying agricultural production has increased the rate of nutrient input into water bodies, greatly accelerating water eutrophication (Yang et al. 2008). This, together with chemical pollutants from heavy industry, creates serious negative effects on the soil water dynamics, impacting on the use of water for irrigation and consumption, as well as on the environment as a whole. With the UK now outside the European Union (EU), any UK changes to EU legislation, such as to the Water Framework Directive[88], may reduce protections to surface and groundwater quality, adversely affecting land use and soil health.

A breach at Erith after the North Sea flood *(Photo: ©1953 UK Government (HMSO)[89])*

Tidal lock, River Idle-River Trent *(Photo: ©Graham Stead)*

Coastal agricultural land is prone to threats of flooding and erosion, which are significantly increased by episodic storm surge and wave setup at sea. This occurred in the North Sea flood of 1953, which resulted in the flooding and salination of 160,000 acres of agricultural land with extensive salt and sand deposits. Subsequent soil analysis showed concentrations of 50 to 60 tonnes of salt per acre

[86] Moffat, R., MacCann, P. and Pearson J. (2017). Bransholme Surface Water Pumping Station (2017), Water Projects Ltd. Viewed 9/11/2020 at https://waterprojectsonline.com/custom_case_study/bransholme-surface-water-pumping-station
[87] Environment Agency (2020). Water Quality Data Archive, Environment Agency. Viewed 11/11/2020 at https://environment.data.gov.uk/water-quality/view/landing
[88] See: https://www.legislation.gov.uk/uksi/2017/407/contents/made and http://www.nationalarchives.gov.uk/doc/open-government-licence/version/2/ Viewed 17/11/2020
[89] Hall, A. (2013). *The North Sea Flood of 1953. Environment & Society Portal, Arcadia (2013), no. 5. Rachel Carson, Center for Environment and Society. UK Government (HMSO).* Viewed 9/11/2020 at *http://<www.environmentandsociety.org/arcadia/north-sea-flood-1953*

deposited in some areas[90]. However, studies tend to omit the effects of long-term salinity on agricultural land[91].

A consequence of climate change will be a rise in sea level, with estimates ranging from one to three metres by 2100 (IMechE 2019), which will have a detrimental effect on land usage in these coastal as well as low-lying estuarine areas. The inadequate provision of sea defences was instrumental in the damage caused by the 1953 flood, which shows the importance of protecting the coastal areas from such events. The artificially maintained lowlands, such as Hatfield Chase and the Fens, were historically developed for agricultural use through drainage, the use of earth floodbanks, tidal barriers and pumping stations, necessary for maintenance. With projected sea rise, many of these existing flood defences and barriers may require substantial rebuilding.

Sea level rise, Coastal erosion, Loss of low-lying land

With sea level rise, coastal erosion is expected to increase, with much of the North East coast of England threatened, from Yorkshire and Lincolnshire down into the Wash and the fenlands of East Anglia. Significant land loss affects rural, urban and agricultural lands, coastal schemes such as the Saltfleet to Gibraltar Point Strategy Initiative that is being developed by the Environment Agency with coastal communities to reduce sand loss and flooding of low-lying land along a 30-mile stretch of the East Coast[92].

There is no doubt that ongoing rises in sea levels will result in loss of land and increased salination of lowlands from coastal flooding and estuarine flooding. Further loss of land due to changes to tidal zones and return of productive land to salt marshlands will increase the brackishness of freshwater aquifers through saltwater ingress.

Holbeck Hall landslide, June 1993 *(Photo: BGS ©UKRI)*

Erosion on east coast of England *(Photo: ©Jane Rickson)*

[90] Summers, D. (1978). The East Coast Floods, David & Charles, London, ISBN-10 : 0715374567 ISBN-13 : 978-0715374566.

[91] Gould, I.J., Wright, I., Collison, M., Ruto, E., Bosworth, G. and Pearson, S. The impact of coastal flooding on agriculture: A case-study of Lincolnshire, United Kingdom. *Land Degradation and Development* 2020; 31: 1545–1559. Viewed 9/11/2020 at https://onlinelibrary.wiley.com/doi/full/10.1002/ldr.3551

[92] See: non-technical-summary-sgp.pdf (environment-agency.gov.uk) Viewed 28/1/2021

A large proportion of the UK coast suffers from erosion, which started to occur well before the current opinions of climate change. In the case of the Norfolk coast, this is estimated as a 1–2 km retreat in the last 900 years (Poulton et al. 2006). The British Geological Survey estimate that the Norfolk coast has eroded at a similar rate for the last 5,000 years, though it is expected that this may increase with a rise in sea levels.

Elsewhere, however, the likely cause of the Holbeck Hall landslide on the Yorkshire coast in 1993 is attributed to a combination of heavy rainfall in the preceding two months and issues related to the drainage of the slope. Extreme weather events are becoming more intense because of climate change. The resulting landslip deposited 1 million tonnes of coastal cliff onto the beach, and over 70m of land and a hotel were lost[93].

Call for Action – Climate Change and Soil Water Dynamics

As positive feedback loops accelerate climate change impacts such as increasing intensity of extreme weather events, increasing emissions from rapid permafrost melting (Hugelius et al. 2020) and sea level rises impacting on coastal and low-lying land, it is essential that the UK and all other countries across the globe use their land resource in the absence of carbon removal or carbon capture technologies at scale. This presents a natural way of eliminating, storing and mitigating emissions at scale as global leaders begin to adopt and implement necessary short- and medium-term transitional plans, to address these urgent issues that face our world. This action will provide a UK countrywide adaptation development framework to be governed within the land-use and planning system. This will be best coordinated with urgent supply chain, distribution, transport, energy and fuel supply decarbonisation. There is therefore a pressing need for action by CEnvs which include:

- **Protecting and maintaining carbon stores:** Leading to improvement in adoption of best practice and long-term protection of UK carbon stores including arable soils, wetlands, peatland and forestry.
- **Intervening in land-use changes** at policy, development and planning levels to ensure that the most sustainable option is carried forward, reducing carbon intensity and increasing carbon sequestration.
- **Identification, development and implementation** of online digital platforms for monitoring, and planning tools to aid planners, landowners and users to adopt the most sustainable land-use options.
- **Reducing the intensity of arable crop farming** by encouraging the reuse of natural fertilisers, significantly reducing the emission and land degradation impact of chemical fertilisers and pesticides. In the UK, intensive agricultural practices have also resulted in soil organic carbon losses of between 40 and 60% (EA 2019).
- **Adapting agricultural practices** to encourage improved recycling of organic wastes into quality compost and anaerobic digestate (thereby supplying primarily stable organic carbon

[93] See: How to classify a landslide - British Geological Survey (bgs.ac.uk) Viewed 10/12/2020

and crop nutrients, respectively) and to encourage the use of cover crops to reduce soil erosion.

- **Development of hydroponic and other non-soil food solutions** to reduce horticultural land pressure in food production.

- **Addressing short-term commercial time frames**: Urgent intervention to influence government policies and decision makers of implementation plans to ensure that barriers caused by relatively short commercial time frames are addressed and aligned with longer-term strategic sustainability targets.

A summary of lists of actions to maximise the amount of carbon stored in land-based ecosystems is set out in the 2017 UNCCD publication[94](Liniger et al. 2017).

We also need to decarbonise supply chains by recycling more land and construction wastes that are lost to landfills, decreasing transport emissions using modern logistics software and tracking devices, selecting lower carbon multimodal options or transport providers minimising or eliminating fossil fuels, and choosing suppliers and distributors with the least carbon footprint. We can achieve this further by:

- **Reducing embedded energy losses** in supply chain supplies utilising digital platforms to maximise the reuse of and recycling of non-hazardous soils and stones.
- **Identification, development and implementation of online digital platforms** for monitoring, and planning tools to aid policymakers, planners, landowners and users to select the most sustainable transport and distribution options for supply and sales of stones and soil.
- **Influencing soil design and engineering** as soil greenhouse gas potential mitigation measures to minimise or eliminate low-level fugitive methane emissions on the ground.

Lastly, we must ensure the adaption of UK soil water management systems by:

- **Establishing and monitoring best practice restoration and maintenance** options for wetland and peatlands.
- **Encouraging the development of a national water management system** to monitor and manage water used for irrigation and choice of suitable crops.
- **Encouraging the development and use of water buffering** systems (both natural and manmade) to reduce the incidence and severity of flooding events caused by heavy rainfall.
- **Awareness of salination impacts** in low-lying land affected by coastal flooding.
- **Considering the role agricultural land could play** in the management of water retention strategies to prevent flooding events, and how farmers could be compensated for this**.**

[94] UNCCD (2017). Global Land Outlook, pp340. Viewed 12/8/2020 at https://knowledge.unccd.int/sites/default/files/2018-06/GLO%20English_Ch12.pdf

Case Study

Land drainage, the River Hull valley, East Yorkshire

The valley is mainly natural wetlands drained in the 18th century and incorporates a complex system of land drains and pumping stations. Land usage is mostly agricultural, with some industrial areas around Hull. Much of the water supply is from a chalk aquifer to the north and pumped groundwater. It is considered to be one of the most 'at-risk' developed floodplains in England, which without defences is at risk to flooding from the sea, river water, surface water and groundwater[95].

The groundwaters have suffered from over-abstraction to the extent that in the Beverley area the springs are now dry and the groundwater and chalk aquifer suffer from agricultural pollution, which is shown in the nitrate levels in the river and in areas has natural salt infiltration (Elliot et al. 1998). This suggests that the land quality of the valley is clearly vulnerable to changes in soil water dynamics.

William Chapman's drainage of the Carrs to the west of the River Hull (Photos: ©Graham Stead)

[95] East Riding of Yorkshire Council (2016). *The River Hull Integrated Catchment Strategy, East Riding of Yorkshire Council.* Viewed 9/11/2020 at https://www.eastriding.gov.uk/council/plans-and-policies/other-plans-and-policies-information/flood-risk/flood-risk-strategy/

Sustainable Development Goals

UN Sustainable Development Goals[96] (SDGs) set decadal global sustainability targets currently for 2030 and are essential in supporting the UK Government's climate change commitments to COP26[97] in November 2021 and the recently announced *The Ten Point Plan for a Green Industrial Revolution.*[98] Land use in terms of soil and stones is covered within all of these goals. The SDGs relate to human activities with soil and stones, which offer opportunities identified in this report for carbon storage, climate change mitigation and adaptation. These relate to the practical measures and good practices outlined in the call for action that CEnvs, and sector, entity and other stakeholder players can take on now.

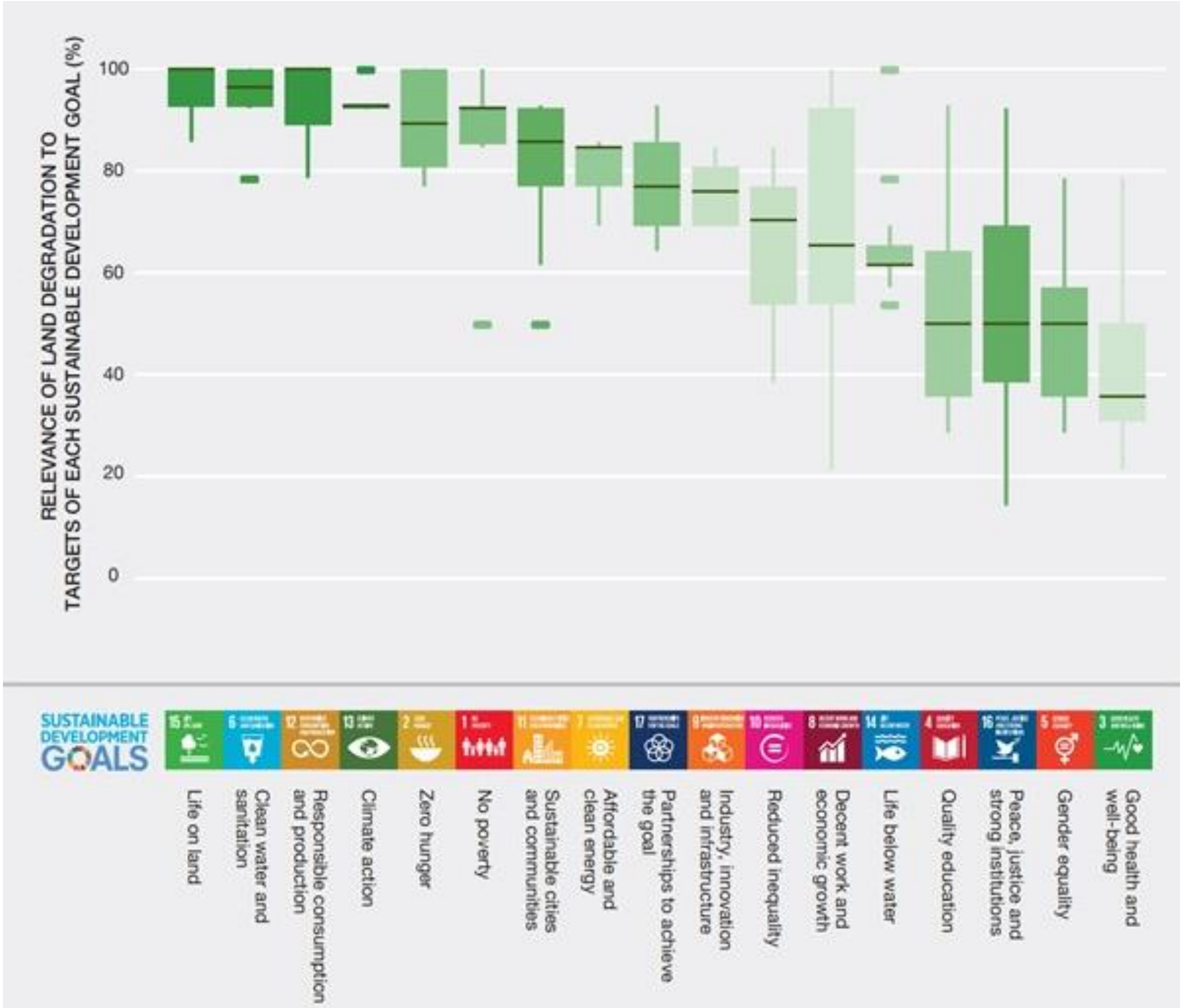

Figure 4. Relevance of land degradation to SDG targets (Source: IPBES 2018)

[96] See: http://sdgs.un.org/goals Viewed 17/11/20
[97] See: https://www.ukcop26.org/ Viewed 27/11/2020
[98] See: https://www.gov.uk/government/publications/the-ten-point-plan-for-a-green-industrial-revolution Viewed 27/11/2020

To illustrate the impact of just one of the features identified in this report, a chart showing the relevance of land degradation to SDGs targets is shown in *Figure 4*. The key SDG challenges (Bouma et al. 2019) influencing the call for action are derived from the themes of this report. The SocEnv Soils and Stones (SaS) Task Group has reviewed the SDGs in relation to the SaS Task Group's calls to action, mapping each to the respective SDG, with the aim of easing alignment of effort to the outcomes of this report, which are shown in *Table 3*. For sustainable remediation activities, CL:AIRE have recently published an online SuRF-UK Supplementary Report 1 & 2, which maps sustainable remediation practices across environmental, social and economic indicators against the UN Sustainable Development Goals[99].

Table 3: Mapping UN SDGs and SocEnv SaS Task Group's Calls for Action

SDG #		SaS Task Group's View	Call for Action
SDG 2: End hunger, achieve food security and improved nutrition, and promote sustainable agriculture	2 ZERO HUNGER	Intensive agricultural practices and impacts of climate change such as drought and flooding	HLaP 3 /7 /8 GIR 3 /4 CSR 1 /2 /6 CL 6 /7 SGP 1 /2
SDG 6: Ensure availability and sustainable management of water and sanitation for all	6 CLEAN WATER AND SANITATION	Soil contamination, run-off, and climate change impacts	HLaP 7 GIR 3 SGP 1 /2 /3 /5 /6
SDG 7: Ensure access to affordable, reliable, sustainable, and modern energy for all	7 AFFORDABLE AND CLEAN ENERGY	Bio crops and biomass cultivation, use and land development	HLaP 8 SGP 5 /6
SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialisation, and foster innovation	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	Sustainable use of soil and stones, design of major developments buildings and land use	HLaP 1 /2 /6 GIR 1 /2 /5 CSR 4 /5 /6 CL 1 /2 /3 /4 /5 SGP 1 /2 /3 /5 /6

[99] SuRF-UK (2020). Supplementary Report 1 & 2. Report 2 provides an Appendix I: Mapping actions to UN SDGs for sustainable remediation issues. https://www.claire.co.uk/projects-and-initiatives/surf-uk Viewed 20/1/2021

SDG #		SaS Task Group's View	Call for Action
SDG 12: Ensure sustainable consumption and production patterns	12 RESPONSIBLE CONSUMPTION AND PRODUCTION	Circular economy, use and recycling of stones and soils, embedded energy, transport	HLaP 1 /2 /3 /4 /6 GIR 1 /2 /5 CSR 1 /2 CL 1 /2 /3 /4 /5 SGP 1 /2 /4 /5 /6
SDG 13: Take urgent action to combat climate change and its impacts	13 CLIMATE ACTION	Impacts, mitigation, and adaption related to land, soils and stones issues including carbon storage and the conservation of peatbogs and wetlands	HLaP 1 /2 /3 /5 /6 GIR 1 /2 CSR 2 /3 /4 /5 SGP 1 /2 /3 /4 /5 /6
SDG 14: Conserve and sustainably use the oceans, seas, and marine resources for sustainable development	14 LIFE BELOW WATER	Sea level rise, coastal erosion, pollution, dredging and stone extraction, land loss and flooding	HLaP 4/7 GIR 3 /4 /5 SGP 1 /2 /3 /4 /5 /6
SDG 15: Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and biodiversity loss	15 LIFE ON LAND	Sustainable management of land, water use and irrigation monitoring and management systems	HLaP 1 /2 /3 /4 /5 /6 /7 GIR 2 CSR 1 /2 /6 CL 2 /6 /7 SGP 1 /2 /3 /4 /5 /6
SDG 17: Strengthen the means of implementation and revitalise the global partnership for sustainable development	17 PARTNERSHIPS FOR THE GOALS	Form strong and committed partnerships employing sustainable practice and design	HLaP 1 /6 /9 CSR 1 /2 /3 SGP 1 /2 /5 /6

Key: Table links to: **Theme Subgroups – Summary and Conclusions** (in next section below)
HLaP=Harmonising Legislation & Policy GIR= Green Industrial Revolution
CSR= Coordinating Stakeholder Response CL= Commercial Levers
SGP= Supporting Good Practice

Theme Subgroups – Summary and Conclusions

The urgency for policy commitment and implementation for soil and stones has been laid bare by these findings. Soil health and resilience to the ongoing and impending challenges is pressing. The ‘Calls for Action’ in each theme are related to their respective sectors. However, there are common aspects for opportunities between sectors, and improvements to the UK’s commitment to the SDGs.

This shows shared concern from all sectors, as well as significant efficiencies to be gained from the development and application of digital platforms, providing accessible live data management solutions in the post-Brexit regime.

Policymakers’ and planners’ alignment and consolidated legislation in a soils framework transcending sectors would enable Chartered Environmentalists to support understanding in their profession, regionally and nationally, influencing legislature policy in the development and improvement of much needed sustainable best practices. The intent is to call for meaningful change and impact from policy and legislature, with practicable and constructive action by landowners and developers. Common aspects in which CEnvs can influence change, and across the UK Devolved Administrations are set out in the following tables with the engagement of SocEnv Licensed Members (LMs) and partnering stakeholders:

Coordinating Stakeholder Response (CSR): Engaging and influencing key stakeholders in:		
Item	**Action**	**Lead body/ Stakeholder**
CSR1	***SocEnv SaS Task Group*** Establishing key areas of mutual cooperation, assessing risks and barriers to sustainable changes and engaging with policy and sector decision makers on the way forward to the adoption of sustainable soils and stones practices.	**Lead/ Chair:** SocEnv LMs Public and Private Sector Not for profit/ NGOs Representatives
CSR2	Building competence in application of soils and stones good practice within stakeholder groups. Working with key colleges and universities and key sector entities in developing sector-adaptable graduates able to gain experience in developing and demonstrating good practices.	**Policy Governance:** Defra, BEIS, NAO Devolved Environment Agencies Planning Authorities Local Authorities **Support and Advice:** Universities, LMs, RTPA, BRE, Funding Councils, ESRC, NERC **Implementation:** LMs, Universities, Other Organisations **Sector Implementation:** Industry Representatives
CSR3	Developing regulation and quality accountability through an auditable assurance process for soils and stones reuses that is needed for all sectors, with due rigour and regulatory accountability, as well as consistency of standard, discipline, and action. Requiring expertise for legislature, commercial incentive and regulation, policy guidance, knowledge awareness and training standards.	
CSR4	Widening the scope to include policymakers, regulators and sector managers that are subject to competence training through schemes such as WAMITAB, particularly in maintaining and improving soil health, reducing carbon intensity, and increasing sequestration of carbon in land-use and developments.	

CSR5	In line with the aims of the 25-Year Environment Plan, improving training opportunities for farmers, soil, and land-use professionals by allocating funds for technical advice to support farmers and land managers.	Training providers e.g. WAMITAB, CL:AIRE **Professional Development:** Young Graduate from LM

Harmonising Legislation and Policy (HLaP) for multisector regulation to significantly improve and address land-use issues and extend the use of sustainable best practices

Item	Action	Lead body/ Stakeholder
HLaP1	Creating a soil legislation framework to enable sustainable use of soils across different sectors.	**Policy Governance:** Defra, HMRC, Devolved Environment Agencies, Land-use Planning Authorities, Devolved and Regional Authorities, CL:AIRE **Support and Advice:** Universities, LMs, RTPA, BRE **Implementation:** Other Organisations, Crown Estates **Sector Implementation:** Agricultural and Industrial Representatives, Organisations such as BSSS, Landowners **Professional Development:** LM's Young Graduate members
HLaP2	Creating a more efficient and effective inter-sector regime of permitted soils and stones operators and the introduction of a bonded risk-based exemption scheme for UK self-regulation of soils and stones activities.	
HLaP3	Reviewing existing legislation and regulation for protection and restoration of healthy soils, for their sustainable use and management, with simpler common regulations within a common 'Soils and Stones Framework' and an ACoP for all soils reuse and recycling.	
HLaP4	Creating mandatory frameworks to generate harmonised guidance and standards for healthy soils based on land use and supporting the UK Government's 25-Year Environment Plan[100] to develop a soil health index that can be used on farms to monitor the implementation of best practices.	
HLaP5	Reviewing current fiscal and environmental barriers to the safe and sustainable reuse of soils and dredgings from land drains, ditches, canals, waterbodies and engineering works, including a review of waste exemptions, permits and a process to meet 'End of Waste' status, with sector equivalence.	
HLaP6	Supporting mandatory protection and maintenance of degraded peatlands and wetlands as well as other aspects of the UK's natural capital, substantially to increase the UK's carbon storage capacity.	**Policy Governance:** Defra, HMRC, Devolved Environment Agencies Land-use Planning Authorities Regional and Local Authorities CL:AIRE
HLaP7	Influencing UK Government to enable the principle of reducing the carbon intensity and increasing sequestration or mitigation to be incorporated into land-use planning, master planning and development regulations supported by online platforms and tools.	

[100] A Green Future: Our 25 Year Plan to Improve the Environment. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/673492/25-year-environment-plan-annex1.pdf Viewed 5/10/2020

HLaP8	Supporting legislation to reduce rapid land degradation caused by crop farming intensity and curb the excessive use of fertilisers causing eutrophication in surface water bodies and pesticides eliminating insects and pollinators.	**Support and Advice:** Universities, LMs, RTPA, BRE **Implementation:** Other Organisations, Landowners. **Sector Implementation:** Agricultural and Industrial Representatives, Organisations such as BSSS, Landowners, Trusts **Professional Development:** LM's Young Graduate members
HLaP9	Revising and updating the current land capability classification systems for both agriculture and forestry, including the updating of the meteorological data set, used to determine climatic limitations and irrigation for crop growing purposes – encouraging their wider use by land managers.	

Green Industrial Revolution (GIR): Influencing increases in efficiency of natural carbon storage, significantly increasing reuse and recycling, and reducing and managing crop yield losses in adverse climate conditions. Encouraging support in establishing funding initiatives from the Environment Land Management schemes detailed in the recent HM Government Ten Point Plan for a Green Industrial Revolution. Key initiatives could include:

Item	Action	Lead body/ Stakeholder
GIR1	Encouraging the development of a **national digital platform, based on the DoWCoP managed by CL:AIRE, for soil and stone reuse**. Influencing sector wide adoption of sustainable best practices with access to self-governance features, including guidance checklists and online tools to aid and inform day-to-day management.	**Policy Governance:** Defra, BEIS, Devolved Environment Agencies **Support and Advice:** Universities, LMs **Implementation:** CL:AIRE **Sector Implementation:** Industry Representatives **Professional Development:** LM's Young Graduate members
GIR2	**Developing a soils platform** to provide a means to share information and collaborate in areas of mutual interest.	**Policy Governance:** Defra, BEIS, Devolved Environment Agencies **Support and Advice:** Universities, LMs
GIR3	Digital platform monitoring of land use and land-use changes in relation to biodiversity, carbon intensity and sequestration in existing and new developments, agriculture, forests, wetlands, and peatlands, as well as areas set aside for natural wilding.	

GIR4	Creating a digital platform of land irrigation and water use, to enable adaptation features involving crop selection and irrigation management improving crop yields in areas prone to increasingly long periods of drought.	**Implementation:** UKSoils, CL:AIRE, BRE, Other Organisations **Sector Implementation:** Industry Representatives, IT professionals **Professional Development:** LM's Young Graduate members
GIR5	Encouraging the development of hydroponics (and other non-soil) food production, monitoring key aspects and impacts to ensure supply chains, crop grown, processes, wastes, water usage and pollinators are sustainably maintained.	**Policy Governance:** Defra, BEIS, Devolved Environment Agencies **Support and Advice:** Universities, LMs **Implementation:** Other Organisations **Sector Implementation:** Industry Representatives **Professional Development:** LM's Young Graduate members
GIR6	Encouraging urban infrastructure and building design that makes use of and maximises the reuse of soils and stones, reduces virgin aggregate and stone and soil use, and minimises its impacts from use of materials such as concrete and plaster – by selection of suppliers reducing supply chain embedded emissions in their supply chains and providing practical recycling routes or options.	**Policy Governance:** Defra, BEIS, Devolved Environment Agencies, Planning Authorities, Local Authorities **Support and Advice:** Universities, LM professionals, RTPA, BRE **Implementation:** Other Organisations **Sector Implementation:** Industry Representatives **Professional Development:** LM's Young Graduate members

Commercial Levers (CLs): Incentivising good practice and penalising unsustainable practices		
Item	**Action**	**Lead body/ Stakeholder**
CL 1	Intervening to influence government policy review and the decision makers of implementation plans to ensure that barriers caused by relatively short commercial time frames are addressed and aligned with longer-term strategic sustainability targets.	**Policy Governance:** WTO, HM Treasury, Defra, HMRC, BEIS, Devolved Environment Agencies, Land-use Planning Authorities, Devolved and Regional Authorities, NALGO, COSLA, NILGA **Support and Advice:** Universities, LMs, RTPA, BRE **Implementation:** Other Organisations, Crown Estates **Sector Implementation:** Agricultural and Industrial Representatives, Organisations such as BSSS, Landowners **Professional Development:** LM's Young Graduate members
CL 2	Influencing HMRC[101] to provide incentives through a waste levy that is tiered in favour of material reuse declarations, which would make the market transparent and dissuade sham recovery practices. Encouraging the market development of permitted consolidation centres for 'End of Waste' non-hazardous soils and stones, that enable registered producers to drop off and users to pick up supplies for reuse.	**Subgroup:** HLaP1 to 5 and GIR1
CL 3	Allowing or exempting short-term storage or banking for 'End of Waste' non-hazardous soils and stones within development boundaries for up to 3 months where space allows, when suitable options for reuse elsewhere are not immediately available or a consolidation centre for soils and stones is not available within a 30-mile radius of the development site.	**Subgroup:** HLaP1 to 5 and GIR1
CL 4	Encouraging the use and renewal of annual bonds by self-regulating operators to assure compliance with regulatory requirements linking the annual bond value to operator good	

[101] See: Landfill tax detailed information at https://www.gov.uk/topic/business-tax/landfill-tax Viewed 28/11/2020

	practice performance in reusing and recycling soils and stones, providing evidence via an online resource and random compliance checks made by the devolved regulatory authorities.	
CL 5	The adoption of national digital platforms to encourage self-regulation, heathy soils, managed crop choices and irrigation as well as land management of carbon and increasing soils and stones resource reuse and recycling across all sectors.	**Subgroup:** GIR2, GIR3, GIR4
CL 6	Incentivising farmers and landowners to adopt sustainable best practices in eliminating land degradation and carbon intensity, working with healthy soils, and options to make contributions to carbon sequestration and biodiversity by working with nature.	**Subgroup:** HLap6 to 9

Supporting Good Practice (SGP) across all sectors and activities		
Item	**Action**	**Lead body/ Stakeholder**
SGP1	Bringing together key stakeholders in the adoption of best practices to improve soil health, efficiency in reuse and recycling of soils and stones, and utilising land-use management across all sectors as a means of substantively increasing natural carbon storage in existing and new developments.	**Policy Governance:** Defra, HMRC, BEIS, Devolved Environment Agencies, Land-use Planning Authorities, Regional and Local Authorities, Higher Education, CL:AIRE **Support and Advice:** Universities, ICE – Life Cycle and Supply chain emissions, LMs, RTPA, BRE, WRAP, Funding Council – ESRC, NERC, etc. **Implementation:** Other Organisations, Training and development entities, Accreditation entities, British Standards, PAS, etc. **Sector Implementation:** Agricultural and Industrial Representatives,
SGP2	Demonstrating the benefits (financial and otherwise) of good soil management through case studies, highlighting best practice through beacon or demonstration schemes.	
SGP3	Adopting best practices that improve land management, soil carbon and health, or as an engineered base for urban and industrial development as well as an adaptation means to alleviate flooding from extreme weather events including SUDS.	
SGP4	Identifying and assessing new green technologies that provide work and prosperity supporting biodiversity and healthy soil and making use of soils and stones as a resource within the circular economy working towards zero waste.	
SPG5	Supporting research on the impacts of salination from coastal water flooding of low-lying land.	

		Organisations such as BSSS, Developers, Land users/ Owners **Professional Development:** LM's Young Graduate members
SGP6	Working with key stakeholders in signposting sources of information, guidance, standards, management options and interventions, for example through a regularly updated website. Improving professional standards of those able to advise, monitor and manage soils and stones issues.	**Subgroup:** SPG1 to 5 International Organisations (UNEP, UNCCD, IPCC)

SocEnv propose that these five action themes are coordinated by a 'Soils and Stones Programme Board' comprising the SocEnv Chief Executive, or a deputised lead as Chair, with the SaS Task Group leads. The approach would need resource support for programme management and technical secretariat to deliver over 2–5 years, with Project Boards that will be required for each of the action themes. SocEnv will invite LMs to lead and support the stakeholder working groups listed in the tables above, to progress these actions with short-, medium- and long-term timelines.

The LMs who engage with this process will pass on invitations to their own Special Interest Groups and members, to both represent the Licensed Member but also, with prior permission, those from international organisations, public entities, research organisations and private multisectoral groups indicated in the lists. Where gaps occur in a working group's structure, invites will be sent to stakeholder organisations or key sector groups to participate.

As the Project Boards assemble, Terms of Reference will be agreed, scoping the objectives and range of issues to be developed by the Board members, as well as their composition and organisation. The actions listed above may be developed and proposed back to the Programme Board for progression. Monitoring and targets will be led and agreed between the Project Boards and the SocEnv Soils and Stones Programme Board. The structure may be fluid to allow members to join or participate in associated task groups, to coordinate issues and actions, as well as programme plans. Executive sponsorship and progress reporting will be provided to the SocEnv Board and its Partners.

Society for the Environment Soil and Stones (SaS) Task Group – Call for Action

When the UK Minister responsible for the Environment recognises **a national emergency facing soils needing urgent action**, it is encouraging that the message is being both heard and understood. This raises the concern that the **prior government focus** on air and water quality has been **at the expense of soil and land**, the quality of which is less visible, less understood and has a more significant legacy impact due to soil chemistry and complexity.

The call for action by every profession and trade working with soils and stones, across each sector, has **never been more urgent**. The SocEnv SaS Task Group has demonstrated that given the opportunity, CEnvs can lead, collaborate, and challenge common barriers, becoming **catalysts for sustainable change** within their sectors and with their peers, between sectors. In the complexity of integrated business systems and ecological landscapes, these skills are **essential to address macro national risks that transcend geo-political frameworks.**

We must understand and respect soil, and that begins with how we talk about soil. The **language we use** reflects the depth of understanding and respect for soil. Demeaning the material beneath our feet as dirt, muck or waste undermines our own existence. As custodians of this valuable, biochemically diverse material, we need to ensure that soils and stones are protected in a way that reflects **our growing and deep concern for natural resources**, which must be demonstrated in the practices we employ and not be **frustrated by contradictory regulation and guidance**.

Our commitment to future generations requires sustainable extraction and use, and effective recycling and recovery, often requiring removal, treatment and reduction in contamination that is choking our environment. Habitats will only flourish, **urban and agricultural land will only keep giving** if silts and dust are kept bound with the ground. Preventing run-off, soil particles or loss of nutrients from being lifted from open ground requires non-till practices and progressive ground works practices with early landscaping, to **pre-empt and adapt to climate change** impact on open, bare grounds in extreme drought or storm periods.

This report is the first stage that will start a process, focusing CEnvs in the development and acquisition of the **necessary tools, training, skills and knowledge and best practice** to face the great challenges and difficult decisions in the not-so-distant future.

To support and enable the delivery of the recent UK Government **Ten Point Plan for a Green Industrial Revolution** and **the implementation of Defra's 25-year plan**, SocEnv will seek to **bring together the resources** that are needed to substantively increase the capacity and **enhance the capability of environmental professionals**, assuring that the necessary key sustainability principles, aims and practices are applied across all sector soils and stones activities. This will support and build the necessary environmental professional expertise to face the challenges of the future.

This support will focus on the following areas:

- **Embracing the digital economy**;
- The recovery and maintenance of **healthy soils**;
- The establishment, **mandatory protection and maintenance of natural carbon stores**, in planning;
- The **reduction of land-carbon intensity and increased sequestration** applied to all land-use developments; and
- Ongoing review of policy and guidance interventions to **increase recycling of soil and stones**.

The SaS Task Group has not repeated the exemplary science and detailed assessments; it is looking at what needs to happen now by **focusing on how we might collaborate and overcome the barriers in adopting best practices** for the effective protection and management of soil and stones, today and for future generations.

The timing of the calls for action could not be better, with the emerging recognition that for too long, soils have been secondary to air and water within the public attention. **Now is the time to 'build back better'** and ensure that we build upon firm foundations, **protecting the fragile and essential soils beneath our feet**.

SocEnv will work towards achieving all the objectives that the task group has worked hard to progress, namely: **improved positioning of soils and stones, better monitoring and enforcement**, and the facilitation of collaboration including **sharing of good practice across sectors.** To achieve this SocEnv will:

- **Lead on the implementation** of the Calls for Action in this report with its Partners.
- **Collaborate and partner with organisations** to raise profile for soils and stones protection, supporting the UK Soils Platform launched on World Soils Day 2020, to signpost knowledge and like-minded bodies.
- **Secure and coordinate resources** to enable us to support our Licensed Members and CEnvs in fostering training and education that reflects best practice, including informing and influencing school curricula, skills training, university courses, research, standards and tools – linking environmental professional practice with education.

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