BRITISH SOCIETY OF SOIL SCIENCE

International Union of Soil Sciences

GLASGOW22

22ND WORLD CONGRESS OF SOIL SCIENCE

SOIL POLICY LEGACY REPORT

DECEMBER 2022

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Sustainable natural systems and effective global policies: how to protect a resource that supports life on Earth

The Soil Policy event held at the 22nd World Congress of Soil Science in Glasgow, Scotland, was the first session of its kind, drawing together an expert group of 14 invited speakers to discuss the complexities, challenges and opportunities of soil policy and governance.

Included in this Legacy report are the main findings of the session, as well as dedicated articles from several speakers from that day.

BRITISH SOCIETY OF SOIL SCIENCE

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FOREWORD, DR BRUCE LASCELLES (BSSS PRESIDENT 2021-2022)

We were delighted to host the World Congress of Soil Science 2022 during the 75th anniversary of the British Society of Soil Science (BSSS).

BSSS is an established international membership organisation and charity committed to the study of soil in its widest aspects. The society brings together those working within academia, practitioners implementing soil science in industry and all those working with, or with an interest in soils. We promote research and education, both academically and in practice, and build collaborative partnerships to help safeguard our soil for the future.

From the outset, we knew that we wanted the World Congress of Soil Science to continue to be the place to share the latest scientific knowledge amongst researchers. However we recognised that we also needed to make sure this scientific knowledge was transferred into guidance for policymakers.

As a result, we delivered the first ever policy day during a World Congress of Soil Science. The oversubscribed event included presentations from researchers, lobbyists, practitioners, and policymakers. We heard from speakers highlighting the continued gaps in knowledge which prevent policymakers from decisionmaking and from practitioners implementing exciting projects with the support of their local governments.

This note is a record of several of the presentations which took place and provide an overview of the current soils policymaking landscape, in the UK and worldwide. It highlights where we could do better and where there is already significant work being done to support the services delivered by our soils.

I would like to take this opportunity to express my thanks to Eleanor Reed, who provided so much of her time to developing the programme and chairing part of the day. I would also like to thank her predecessor in the role, Ian Rugg, who was instrumental in developing the concept for the day.

This note cannot however be the end. We know that policy evolves, as does research and best practice. This means that there is the need to develop an ongoing relationship between the scientific community and policymakers.

As our new President, Jack Hannam, takes our strategy forward, we will continue to see the links between researchers, practitioners and policymakers, high on our agenda. We believe we have a key role in facilitating this discussion as part of our responsibility in representing all facets of soil science from within the UK and internationally. We have committed to host a policymakers' session at future Annual Conferences, to ensure our governments have the right evidence, at the right time, so that they can make the right decisions on behalf of us all.

WCSS 2022 SOIL POLICY EXECUTIVE SUMMARY

The Soil Policy event at the World Congress of Soil Science 2022, drew together an expert group of invited speakers, policy makers, academics, regulators, advisers, politicians, scientists, students and industry. Focused on solutions and contribution to environmental targets, such as net zero; climate change mitigation and adaptation; food security and biodiversity recovery, the day facilitated knowledge exchange and engagement.

The complex soil policy challenges were debated with barriers, challenges and learnings highlighted and actions needed to address the degradation of soils discussed. Common threads which ran clearly through the day's discussion bode well for future collaboration to deliver more effective soil policy and governance to drive action and protect our soils for the future.

BARRIERS AND CHALLENGES

Overarching framework for soil policy: Currently there is no binding overarching framework that strategically defines policy priorities, goals or parameters for soil protection. Long-term actions are more complex to control, less visible, harder to measure and more likely to involve controversial choices, making it more difficult to make progress without building coalitions.

Siloed working: The nature of siloed working and the lack of focus on prevention make it easier for policymakers to pursue short-term solutions. Many soil policies can be difficult to formulate and implement well, because they depend on a level of knowledge, mobilisation, governance and policy control that is rarely possible in real life. For more complex problems, it is often not entirely clear what is driving a problem, and the number of stakeholders involved make it difficult to disentangle cause and effect.

Overcoming systemic challenges: Countries and regions are facing large, systemic challenges, such as financing gaps, tackling cross-cutting issues and breaking down boundaries between different disciplines and policy areas, resulting in an inability to invest in research, data analysis, and a lack of enforcement capacity when policies and actions are adopted.

Slow uptake of actions: Fostering the uptake of sustainable soil and land management is a complex process and impacting policy is difficult, due to the challenges translating research into policy-speak and to those inherent in the policymaking process itself.

Gaps in knowledge and policy: Although progress has been made across the various sectors in adopting key policies and actions known to reduce soil erosion, degradation and pollution, significant gaps remain.

RECOMMENDATIONS

Rather than just focusing on personal, local and regional agendas, it is essential to think nationally, internationally and globally and highlight the real societal costs, such as inadequate nutrition, of soil pollution to government. Significant progress is needed to put into place the Zero Pollution Action Plan for Air, Water and Soil, to protect and restore our soils, to adopt sustainable soil management practices, identify and remediate contaminated soil sites, and improve the monitoring of soil quality.

To create real change, where scientific knowledge best influences real-life policy, the British Society of Soil Science and our speakers recommended that: "to raise soil's political profile, we must look at three phases of soil policy evolution:

RAISING AWARENESS

Building an understanding among policy makers

RAISING AMBITION

Joining forces and building a case for soil in pivotal umbrella policies

EXECUTION

Detailed and targeted policy development, building consensus at strategic and operational levels

To enable all of this we need consensus from the scientific community at the most fundamental level – on how we classify our soils, on the protocols for monitoring them, and that everyone can access and make full use of this critical information. This is vital so that common metrics can flow, and a common language and understanding can underpin every soil assessment and improvement initiative. This is the leadership we need from the scientific community." ***Ellen Fay, Sustainable Soils Alliance***

WE CAN TAKE THE FOLLOWING STEPS TO ACHIEVE THIS TOGETHER:

BUILDING AN UNDERSTANDING, RAISING AMBITION, JOINING FORCES AND BUILDING A CASE FOR SOIL EXECUTION

"Healthy soils need to be at the heart of the European Green Deal. The Soil Health Law will provide the path towards Healthy Soils across the EU by 2050. Sustainable soils should be the new normal for Europe, people, food, nature and climate. Soils are essential for achieving climate neutrality, a clean and circular economy, reversing biodiversity loss, providing healthy food, safeguarding human health, halting desertification and land degradation. A framework and a set of parameters are needed for protection, sustainable use and restoration of soils. Key action at national level were identified: set net land take reduction targets, integrate land take hierarchy and give priority to re-use and recycling of land and the quality of soils through appropriate regulatory initiatives." ***Arwyn Jones, Joint Research Centre, European Commission***

"We need to safeguard and enhance the vitality and productivity of soil through scientific research and advancement and highlight how a comprehensive strategy is needed to increase the adoption of soil health management systems. To assess soil health, we must identify the most effective indicators to qualify changes in soil health and develop a soil health reference for farmers and stakeholders. We must also make a soil business case." ***Cristine Morgan, Chief Scientific Officer, Soil Health Institute USA***

"Soil science should play a crucial role in re-connecting stakeholders and citizens with the policy arena and the huge communication gap between researchers, the environmental policy arena and land users, among which farmers are the largest group, needs to be addressed. The focus needs to be on "services" provided by ecosystems to mankind in terms of producing healthy food, protecting soil and water quality, combating climate change and land degradation. Soils play a major role in all of this. Measurements can provide information on these services and on thresholds, separating 'good' from 'not good enough'. This would, when part of legislation, provide much needed clarity and in doing so, soil science plays a key role." ***Johan Bouma, Emeritus Professor of Soil Science, Wageningen University***

"We all need to come together for the importance of soil being recognised, in the hope that our combined efforts trigger adoption by countries of different tools and definitions. Partnerships, gender balance and inclusion of youth in soil are crucial and should be common action. As the way forward we must continue advocating soil governance at regional and national level, raise awareness to the general public on the importance of soil, implement a new GSP action framework, promote soil solutions in the UN convention and advocate for investment on suitable soil management." ***Ronald Vargas, Secretary of the Global Soil Partnership, Food and Agriculture Organization of the United Nations (FAO)***

"We must develop a national soil strategy with the overarching objectives: to reduce and manage soil consumption on the basis of an overall perspective, protect soil from harmful impacts, restore degraded soils, improve awareness of the value and sensitivity of soil and strengthen international commitment. Key factors for success include a high 'level of flight', loose co-operation with federal offices for agriculture and for spatial planning, the support of the minister in charge, goal of no-net-soil-loss as an attention-gathering topic, national and international activities and the 2030 agenda of the Global Soil Partnership (FAO 2012). The mission is to ensure that the functions of soil are guaranteed in the long-term, so that future generations are also able to use this finite, non-renewable resource for their own needs." ***Ruedi Stähli, Scientific Officer, Swiss Federal Office for the Environment***

It is essential to balance immediate needs with longer-term investment, build a business case, model cost-benefit analysis and provide a clear roadmap to unlock value through technology and data linkage across businesses, government, communities and individuals. We must learn from other disciplines and industries, find common ground, link stakeholder groups, personalise each journey and move away from a one size fits all approach to deliver step changes, behavioural change and knowledge exchange.

"There is a real need to understand gaps in science related to climate change, to look at data infrastructure and soil health indicators that provide value for money and address the need for soil monitoring frameworks to underpin robust environmental policy development. International collaborations are key to success." ***Mathew Williams, Chief Scientific Adviser (CSA) Environment, Natural Resources and Agriculture, Scottish Government***

"We must secure positive behavioural change of farms, delivering multiple public wings, empowering farmers to make better quality decisions, securing consensus and delivering integrity and transparency." ***John Gilliland, Director of Agriculture & Sustainability, Devenish Nutrition***

"Restoring soil health means from the level of the farm up to the level of the food system with key focus on joining the dots between climate, nature and health and with soil health being at the heart of the shift to agroecological farming and land use. There are seven ways to restore soil health, looking at soil monitoring, increasing organic matter, reducing soil disturbance, covering bare soil with continuous plant cover, planting more trees on farmland, reducing soil compaction and designing crop rotation to improve soil health. It is important to link up farmers, academics, advisors, researchers and businesses to find lasting solutions to practical problems. The ideas are often coming from farmers themselves." ***David McKay, Head of Policy (Scotland), Soil Association***

"Reliable and robust data collection, national soil testing programmes, better knowledge exchange - providing farmers and growers with the knowledge and skills they need, and taking a more tailored and holistic approach to encourage soil health, are key. Improved soil health provides multiple benefits for food production, climate resilience, carbon storage, water management and numerous environmental benefits. In our academic discussions and legislation deliberations, we need to make sure we create understandable policies for practitioners to deliver." ***Phil Jarvis, Member of the NFU Environment Forum***

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BRITISH SOCIETY OF SOIL SCIENCE

Critical Soil Governance Lessons From The Around The World: The Good, The Bad And The Ugly

Lewis Peake,
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CRITICAL SOIL GOVERNANCE LESSONS FROM THE AROUND THE WORLD: THE GOOD, THE BAD AND THE UGLY,

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ABBREVIATIONS

FAO: UN Food and agriculture organization
LDN: Land degradation neutrality
PFP: Prime farmland preservation
NPP: Net primary production
SDG: Sustainable development goal(s)
SES: Soil ecosystem services
SSM: Sustainable soil management

INTRODUCTION

This article is one of several outputs based on independent research into international, national and sub-national soil governance, conducted primarily from mid-2020 until early 2022, and still ongoing. Data was acquired from a wide range of sources, including the FAO soil law online databases FAOLEX and SoiLEX, an extended literature search, international and national websites, and personal communication. Every country[1] was assessed, to the extent that information was available or could be inferred, and many self-governing states within countries were included, where important distinctions became apparent. Further details about the methods used can be found elsewhere [1, 2].

The vital importance of soil and the provision of essential soil ecosystem services (SES) to humanity have been identified and reiterated so often that this needs no further explanation here. However, of particular contemporary relevance is the role of soil in exacerbating or mitigating climate change.

THE COMPONENTS OF SOIL GOVERNANCE

Soil governance refers collectively to any policies, laws, regulations, management strategies, informal traditions or other institutional or individual behaviours that influence the use or protection of soil, and encompassing threats posed by soil. Soil is subject to four broad categories of anthropogenic threat, which can overlap:

1. soil degradation
2. destruction or conversion of natural ecosystems
3. conversion of farmland to urban or industrial use
4. public health issues arising from soil use, transformation or disposal.

Targeted policy instruments designed to prevent or mitigate one or more of these threats can be categorised as follows:

A. Regulations to prohibit (or guidance to discourage) certain actions
   i. enforced by penalties
   ii. facilitated by financial support
B. Restrictions on development involving change of use
   i. enforced by zoning laws
   ii. enforced by laws (or encouraged by guidance) based on ad hoc site evaluation
   iii. enforced by public acquisition of land
   iv. facilitated by financial support
C. Generic incentives to preserve land or to enhance its ecosystem services value
   i. taking land out of agricultural production
   ii. converting intensively farmed land via extensification
   iii. declining to develop land or intensify its use

However, beyond these specific problems and solutions, comprehensive soil governance embraces a much wider remit. Best practice should include most, if not all, of the following criteria:

1. a national soil policy, or one or more other policies that prominently feature soil as a priority.
2. one or more laws that offer unambiguous protection or amelioration for soil from degradation (e.g., erosion, contamination, nutrient depletion, salinization or structural damage).
3. promotion of soil health and strengthening of SES, including climate change mitigation, supported by soil monitoring.
4. legal protection for natural ecosystems and fostering of forestation or ecological restoration.
5. policies and laws promoting PFP.
6. implementation of LDN or its equivalent via land protection and/or restoration, or land take[2] limits.
7. a commitment to the UN SDGs including no poverty and zero hunger, addressing for example, food security, land tenure, farm support, gender equality, and Indigenous peoples' rights.
8. schemes encouraging regenerative agriculture, agroecology, sustainable land management (SLM) and SSM including *inter alia*, agroforestry, minimum tillage, cover crops, leys, organic farming, climate-smart agriculture (CSA), IPM[3] and payments for ecosystem services (PES).
9. a program of soil science education, professional training and accreditation, support for soil related research, as well as general communication to citizens of the importance of soil to society and to the environment.
10. effective governance, i.e. implementation of best practice, enforcement of laws, respect for legal rights, freedom of information and a lack of corruption.
11. policies and practices that also reflect a regional and global perspective on all of the above.

FROM THEORY TO PRACTICE

Effective soil governance is facilitated by, though not contingent upon, creating a published soil policy. The policy needs to be translated into soil laws, but even this is inadequate, if the crucial third step is not achieved: implementation and comprehensive enforcement. Many states have achieved the first two steps, but very few the third. Yet the first two steps, though helpful, are not an absolute prerequisite because, paradoxically, a very small number of states have effectively achieved the third step, i.e. best practice soil governance, without these foundations. In such cases this has occurred due to soil protection being explicitly incorporated into other policies or practices, such as in Cabo Verde [3], or a long-established tradition of assiduously protecting soil and traditional agroecological systems in parts of the Himalayas [4, 5].

Over 90% of the world's countries have policies or legislation that refer to soil, but only 45% have one or more explicit soil laws, and only 15% have a published soil policy, i.e. a standalone document

[1]"Country" refers to national states recognised by all members of the UN, currently numbering 193, along with Cook Islands and Niue, which have entries in FAOLEX, and are described as independent states in free association within the Realm of New Zealand. [2]Land take refers to the consumption of rural land by urban and infrastructure development. [3]Integrated pest management (an environmentally-sensitive pest control strategy that minimises the use of synthetic pesticides)

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devoted to soil protection. Farmland protection or restricted land take, also exists in some form, in the policies or legislation of approximately 90% of countries, if one includes adoption of LDN policy [6], without which the figure falls to 50%. However, the substance of many of these legal instruments consists of little more than high-level guidance, with only 22% of countries stipulating mandatory PFP laws. Furthermore, these data purely measure documented legislation, not enforcement, which evidence suggests frequently falls well short of intent [7-9] or creates unforeseen problems [10]. These figures have been extracted from a detailed review conducted in 2021 [1]. The data have been revisited and updated since, to some extent, but any subsequent changes are likely to be minor; some of these laws are more than a century old and legislative changes tend to be gradual.

When considering what facilitates or hinders soil governance, one can loosely define five groups of stakeholders or actors that are agents of change in this space. First and foremost, perhaps are landowners and land managers, who usually have the most direct relationship with and dependence on soil, from farmers to national governments. In close collaboration with the first group, are the soil practitioners: agronomists, surveyors, field scientists, etc. Thirdly are the policymakers, in the broadest sense, not just politicians and civil servants, but lawyers, NGOs, charitable trusts, consultants, educators and even members of the public, i.e. anyone who might influence policy or how it is applied. A group that can be more influential even than policymakers are developers, primarily within the construction industry, but representing merely the tip of the iceberg of commerce and market forces. Last, but not least, are the independent communicators: academics, journalists and whistle blowers.
Each of these groups can act, deliberately or inadvertently, in protective or destructive ways, or sometimes in both directions simultaneously. Individuals may also occupy more than one group. This makes for a complex network of relationships with many potential conflicts of interest. Negative outcomes are sometimes the unintended consequences of legitimate, but often short-term, vested interests, but can also be the result of a range of systemic weaknesses or failures.

LEVELS OF NATIONAL ATTAINMENT

To appreciate the practical realities and effectiveness of soil policies and laws in a given country, it is necessary to put the percentages above into a more nuanced context by considering the less tangible aspects of soil governance that evidence implementation and enforcement. Hence, as part of the same study, a range of sources, including global indices of probity and environmental performance, was used to group countries according to their soil governance attainment levels, a league table of sorts. Such an exercise inevitably incorporates a degree of subjectivity, and is therefore potentially controversial, but great care was taken to cross-check multiple sources from a variety of media. A complete absence of relevant information for some countries was also instructive.

Despite many recurring soil governance features throughout the countries of the world, this exercise also emphasised the fact that every country is unique and has its own priorities and preoccupations. One size certainly does not fit all, as becomes all too apparent in any literature search. For example, some countries are historically so strongly associated with a single aspect of soil governance, such as forest protection, soil conservation, farmland preservation or agroecology, that it can be extremely difficult to find information on any other aspects of soil governance in those places.

On the one hand, this highlights the need to assess each country accordingly and cautiously, because specific laws that are critically important in some countries may simply be inapplicable or much less important in others. On the other hand, such insights can also reveal potential weaknesses and risks, in the form of policy gaps, such as where the absence of a law that has never been perceived as a need, exposes a country to new risks, as its society changes. A clear example is provided by Bhutan which is renowned for its exemplary forest protection and tradition of sustainable agroforestry.

However, while Bhutan's agricultural and land zoning policies acknowledges the need to protect and improve its very scarce fertile soil [11], no legal instruments have been created to prevent the loss of productive farmland, some of which is being consumed by accelerating urban development [12, 13].

Five levels of soil governance attainment are defined below, with approximate percentages of countries in each:

Level 1: little or no soil governance (20% of countries)

This refers to states where generalised environmental or agricultural policies may exist, but soil-related law and policy appears to be virtually absent. However, this group also includes some small island or desert nations, where what little soil or cultivable land there is, may already be carefully managed and protected by tradition.

Level 2: inconsistent enforcement often amounting to soil governance in name only (55%)

This group includes states that have law and policy instruments to address soil governance, some very robust in language, but coupled with ineffective governance, including widespread lack of enforcement. There are multiple causal factors, but common problems include immature administrative and legal institutions, and large disparities of wealth and power, leading to economic pressure to ignore best practice policies or to circumvent legislation [14, 15].

Level 3: limited or tactical soil governance (19%)

Many states, including most of the world's top ten economies, have achieved a measure of success in formal soil protection, but good intentions are not always supported by effective implementation or enforcement. Most states following this course tend to apply a range of laws and policy measures, including economic measures, such as zoning, taxation, incentivisation or ad hoc land acquisition, rather than a holistic and consistently rigorous approach, resulting in associated pitfalls, such as complexity, inconsistency and many opportunities for determined stakeholders to circumvent regulations.

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Level 4: progressing from tactical to strategic soil governance (4%)

This level identifies a small number of states that typically apply tactical soil governance to a high standard, in some situations taking a leading role, and may be on the cusp of embracing new approaches or legislation that could elevate them to the level of best practice.

Level 5: strategic and effective soil governance – the "standard bearers" (2%)[4]

This select group consistently operates best practice soil governance, regulating and enforcing soil use and protection in the common interest, embodying to a significant extent the concepts of soil security [16], SSM [17] and the objectives of the SDGs. Such states typically have a defined soil-specific policy or other policy wordings that safeguard soil as a valuable resource. There are typically effective legal instruments to monitor soil quality, prevent or remediate many, if not all, types of soil degradation, restrict soil sealing and enforce PFP. Furthermore, the legal frameworks of these governments explicitly recognise and prioritise critical SES far beyond basic agricultural utility. These states generally demonstrate a high standard of probity, rule of law, and environmental justice, alongside an ethos that transcends narrow national goals.

The four countries considered to be at level 5 are Cabo Verde, Cuba, Switzerland and Uruguay. For practical reasons, these percentages refer primarily to the UN member countries, but it was observed that soil governance varies significantly among the self-governing states within many countries, notably Australia, Austria, Belgium, Canada, Germany, Italy, India, New Zealand, the UK, and the US. Exceptional examples of sub-national best practice were identified in Salzburg Länder (Austria) and Wales (UK), both level 5, and also Sikkim (India), at level 4. There are even examples of discrete best practice within smaller jurisdictions, for example, the Ontario Greenbelt [18] and the German cities of Osnabrück and Stuttgart [19].

While the standards set by, for example, Switzerland and Salzburg are exemplary, such assessments must be seen in the context of a highly developed state that, like many others, has historically sealed much land and already inflicted many harms on its soil. The situation is hugely different in countries like Cabo Verde and Cuba, where protocols and processes might not all be as assiduously organised and documented as in wealthier countries, but where, given the extreme environmental conditions and the limited resources available, the achievements are arguably even greater.

THE "GREY ZONE" OF PRIME FARMLAND PRESERVATION (PFP)

While soil and land are not synonymous, they are often conflated, and unavoidably interrelated in the context of governance. A legal infringement of land usually refers to territorial property rights, in which the litigant is typically the landowner. However, the law can separately be applied to soil as a legal entity in its own right, offering it protection, even from its 'owner', for the common good. Where the blurring of land and soil becomes problematic is in instances of proposed changes to land use, such as land take that are framed only in relation to land despite having significant impact on the soil within, or adjacent to, that land. This weakness or ambiguity can apply to agricultural, environmental or planning legislation and, as a result, important soil implications of land use conversion can, sometimes inadvertently, fall between all three and fail to be adequately addressed.

Agricultural laws relate to the direct impact of farming on soil and hence can, if properly implemented and enforced, offer protection against the first of the four threats listed earlier, soil degradation (though not necessarily soil sealing[5]). Environmental laws rarely offer protections that are specifically aimed at soil, but similarly, can offer safeguards against the second of the threats listed earlier, destruction or conversion of natural ecosystems. The fourth threat, that posed by soil itself, in any setting, may be covered by laws concerned with environmental health and hazardous waste.

The third threat, conversion of farmland to urban or industrial use, which includes soil sealing, the most extreme form of soil degradation, is typically governed by spatial planning laws. However, despite the soil-related implications of the land use changes controlled by planning legislation, these laws often ignore soil. The primary focus of planning is typically the change being made and the thing being added, not that which is lost or destroyed in the process. If soil is mentioned, it is often only as a technical detail (e.g., in relation to drainage or slope stability). There is in effect a blind spot whereby the legal instruments with the greatest power to affect soil, sometimes irreversibly, are often framed and worded with little or no reference to the soil. This governance vulnerability is a recurring issue throughout the world.

Prime farmland, that which is graded as highly productive or versatile in its use, is especially vulnerable to conversion because historically it is often located close to urban centres and industry, and costs less to transform than: (i) brownfield sites, which may need clearing and decontaminating, or (ii) remote or barren land which may lack any infrastructure. Farmland is also vulnerable for other less tangible reasons.

Natural ecosystems are highly regarded by virtue of being undeveloped and hence less polluted, aesthetically pleasing and biodiverse. Some farmland is also appreciated for its aesthetic value and rural setting, and historically farmers have been viewed in a positive light as food producers and custodians of the land. In recent decades, however, agriculture has come to be regarded by the general public as a mixed blessing. Since the middle of the 20th century food production has increased and stabilised in much of the world, but at the cost of many negative impacts of large-scale industrialised agriculture, such as pollution, habitat destruction, resource depletion and soil degradation. Indeed, globally agriculture has been the main cause of the destruction of natural ecosystems and in the 21st century is a significant contributor to climate change. As a result of this radical paradigm shift, agriculture is now often regarded as the "enemy of nature".

Farmland and farming are two different things but are strongly associated in the public mind. Consequently, farmland is sometimes regarded as an expendable commodity, when the choice is between that and natural or semi-natural land, with its variety of positive associations.

[4]This corresponds to four UN member countries· but two sub-national states were also rated at this level. [5]Soil sealing· i·e· topsoil removal and covering with concrete or asphalt, is an extreme form of soil degradation that is mostly associated with land take and urbanisation. Agricultural laws do sometimes cover sealing on farmland.

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Furthermore, the soil that is the main component of land, is largely invisible and lacks the aesthetic characteristics associated with landscape, and with the woodland and wildlife that depend on soil for their existence. Yet herein lies a great paradox of conservation.

With respect to SES, agricultural land, especially prime cropland, can exceed most natural ecosystems in its total capacity to benefit society. While the latter often have exceptional landscape appeal, this is partially both a cause and a result of their historically low economic value and low-grade soils. Such landscapes are also sometimes the product of human intervention and may be biodiverse only as a result of neglect and later conservation. Farmland often has much greater soil biodiversity than natural ecosystems and even its overall biodiversity can have a higher intrinsic potential. Soil biodiversity increases in relation to available resources, which are more abundant in productive soil [20] and is optimal where plant diversity is high, such as in pasture [21]. However, when arable land has a crop mix which is as diverse as nearby grassland on the same soil type, it exhibits equivalent soil biodiversity [22].

SES cannot be fully quantified, but a useful proxy of it is the potential net primary production (NPP), a biological measure of plant growth. While crude, the NPP of land is one of the best reflections of its capacity to supply adequate water, nutrients and the benign conditions conducive to life [23]. Consequently, humans have intuitively selected areas of high relative NPP as favourable sources of food and settlement and prime farmland has high NPP, by definition. Furthermore, a corollary of this is that the characteristics of soil that support high NPP tend also to provide greater levels of other SES, including carbon storage, water and air filtration, water storage and drainage (which facilitate flood mitigation), pest control and decontamination, all of which are enhanced by soil biodiversity [20]. The loss of such land is serious enough in terms of agricultural production and both food security and sovereignty, but also for so many other important reasons. Natural ecosystems are critically important for our physical, mental and spiritual wellbeing, but if we nurture these landscapes and endangered species exclusively, we risk taking our eye off the ball of the critical SES that provide our life support systems.

Many experts and policymakers appreciate the seriousness of this problem and there are laws, regulations, zoning policies and incentive schemes, etc., being implemented to mitigate it. However, these initiatives are few and far between, and in many cases apply only in particular locations or types of landscape, or are voluntary. Barely more than 40 countries (one in five), along with a few regional states, have in place a mandatory PFP, but fewer than ten appear to be enforcing this law.

To take one example, the UK has had a PFP policy in place for more than 50 years and this manifests itself as a planning regulation to protect the "best and most versatile" land and that was, until 35 years ago, mandatory and centrally governed. However, with the exception of the devolved nation of Wales, both the policy wording and its governance have become increasingly diluted and voluntary, and entirely delegated to local authorities [24]. In short, the policy allows for PFP but does nothing to mandate it, outside protected areas such as green belts and designated landscapes, and rates of land take have accelerated accordingly [25]. In May 2021 the UK government proposed a more radical reform of the planning regulations (in England) which was presented as the biggest overhaul to the planning system since the 1947 Town and Country Planning Act and would have removed what little PFP still exists, by creating zones with a priori planning permission for infrastructure projects [26]. This bill was abandoned in 2022, due to overwhelming opposition but, at time of writing (September 2022), the new Truss government has expressed its intention to introduce similar planning deregulation in specified zones, with a relaxation of both farmland and environmental protections [27]. This approach appears to be starkly at odds with the government's stated goals of Net Zero by 2050 and the binding environmental targets in its 2021 Environment Act.

BEST PRACTICE SOIL GOVERNANCE RECOMMENDATIONS

Highlighting the problems facing soil governance, begs the question of practical solutions. With a view to creating or influencing best practice soil governance policy, a list of suggested options and strategies is presented below:

- **Create a soil policy**
If no soil policy exists, that is a good place to start, or at the very least, provide a team within government that promotes a soil-centric ethic and approach. Soil is cross-sectoral (environment, agriculture, planning, construction, water, etc.), but will always remain the "Cinderella" resource, if its fate is left to these separate sectors.

- **Observe best practice elsewhere**
A small number of countries, or self-governing states within countries, have achieved a relatively high standard of soil governance. Of those with comparable geography, socioeconomics, and politics to one's own country, investigate how they differ from countries with less effective soil governance. Which departments have responsibility for soil and how are they structured? Are soil governance policies driven by specific national priorities? Is public participation important? Are innovative methodologies or regulations being applied?

- **Review national planning strategy**
Planning interacts with many, if not all, other sectors of the economy and this must be reflected in planning policy. Much planning literature makes no reference to soil, and planning is often where soil governance breaks down. Aspirational references to soil protection, as are found within environmental policies, are ineffective if they are not embodied in planning policies and laws that will have the greatest influence on land use change. Countries with effective soil governance tend to have ministries, or other centralised functions, responsible for planning oversight, with close ties to other soil-related sectors that permeate their spatial planning laws.

- **Introduce mandatory SES evaluation for infrastructure projects**
This is perhaps the most ambitious suggestion but potentially the most effective. For almost a century, land evaluation[6] has been used primarily with a relatively narrow focus, to assess the productive potential of land for agriculture and forestry. These techniques have now been adapted to encompass the full range of SES and are starting to be

[6] Land evaluation techniques have been applied for approximately a century, to assess the suitability of land for specific land uses and to facilitate PFP. With the increasing use of IT and data analysis, the terms "multi-criteria decision analysis (MCDA)" or "multi-criteria decision-making (MCDM)" are often used in conjunction with land evaluation, to reflect both a greater depth of analysis and a wider breadth of application criteria.

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applied to any form of land use change or infrastructure project. This approach allows the assessment of the total impact of any development, not just any loss of agricultural land, but the combined effect on carbon storage, GHG emissions, drainage and flood mitigation, biodiversity, contamination, amenity, heritage, and so on. To be effective, these techniques need to be incorporated as mandatory regulations and applied as a proxy for, or counterbalance to, purely monetary values.

CONCLUDING REMARKS

Without soil, it is almost impossible to imagine higher forms of terrestrial life, let alone functioning human societies, which is why formal or informal soil governance has always been a core activity, regardless of whether we recognise it or give it a name. Yet soil remains conspicuous by its absence from most policy documents, even many dealing with environment and agriculture.

The world faces serious and accelerating global environmental problems, for which there are no simple solutions, and in which soil governance has a pivotal role. It is nonsensical for countries to proclaim net zero or carbon neutral policies while eschewing sound soil governance, but policymakers may not all necessarily understand this connection, or the indirect consequences of some policies. So, one of the most important roles for the soil science community is to educate others by communicating the interdependency between soil and climate change mitigation, and the role of soil in other essential life support systems. It is therefore vital that all of those involved in any aspect of soil governance take every opportunity to speak out and act where possible to shift policy and behaviour towards greater appreciation and protection of soil resources.

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BRITISH SOCIETY OF SOIL SCIENCE

Engaging Stakeholders When Aiming For Effective Land-use Policies In The Information Age

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ENGAGING STAKEHOLDERS WHEN AIMING FOR EFFECTIVE LAND-USE POLICIES IN THE INFORMATION AGE

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1. A COMMON STARTING POINT

The concept of sustainable development can function as a common and attractive starting point of any discussion on the sustainability issue distinguishing economic, social and environmental aspects that need to be considered jointly when trying to implement policies that are intended to contribute to sustainable development. I have never met any person who was against sustainable development! Problems arise when specific targets, indicators and thresholds have to be defined. In the past economic aspects have received much, perhaps too much, emphasis while social and environmental aspects were often considered in an economic context. We therefore propose to follow a different sequence in this paper: environmental first, followed by social and economic aspects. Where to start?

2. THE UN SUSTAINABLE DEVELOPMENT GOALS (SDGs)

In 2015, 193 countries, attending the general assembly of the United Nations in New York, approved Seventeen Sustainable Development Goals (SDGs), including targets and indicators. (https://sdgs.un.org). Again, general agreement be it only after considerable discussion. The SDGs are summarized in the following widely distributed scheme.

Of many natural ecosystems in the world we select land use associated with agriculture that occupies the largest land area. But forests and city greens, to mention just two important ecosystems, deserve as much attention. When discussing relations between science and policy, a focus on the SDGs (and on the associated Green Deal for Europe) is attractive as it allows a direct link of research with established policy that is internationally accepted and well known. In contrast to the past: there are now clear goals to be addressed.

At least five SDGs have a direct and clear relationship with agriculture:

SDG 2: zero hunger
SDG 3: good health and well being
SDG 6: clean water and sanitation
SDG13: climate action
SDG15: life on land

Starting the analysis with the "ENVIRONMENTAL" dimension we focus on the soil-water-atmosphere-plant system that can only be characterized by an interdisciplinary approach where al least soil science, hydrology, meteorology and agronomy work together. Many measurement methods are available now and many operational computer models can also characterize such systems, forming an ideal vehicle for interdisciplinarity as each discipline has to deliver basic data for the models (e.g. White et al, 2013, Kroes et al, 2017, Holzworth et al, 2018).

There is, however, a problem with targets, indictors and thresholds as defined by the SDG documentation. This presents a problem for communication and for future policies and regulations :For example: SDG target 2.4 (abridged): "by 2030 ensure sustainable food production systems and implement resilient agricultural practices that help maintain ecosystems". The associated indicator: "proportion of the agricultural area under productive and sustainable agriculture" threshold is a % value. Nice for bookkeeping but how to determine that? How to assess whether or not a farm is productive and sustainable? If criteria for sustainability are not defined, such percentages remain meaningless and a possible victim of bureaucratic manipulation.

The challenge is to establish the effect of land management on contributions by a given ecosystem to the SDGs and this can be well described by the concept of ecosystem services: services provided by ecosystems to mankind,as first defined by the UN Millenium goals of 2005 (www.millenniumindicators.un.org). Note that the new Common Agricultural Policy of the European Union for the period 2021-2027 (including subsidies of 350 billion €) mentions ecosystem services and plans to award part of their support for provided ecosystem services.

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3. INTERDISCIPLINARY ECOSYSTEM SERVICES

Again, each SDG is determined by environmental social and economic criteria. For example, SDG2 (abbreviated as "zero hunger") will not only be influenced by adequate production of food but also by market forces , including transportation, and by consumer choices and their ability to pay for food, thus including the complete food chain. But the environmental ecosystem service can be articulated as :"production of healthy food". Similar considerations apply to the other SDGs when focused on agriculture, resulting in the following list of ecosystem services:

- production of healthy food (SDG 2&3)
- providing clean ground- and surface water (SDG 6)
- reduction of greenhouse gas emissions and increasing carbon capture (SDG13)
- increasing biodiversity and avoid degradation of soils (SDG15).

As discussed in section 2, ecosystem services can only be determined by an interdisciplinary effort. Soil scientists cannot do the job by themselves, nor can colleagues of other disciplines! That's why the expression : "soil ecosystem services" is confusing and it is better to refer to: "contributions by soils to ecosystem services in line with the SDGs and the Green Deal" (to be discussed later) . The relation between soil functions, ecosystem services and the SDGs is visualized in Figure 1.

When focusing on individual farms, where innovative management will have to be realized, the question can be raised whether or not adequate ecosystem services are provided for that particular farm at that particular location, considering all the fields of the farm. Operational measurement methods and definition of thresholds are therefore needed to seperate the "good" from the "not yet good enough" (see later discussion in section 7). The manner by which results are judged is important. Rather than a demotivating "bad", one can hint positively to possible future success. Current discussions all too often have a negative focus that demotivate and inhibit progress.

For groundwater quality (SDG6) an

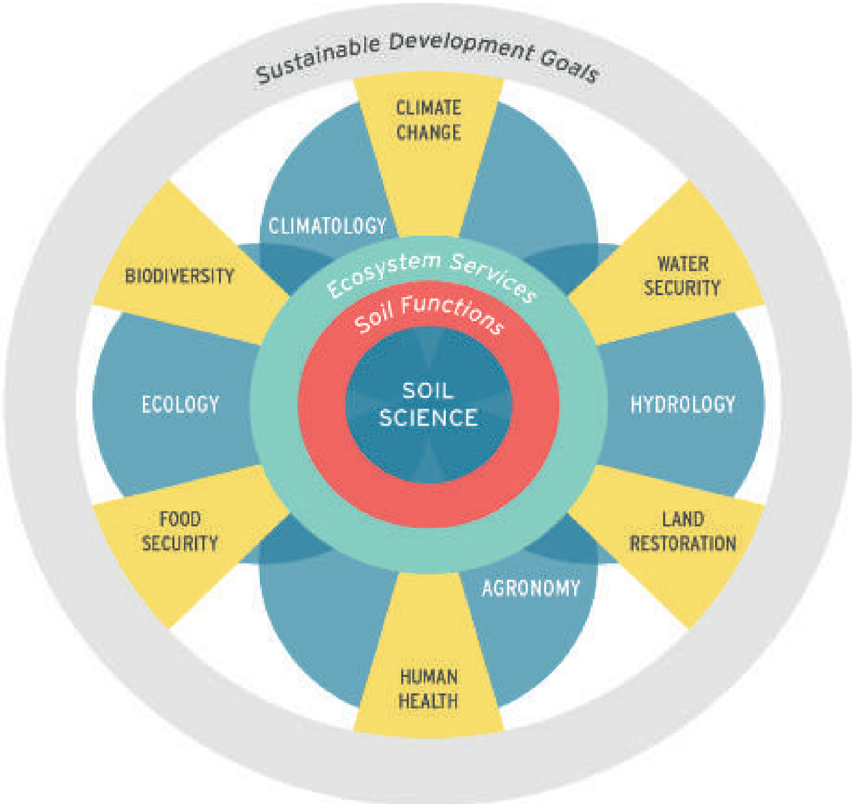

Figure 1. *Schematic representation of soils contributing to ecosystem services that, in turn, contribute to sustainable development goals. Similar diagrams can be made for other involved disciplines.*

important threshold has already been defined and is in effect for more than 80 years: 50 mg nitrate/l. Also, critical N and P contents are defined for surface waters in the European Water Framewerk Directive, introduced in the year 2000 (www.euwaterframeworkdirective.com). So far, however, thresholds for the other services are not yet defined nor are operational measurement methods always available (as is further discussed in section 7). This presents a confusing situation that only the research community can solve: a clear challenge!

There is also a more basic problem here. Rather than focus on measured water quality to assess whether or not the thresholds for SDG6 are met, existing rules and regulations define measures that are assumed to be important to stay below the threshold: e.g. max. fertilization rate of 170 kg N from manure or a critical number of cows/ha. Such a given fertilization rate works out quite differently in different soils. For example, nitrification is much more pronounced in sandy than in clayey soils and split applications of manure can be quite effective in reducing leaching rates. But fertilization rates are means to reach a water quality goal and implies that the regulator imposes management decisions on the farmer. He occupies the chair of the farmer: a highly sensitive issue that is easily avoided when direct measurements of water quality are made. Modern techniques are available to do so!
A general focus on direct measurement is urgent, as regulations on greenhouse gas emissions, carbon capture, biodiversity preservation and omitting soil degradation are likely in future and following the current tendency to focus on means to reach goals rather than on the goals themselves is bound to create severe operational problems. Again, developing measuring and monitoring methods that are not too expensive while providing rapid, reliable results forms a major but potentially most rewarding challenge for the research community.

4. WHY IS SOIL SO IMPORTANT FOR DEFINING ECOSYSTEM SERVICES?

As mentioned above, many scientific disciplines contribute to ecosystem services in an interdisciplinary context. Why should soil scientists emphasize the important soil contribution? Other disciplines certainly have their claims

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which they clearly articulate. This type of breast-beating is not productive. We have two good reasons to articulate the important and central role of soils:

1. Soils are by far the most permanent component of the lot and are therefore most suitable as an "anchor" for the ecosystem services.

2. Soil maps show the distribution of different types of soil in landscapes. This is crucial to answer the common question:"What happens where?"

Soil science should focus on soil contributions to the various ecosystem services in line with the SDGs that have to be considered in a socio-economic and political context that is largely beyond our control but can be affected by developing and presenting land-use scenarios developed in Living Labs.
Soil health expresses soil conditions and was defined by the EC Mission Board of Soil Health and Food as: the capacity of soils to contribute to ecosystem services in line with the SDGs and the Green Deal. (Veerman et al, 2020, Bouma et al, 2021).

An aside: the joint use of soil quality and soil health is confusing for outsiders. Some even suggest that their meaning is the same. But why have two terms for the same item? We suggest to use soil health for actual conditions and soil quality for the range of soil health values as a function of management in a given soil. Soil health can therefore be compared with a patient visiting the docter at a given time , measuring blood pressure and temperature and possibly some other tests leading to the conclusion that the patient is either healthy or not. Soil quality can represent the range of soil health values obtained for a given soil type, subjected to various forms of management. In human terms: the range of health statistics for a given cohort of patients, e.g.: 18-25 year olds (comparable to a young Fluvisols) , 70plus (old Ultisols), immigrants (Oxisols) etc., each cohort corresponding conceptually with a soil type subjected to different forms of management resulting in a series of so-called phenoforms for that particular soil type (the genoform) (Bonfante et. al 2020).

The good news: Soil contributions to ecosystem services, as mentioned, are very important if not crucial and demonstrating this is not only quite feasible but also the best way to promote the soil science profession. But it needs to be done!

5. BUT HOW ABOUT THE SOCIAL DIMENSION?

So far, this is a conceptual and technical story but we must realize that whatever we concoct will only contribute to sustainable development if farmers (and other land users for that matter) adopt management practices that satisfy the thresholds of the various ecosystem services and all of that in a socio-economic context!

This introduces the important SOCIAL dimension. Three considerations:

1. In their: "Soil Deal for Europe", the European Union focusus on joint work of farmers and researchers in: "Living Labs": "spaces for co-innovation, through participatory, transdisciplinary systemic research" (EC, 2021). "Living Labs" will become inspiring" Lighthouses" if they meet the various thresholds! Key question: what are we going to do in a given "Living Lab"? How to interact with farmers, what to measure using existing methodology and what new research may be needed?

2. Farmers are quite concerned about their economic future, they are critical of complex, unclear and ever changing environmental rules and regulations and they lack independent advice (e.g. Bampa et al, 20219; Schroder et al,2020, Bouma, 2021). Above all they want clarity! "Show us clear goals and we will reach them!". In a recent Dutch inquiry 88% of farmers did not trust government. This presents a serious challenge to our democratic system. Can researchers help to restore trust?

3. Realize that every farmer is different and that is their strength: they are independant and must apply adoptive management every day reacting to ever changing weather conditions (in addition to market fluctuations). They don't look at their Decision Support System at 5AM in the morning to find out what they should do. They pick up elements for their particular farming system primarily by interacting with colleagues and by adopting aspects presented by the research community . Note the excellent work by the US National Soil Health Institute when interacting with farmers (https://soilhealthinstitute.org).
In fact, we ask modern farmers to play chess on five boards simultaneously meeting the thresholds of all the ecosystem services at the same time. They face "wicked" problems that have no single solution but only a series of options ("scenarios") from which a choice has to be made. Interaction with scientists is then crucial and , again, soil scientists can play an important role here. Different scenarios are developed , also considering the ECONOMIC dimension. Note excellent work on economic aspects of regenerative farming by the US National Soil Health Institute. Cristine Morgan raises an intriguing question. They find that even when convincing evidence is produced, supporting innovative management that is both environmentally and economically much better than management followed so far, some farmers may still not adopt the measures. This certainly illustrates the social and psychological dimension of sustainable development and the importance of social intelligence on the part of those interacting with the farmers.

6. A REFLECTION ON KNOWLEDGE GENERATION AND EXCHANGE

Interaction with scientists, to be realized within :"Living labs", implies connection between different kinds of knowledge and this complicated process justifies some additional attention.. Interactions can be visualized in a knowledge diagram (Bouma et al, 2011) See Figure 2 on the next page.

The vertical ax ranges from empirical to mechanistic, the horizontal one from qualitative to quantitative. Much practical ("tacit") knowledge can be represented by K1 and K2, while K4-K5 characterize increasingly detailed and specialistic scientific knowledge and K3 occupies an intermediate position. There clearly is a gap now between the left and the right side of the diagram. Most publications in the refereed scientific soil science literature have a K5 nature:*"knowing more and more about less and less"*. The challenge of the "Living Lab" concept is to really connect the two types of

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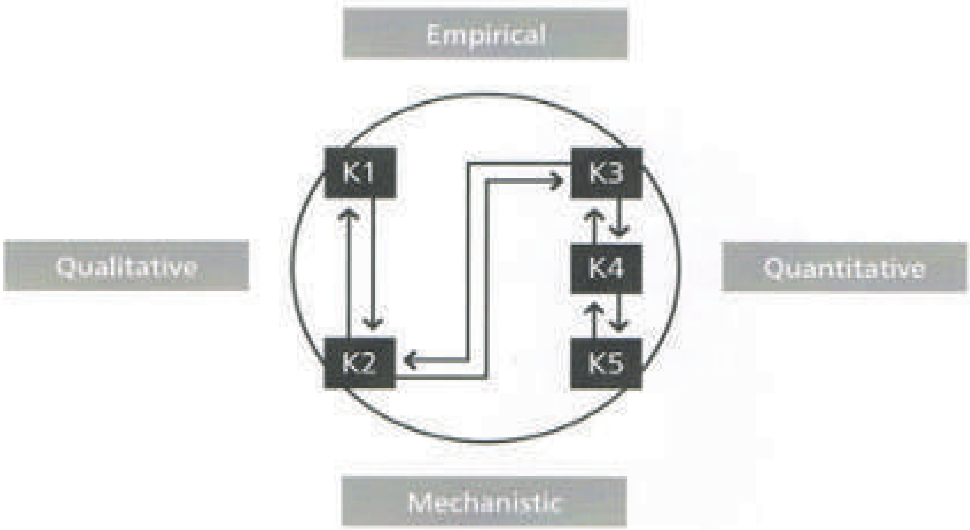

Figure 2. *A knowledge diagram visualizing interaction between different forms of knowledge*

knowledge: true interaction involves a continuous two-way flux between "tacit" and "scientific" knowledge, resulting in knowledge that is not only scientifically sound, reflects practical experience and is accessible and inspirational to stakeholders. Only then will stakeholders internalize external knowledge and can activities in :"Living Labs" lead to the establishment of:"Lighthouses" for farms occupying particular soil types in a given region.

7. LET'S GET GOING: EXPLORE HOW TO ASSESS A FARM (LIVING LAB) USING EXISTING INFORMATION

The Pavlov reaction of too many researchers, when faced with a problem, is to directly suggest new research. But after a hundred years of research there is already a broad knowledge base, as politicians are happy to remind us of. Bouma et al (2015) analysed five environmental case studies and concluded that three could be well addressed by applying available expertise. Only two needed additional research that could specifically be focused on lack of essential knowledge that became obvious when applying existing knowledge. Looking at Figure 2, a multi-step general research approach was therefore advised: always with K1 and K2, see what K3 (or sometimes K4) could do and if that is not successful go to either K4 or K5 implying new but now well focused research.

Defining ecosystem services and corresponding thresholds has been explored for an experimental farm in the Netherlands, including a test which measurement methods are already available and how thresholds can be defined. Also the effect of soil health was determined. Details of procedures followed were presented in detail by Bouma et al (2022). Here, a general description will be presented. The intention of this explorative study was not to produce a final methodology but to see what can be done with currently available knowledge and expertise and to define needed new research. .

The SDG and Green Deal goals have to be met by 2030. We have to act now! No time to lose! Future research , when needed, will have to specifically focus on gaps that show up after existing knowledge is applied and turns out to be inadequate.

Strictly speaking, the experimental farm of Wageningen University and Research, being assessed, does not qualify as an independent farm. But conditions described are representative for arable farms on light textured, calcareous marine soils in the Netherlands and can function when exploring ecosystem services in terms of measurement and definition of thresholds

Figure 3. *A typical arable farm in the Flevopolder in the Netherlands on a calcareous, light clay marine soil, for which an explorative analysis is performed simulating the establishment of a: "Living Lab" with the aim to establish a: "Lighthouse" in which the various required ecosystem services have met their threshold values. This includes the role of soil, expressed in terms of soil health.*

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7.1. FIRST THE ECOSYSTEM SERVICES:

The ecosystem services will be discussed separately, as summarized in Table 1.

ECOSYSTEM SERVICE	INDICATOR	THRESHOLD	RESULT
SDG2: biomass production	Local yields and Yw	80%Yw	Positive
SDG3: pollution	EU & Local reg.	EU & Local reg.	Positive
SDG6: water quality	EU & Local reg.	EU & Local reg.	Negative
SDG13: greenhouse gas emissions	Not defined	Not defined	Negative
SDG13 carbon capture	%C	2.0%	Positive
SDG15: biodiversity pres.	Not defined	Not defined	Negative
SDG15: land degradation	Soil health	Does not apply	Positive

Table 1. *Ecosystem services, their indicators and thresholds as explored for the experimental "Living Lab".*

Production levels (SDG2) compared favorably with yields obtained in the area for similar soils. A more theoretical approach was followed by applying yield simulations where Yw is the yield assuming optimal fertility and no pests and diseases. 80% of Yw is considered satisfactory (van Ittersum et al, 2013) and this value was attained here. Conclusion: positive. Thresholds for a variety of soil pollutants (SDG3) have been defined by existing environmental laws and were not exceeded in the soils being considered.

This, however, is a highly dynamic field of research where new pollutants appear all the time. The positive conclusion is therefore time-bound. Groundwater quality (SDG6) was not measured on-site but only kilometers away in the national measurement network. Lack of data, now resulting in a negative judgement for this particular farm, can be easily overcome in future by making measurements with widely available monitoring equipment. The nearest surface water body was kilometers away and its quality could not be attributed to nutrient management on this particular farm. But critical distances between farms and surface waters have not yet been defined. Greenhouse gas emissions (SDG13) are reported for the entire country of the Netherlands indicating that agriculture contributes only 10% to the total, while industry and traffic contribute 80% (Ruyssenaars and van der Net, 2022).

This is important to keep in mind, also for other countries, when considering goals on national level, focusing policies on areas where the largest gains can be made.

Model applications of greenhouse gas emissions are not yet available for the local level, let alone threshold levels. The latter should probably have a regional character. Measurements are very much needed to calibrate models and are largely lacking so far. Drones and, in future, satellites offer attractive opportunities.

There is a clear research need here and at this point in time only a negative result is obtained. Carbon capture by soil is considered in the context of soil heath, to be discussed next. The proposed threshold of 2%C (section 7.2) is still the subject of discussion. %C is the result of a dynamic equilibrium: C decomposition leads to emission of CO_2, a greenhouse gas. But when more organic matter is added to the soil by (green) manuring or by adding compost than is emitted, the %C increases. Based on data for this particular soil type, a threshold of 2.0%C seemed realistic in terms what can be reached by innovative management. Biodiversity (SDG15) presents identical problems as with greenhouse gas emissions for SDG13: no standardized measurement method and no thresholds. In the Netherlands 161 NATURE 2000 areas have been defined where nature is unique and needs protection. The biodiversity concept could thus be focused on these NATURE 2000 areas in a given region and not on individual farms where farmers have options to increase biodiversity on their farms if it fits in their management plans. One could argue that nature quality in the NATURE 2000 areas is protected by lack of significant pollution of air and water by farms within a critical distance from these areas (and by other sources of pollution). This would require thresholds for emissions on farm level on the one hand and critical deposition levels in NATURE 2000 areas on the other. But recently questions have been raised in the Netherlands whether current critical deposition rates of pollutants, particularly nitrogen, are realistic and based on solid research. So far, it is unclear what all this means for an individual farm, certainly when it occurs at a substantial distance from one of the NATURE 2000 areas as is the case here. At this point in time the judgement about the biodiversity component of SDG 15 has therefore to be negative. The other element of SDG15, land degradation, was covered by determining soil health to be discussed next (which turned out to be positive).

When judging the overall provision of ecosystem services of this Living Lab, the judgment has to be negative. This would also have been the result if only one service would have been negative, following the principle: "one-out, all out". Negative results can focus research on the negative services, exploring literature, initiating new research or adopting results obtained at "Lighthouses" at the same type of soil. A :"Lighthouse" should shine only at maximum capacity corresponding with meeting all thresholds.

7.2 SOIL-HEALTH AS AN INDICATOR FOR LAND DEGRADATION

SOIL HEALTH INDICATOR	ACTUAL VALUE	THRESHOLD	RESULT
Soil pollution: EU & Local reg.	Below thresholds	By reg.	Positive
Soil structure: bulk density	1.35 g/cm3,sd 0.08	1.55g /cm3	Positive
Penetrometer resistance	0.67 Mpa,sd 0.31	5 Mpa	Positive
Organic matter content	2.9%, sd 0.32	2.0%	Positive
Soil biodiversity	% org matter as proxy	Not yet defined	Positive
Soil fertility: regime based on soil testing			Positive

Table 2. *Soil health indicators, thresholds and results for light clay, calcareous marine soils on the "Living Lab" being characterized.*

ENGAGING STAKEHOLDERS WHEN AIMING FOR EFFECTIVE LAND-USE POLICIES IN THE INFORMATION AGE

Johan Bouma - Emeritus Professor of Soil Science, Wageningen University, The Netherlands (continued)

A set of relatively simple soil health indicators has been defined by the EU Mission Board of Soil Health and Food based on the principle *"let the roots do the talking"*. (Veerman et al, 2020). The soil being considered was not polluted. Heavy-metal levels were below defined thresholds in existing regulations. Result: positive. Soil structure was characterized by two methods: bulk density and penetration resistance. The thresholds of 1.55g/cm3 and 5Mpa, respectively, were both derived from soil profile investigations in the same type of soil observing rooting patterns. Actual measurements were below these thresholds, resulting in a positive conclusion. The standard measurement method for bulk density, based on sampling small cores, followed by measurement in the laboratory, is relatively costly and time consuming. Also, small cores result in relatively high standard errors. Further development of proximal field methods is therefore recommended. Proximal methods are also available now for measurement of organic matter content, which is preferable to traditional methods requiring field sampling and laboratory measurement. When made here, results were below the selected threshold resulting in a positive result. The threshold of 2.0% C was based on analysing results obtained for this type of soil, selecting what appeared to be a reasonable goal. (see section 7.1). The soil biodiversity indicator offers problems because so far no unified procedure has been defined. Many methods are presented in literature (e.g. Mobius-Clune et.al , 2016; Stott, 2019). In this study soil organic matter was chosen as a proxy value but this is unsatisfactory. But declaring the soil to be unhealthy because of lack of a method to assess soil biodiversity would be problematic considering the high organic matter content of the soil and the favorable soil structure. We conclude, therefore, that this soil is healthy, providing a positive indication for lack of soil degradation as part of SDG15. Soil health is, however, not only relevant for SDG15. A healthy soil contributes significantly to the production of healthy food, to water quality when proper water management is applied coupled with precision fertilization practices and to restricting greenhouse-gas emission by carbon capture.

The soil would not have been healthy if only one indicator would have been negative, following again the "one-out, all-out" principle. A soil is healthy or not; "almost healthy" would be an unrealistic proposition and distinguishing separate indicators allows a research focus on the ones that are negative at a given time.

7.3. CREATING A LIGHTHOUSE AND THEN WHAT?

If all environmental indicators meet their (regional) thresholds and if the socio-economic analysis is positive, a :"Lighthouse" for that particular soil type can be created. Management practices have to be well documented and framed to inspire other farmers. This is a crucial part of the "Living Lab" procedure.Overall change in a region is only achieved when farmers working on identical soils are inspired by and adopt management procedures demonstrated by the: "Lighthouse". Farmers will never completely adopt management practices, developed elsewhere, but certain aspects that fit their particular farming style.

Modern communication techniques are not only needed to inspire farmers but also citizens at large, counteracting much current negative publicity on modern agriculture that often not only irritates but also demotivates farmers. "Lighthouses", demonstrating that modern farms make substantial contributions to sustainable development, are the most convincing reaction to such negative reports.

8. ADVANTAGES OF THE SUGGESTED APPROACH

1. This farmer-focused approach provides a much needed, clear picture of the challenging goals to be achieved based on measured indicators and thresholds that can be the basis for transparent legislation. A:*"point at the horizon"*! Realize that if farmers don't act, nothing will happen.

2. The Living Lab approach implies that farmer expertise and scientific insights are combined to derive a farm-specific and economically attractive management plan that meets the various thresholds, resulting in a Lighthouse.

3. Various management schemes vigourously being promoted by their adherents (*biological, regenerative, nature-inclusive, circular, precision etc*) can and will still be inspiring but can now all be judged in the same manner, providing much needed clarity and avoiding unproductive discussions as to what scheme is best.

4. The policy arena receives clear suggestions from the science arena for region-specific indicators and thresholds, allowing transparent rules and regulations. Subsidies can be focused on meeting the thresholds. No more general /ha payments. This will help to reduce the gap between policy and the stakeholders.

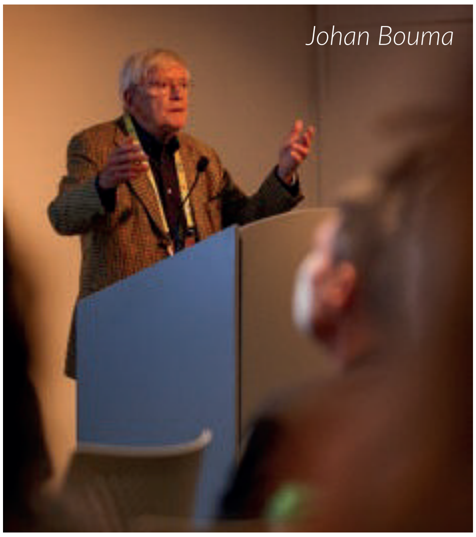
5. The soil research community is challenged to derive operational methods to measure indicators and determine thresholds all in an interdisciplinary context. Much knowledge is already available and suppression of the Pavlov reaction: "we need more research" is needed. More emphasis on K3 approaches rather than on only K5 would be advisable. But basic 5 research is still needed to advance the field but can be focused better when inspired by a preceding K-analysis, as part of the:"Living Lab" approach.

6. By demonstrating crucial contributions to ecosystem services, soil science shows its strength and vigour as a scientific discipline in the most effective manner to colleague researchers and to the outside world.

9. FINAL CONCLUSIONS

Soil science can and should play a crucial role in re-connecting stakeholders and citizens with the environmental policy arena.

As we get evermore excited about artificial intelligence, let's not forget about social intelligence that is more needed than ever as we try to apply our expertise to the real world!



Johan Bouma

ENGAGING STAKEHOLDERS WHEN AIMING FOR EFFECTIVE LAND-USE POLICIES IN THE INFORMATION AGE

Johan Bouma - Emeritus Professor of Soil Science, Wageningen University, The Netherlands (continued)

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SOIL POLICY LEGACY REPORT DECEMBER 2022

BRITISH SOCIETY OF SOIL SCIENCE

The Need For A Soil Health Framework To Support Policy Development; Why Scientists Must Join Up, Align and Underpin Policy

Ellen Fay,
Founder & Executive Director, Sustainable Soils Alliance (SSA)

THE NEED FOR A SOIL HEALTH FRAMEWORK TO SUPPORT POLICY DEVELOPMENT; WHY SCIENTISTS MUST JOIN UP, ALIGN AND UNDERPIN POLICY *Ellen Fay - Founder & Executive Director, Sustainable Soils Alliance (SSA)*

A BRIEF HISTORY OF SOILS AND POLICY

Bringing soil science and policymaking together is the fundamental objective of the organisation I co-founded in 2017, the Sustainable Soils Alliance (SSA).

Our constitution reflects the challenge at hand, so we function as a hybrid of a campaigning organisation and a think tank; on the one hand calling on policymakers, corporations and other stakeholders to give soils the status they deserve and on the other channelling soil expertise to help ensure this is done with rigour and authenticity. Our hope is that by supporting these links we can promote the creation of soil policies that are clear, consistent and ambitious.

We were delighted therefore that the British Society of Soil Science (BSSS) took the opportunity of their World Congress tenure to convene its first ever policy session in a history stretching back nearly a century. Timely, because soils are finally on the agenda of politicians both here and around the world – and because they are increasingly looking to scientists for answers.

It is often said that soils are the Cinderella among other environmental indicators. We corroborated this in 2020 when we demonstrated that of the money spent on monitoring the three principal environmental indicators in England – air, soil and water - soil receives just 0.4%. If the value we place on something is reflected by the financial investment we give it, then this figure paints a pretty clear picture of soil's place in our society's pecking order.

At the time of our launch, various incarnations of soil strategies were in place across the four nations, but none were fit for purpose - each missing the standards, monitoring and targets needed to deliver sustained soil health. The 2014 proposed EU Soil Framework Directive – the traditional instrument for unlocking national policy and investment – was the only environmental Directive ever to have been rejected by EU governments. The continuing lack of a common policy framework for assessing the state of our soils has perpetuated a siloing of work, research, and a general lack of coordination among the various sectors involved in soil.

RECENT OPPORTUNITIES FOR SOIL

Against this backdrop we began our efforts by loosely working from a 'shopping list' of areas where we felt governments were best placed to intercede formally – either through tangible policy intervention, financial investment, or leadership and collaboration. We organised these according to the four 'drivers' of soil health: measuring and monitoring against standards and targets; incentivisation for long-term improvement; regulation against degradation; and education, advice and guidance to support delivery of the above long-term.

Over this period, soil has come into the spotlight for a variety of reasons, and tangible progress has been both top down (national policy developments) and bottom up (the regenerative farming movement, food businesses, ecosystem markets). A veritable groundswell of interest now comes from a huge variety of organisations – science, policymakers, farmers, businesses, NGOs - increasingly even the investment community.

DIFFERING APPROACHES

This explosion of attention comes with a challenge, however. Each of these interests or sectors has their own language and terminology for soil - as well as differing objectives and outcomes. There is a risk of fragmentation, and a danger that all these efforts will not add up to the sum of their parts.

We believe that, while the stars are now aligning for soils in terms of public interest and political will, seizing this momentum will require these various stakeholders to unite, align and collaborate like never before. But this in turn depends on the promotion and availability of solid shared scientific foundations from which everybody can build.

But where to find these foundations? From the start, our efforts are hindered because we do not have agreed standards, or even agreed ways to measure the soil. From our experience meeting organisations from across the spectrum, and with the inherent variability of soil types across the landscape, it is obvious that there is often not even agreement on how to describe and group various soils using a universal system.

Under these circumstances, a particular land manager might define their land as being one soil type, while another might refer to the same land differently and imply that another soil type is present. A farm adviser or scientist might decide to measure texture to quantify the soil type in the topsoil, but what happens if the texture varies at depth below 30 cm across a field, whilst the topsoil texture is constant? Does this matter when setting benchmarks, standards and targets?

THE EXAMPLE OF PROTECTING AND IMPROVING WATER IN ENVIRONMENTAL POLICY

To illustrate the challenge, we can look to the experience of another critical environmental indicator – water, whose EU directive (European Water Framework Directive - WFD) has developed ways to classify water bodies with standards, targets, monitoring and a well-funded programme to deliver improvement with a strong foundation of regulation. Admittedly there is still a long way to go with improving water, but at least we have an agreed technical framework – and with it a direction of travel.

The WFD required extensive debate, deliberation and consultation. The process of conceptualising was vital, because it established consistent agreement about the language, concepts, science and metrics at stake, unlocking powers for the bodies responsible, policy development, and public understanding. This in turn opened the door not just to investment and political commitment but also to structure and rigour in how we monitor and care for our waterways, how we identify and address threats, and how we allocate responsibilities and duty of care.

It is evident that soil has not been through such a process – the same consistency of resources has not been applied, and there has not been the same coalescence around a common understanding. We are left with a lack of agreement around the basics, such as describing soil type, agreed methodologies for monitoring, parameters for setting standards, and targets for improvement.

This cascades through industry and other parts of the community, and acts as a critical barrier to joined-up decision making, aggregation of data, and ultimately a sense of direction and common purpose.

THE NEED FOR A SOIL HEALTH FRAMEWORK TO SUPPORT POLICY DEVELOPMENT; WHY SCIENTISTS MUST JOIN UP, ALIGN AND UNDERPIN POLICY *Ellen Fay - Founder & Executive Director, Sustainable Soils Alliance (SSA) (continued)*

THE NEED FOR LEADERSHIP AND AGREEMENT FROM THE SCIENTIFIC COMMUNITY TO FOSTER WIDER CONFIDENCE AND COMMON PURPOSE

It is not to say that we don't measure our soils. In fact, throughout our existence we have seen one soil monitoring initiative after another – from governments, NGOs, businesses and research institutes – but each one carried out with different approaches to soil description, monitoring and interpretation. To make this even more complicated here in England, our national soil mapping which could underpin a common soil framework is mostly not in the public domain or open access.

It is not hard to imagine what all this means in practice. The all-important data from these important projects fails consistently to add up to a coherent whole or even a coherent conversation, with predictable and disappointing consequences for our overall understanding of soil health.

The origins of this situation are clear - a vacuum where we need leadership, conflicts of interest where we need collaboration, compromise and alignment, but above all a failure (so far) to achieve consensus on a few core scientific principles.

It is widely accepted that soil health metrics vary according to soil type and we have ways to classify soils to take their diversity into account. What is missing is for these approaches to be co-ordinated within one agreed framework that shows how a small number of fit-for-purpose but different approaches to describing, grouping and mapping soils across the landscape fit together. This can then become the common reference point for soil initiatives – from monitoring right through to education.

We believe there is now an urgent need for such a framework, one that applies metrics and benchmarks within a system that describes soils appropriately and simply and does not soak up the already limited resources available to soils work. A framework that everyone is signed up to, can access freely and fully, is clear and relatable, and can be used to its full potential in every soil initiative without hindrance from ownership issues or doubts about whether it is the right approach.

While this is ultimately a policy challenge, only the scientific community is capable of delivering it. Because only the scientific community has the expertise to agree and 'sign off' the basic principles at stake.

As was noted at the Congress, right now we do not need soil scientists to dwell on the third decimal, we don't want new evidence. Rather we want to know *what it is, how to do it, and what it means* – so that we can all be part of something that is moving forward and is built on solid foundations.

But how? Mandela said *it's always impossible until it's done*, in that spirit we hope this task will be grasped because it is critical for progress. It would give policymakers the tools to develop ambitious and impactful policies – against which they can be held to account.
This in turn cascades through society and industry: it enables us to reassure farmers that they are measuring their soils for the right reasons – and that these measurements will help them identify practices that will improve both their soils and their yields; it is needed to engage the food industry to reflect soil health in the way they source their produce – and support farmers in their journey; it would enable new income streams to be unlocked for land managers to reflect the environmental improvement healthy soils can deliver; and finally, such a framework is needed to generate data to show the public the state of our soils, how this is changing over time – and why this is important – so they, in turn, can understand and value soils as the soil science community does.

SOIL POLICY LEGACY REPORT DECEMBER 2022

BRITISH SOCIETY OF SOIL SCIENCE

Soil Protection in Switzerland: Steps, Hurdles, Successes and Soil Strategy

Elena Havlicek and Ruedi Staehli,
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SOIL PROTECTION IN SWITZERLAND: STEPS, HURDLES, SUCCESSES, AND SOIL STRATEGY

Elena Havlicek and Ruedi Staehli - Swiss Federal Office for the Environment (FOEN) Soil and Biotechnology Division

PUTTING IN PLACE A LEGAL FRAMEWORK

In Switzerland the legal recognition of soil as a resource that needs protection began in 1973 when the first preliminary draft of the Environmental Protection Act (EPA) gave high priority to soil protection and contained provisions against pollution and physical impact on soils. However, this preliminary draft was not successful in the consultation process and never came into force. In the following EPA draft, soil protection was limited to a few scattered soil-related provisions in the areas of air pollution control and environmentally hazardous substances. During the parliamentary deliberations, however, the National Council added a new chapter “soil pollution”, which focused on the precautionary protection of soil against chemical pollution. These provisions of the EPA of 1983 were then specified in the Ordinance on Soil Pollutants in 1986. With the EPA revision in 1993, the Federal Council presented a substantially expanded soil protection law by adding protection against physical threats such as compaction and erosion and the obligation to remediate polluted soils. Finally, in 1998, the Federal Council passed the new Ordinance on Threats to Soils that was approved by the parliament and that is still in force.

ASSESSING THE SITUATION

Almost 25 years after the adoption of the soil ordinance, the situation remains worrying. While some measures of soil protection have been successfully applied, others still suffer from a lack of attention and implementation. Soil use is still not sustainable, especially with regard to the high land take for urban development. Switzerland is continuously losing its soils: unsealed land area is shrinking, soil is disappearing because of erosion and the decline of organic matter, and soil functions are being lost owing to compaction and contamination (Fig. 1).

However, a notable exception is soil protection on construction sites. The article 7 of the Soil Ordinance from 1998 specifically addresses the protection of soils that are excavated to allow for the construction of roads or buildings. Moreover, in 2016, a revision of the Ordinance on the Avoidance and the Disposal of Waste has strengthened the protection of excavated soils by introducing an obligation to reuse them, if their quality is appropriate.

Legend:

● Strong threat to soil function
▲ Partial threat to soil function
■ No threat to soil function

	Soil sealing	Soil compaction	Soil erosion and landslides	Decline of soil organic matter	Decline of soil biodiversity	Soil contamination	Acidification, eutrophication	Salinization	Flooding
Habitat	●	●	●	●	▲	▲	▲	▲	▲
Regulating	●	●	●	●	●	●	●	●	▲
Production	●	●	●	●	●	●	●	●	▲
Support	■	■	●	■	■	■	■	■	▲
Raw material	▲	■	▲	■	■	■	■	■	■
Archive	▲	■	▲	■	■	■	■	■	■

Figure 1. *Assessment of different threats to soil functions (Swiss Federal council 2020)*

Ordinance on Threats to Soils (1998)
Art. 7 Treatment of excavated soils
[1]Any person who handles or excavates soil must do so in such a way that it can be used again as soil.
RS 814.12 - Ordonnance du 1er juillet 1998 sur les atteintes portées aux sols (OSol) (admin.ch)

Ordinance on the Avoidance and the Disposal of Waste (2016)
Art. 18 Removed topsoil and subsoil
[1]Removed topsoil and subsoil must be recovered in full if possible provided *[soil quality]*
SR 814.600 - Ordinance of 4 December 2015 on the Avoidance and the Disposal of Waste (Waste Ordinance, ADWO) (admin.ch)

These regulations have firmly established soil protection in the context of projects subject to environmental impact assessment, by introducing a legal obligation to protect and reuse excavated soils. However, a legal framework is not sufficient for an operational implementation. Soil scientists were instrumental in drawing up guidelines for the proper handling of excavated soils, and also in implementing those guidelines on the construction sites. For more than 20 years now, the FOEN has provided financial support for conducting specific training courses for specialists of soil protection on construction sites and for setting up a certification system. In collaboration with scientists and practitioners, the FOEN continues to develop and publish guidelines, which are periodically revised and updated (fig. 2). After more than 20 years of experience, soil protection, at least on major construction sites where an environmental impact assessment is mandatory, is proving effective. Along with the legal requirements and the scientific input, a strong and long-lasting collaboration with the Swiss Soil Science Society, which brings together scientists, policy makers and practitioners, was decisive in achieving this success.

Figure 2. *Examples of federal guidelines that outline the requirements of federal environmental law and describe the current practices for soil management on construction sites (Soil: Publications (admin.ch)*

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SWISS SOIL STRATEGY

Acknowledging the situation and the state of soils in Switzerland (see box NRP68), in 2013 the Federal Office for the Environment (FOEN) undertook to assess the situation and to develop a national soil strategy together with the Federal Offices for Spatial Development (ARE) and Agriculture (FOAG). The objective of the strategy is to provide a guiding framework and decision-making support to the relevant federal and cantonal authorities and to highlight ways in which the identified challenges can be tackled.

Box NRP68
In the same period, the findings of the evaluations of the state of Switzerland's soils carried out for the development of the strategy were also used to develop the objectives of the National Research Programme 68 "Sustainable Use of Soil as a Resource" (NRP 68, 2013-2018). The overall synthesis report of the National Research Programme 68 "Sustainable Use of Soil as a Resource" (NRP 68), published in 2017, stated that progress since the Soil Ordinance came into effect had been modest and that the current policy had to be regarded as a failure. In particular, the report noted that the political will to provide the necessary financial resources for an effective soil protection was lacking. The NRP 68 recommended that soil quality, and soil functions, be taken into account in spatial planning and to link soil management to soil quality. More attention should be given to the impact of soil on climate and the gaps in soil mapping should be closed urgently. Conversely, adopting the Swiss Soil National Strategy was one of the key recommendations of the NRP 68

DEVELOPING A STRATEGY

The leading federal offices (FOEN, ARE, FOAG) have adopted a step-by-step approach, from an overall vision to strategic approaches. Specific measures will be developed later and are not yet specified in the strategy (fig. 3).

In a first phase, the three offices defined a common vision (preserving the soil functions for future generations) and agreed on six **overarching objectives**:

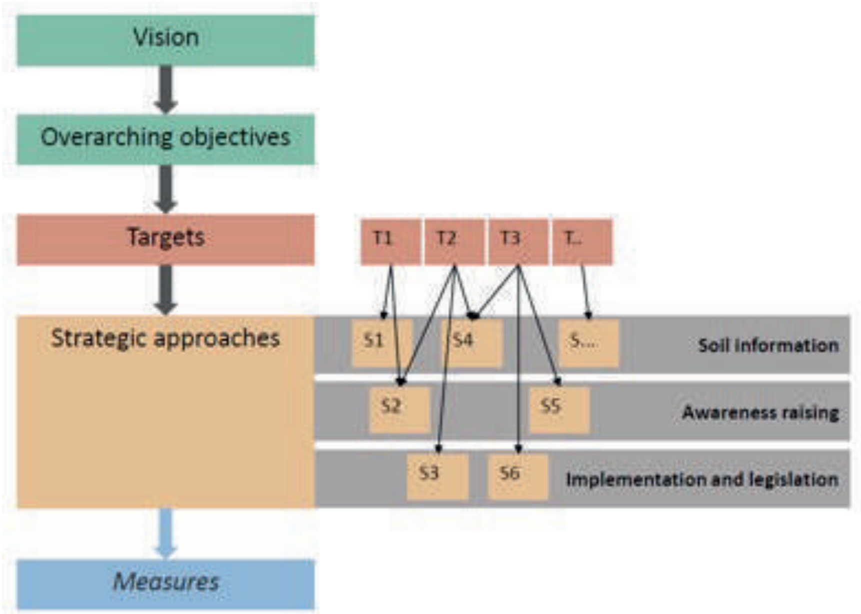

Figure 3. *Stepwise approach in developing a soil strategy*

FIELD	TARGET	STRATEGIC APPROACH
Agriculture	No lasting loss of soil biodiversity owning to agricultural use	Promote agricultural practices that ensure preservation of soil biodiversity
		Draw up target and reference values for soil biodiversity
Construction sites	No lasting degradation of soil functions because of physical, chemical or biological soil degradation due to construction activities	Strengthen the enforcement of physical and biological soil protection, in particular for construction projects not subject to an EIA
Soil use in urban areas	Restoration of soil functions of unsealed soils within urban areas that have been subject to physical degradation and contamination	Review the operating framework for restoring soil functions of soils in urban areas

Table 1. *Examples of targets and strategic approaches from the Swiss Soil Strategy (adapted)*

- reduce soil consumption (by 2050, reach a neutral state i.e. achieve net-zero loss of soil functionality)
- manage soil consumption on the basis of an overall perspective (including soil functions' preservation)
- protect soil from harmful impacts
- restore degraded soils
- improve perception of the value and vulnerability of soils
- strengthen international commitment

The second phase of developing a Soil Strategy was dedicated to identifying the challenges that had to be tackled in order to reach the overarching objectives. The strategy then sets out specific **targets** and **strategic approaches** for eight relevant fields (table 1).

It is important to note that the "strategic approaches" are not yet concrete measures but constitute starting points and indications where measures must be developed, in cooperation with the cantons and other stakeholders.

The strategic approaches have been grouped into three "action areas": Many of the strategic approaches address the lack of soil information: currently, only about 20% of agricultural soils have been mapped on a national scale. Similarly, the lack of awareness of the importance and vulnerability of soils constitutes a major obstacle to the development of soil policies and to the implementation of sustainable soil management practices; hence, this topic is among the six overarching objectives and many strategic

SOIL PROTECTION IN SWITZERLAND: STEPS, HURDLES, SUCCESSES, AND SOIL STRATEGY

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approaches aim to raise awareness among target groups whose actions and decisions have a particularly significant effect on soil functions. A survey of the cantons, commissioned by the FOEN (Interface 2013) showed that the greatest deficit occurs in the implementation of soil protection measures; although the legal requirements are fit for purpose, they are not sufficiently enforced. The third action area therefore focuses on implementation and legislation and plans to examine existing regulations to identify overlaps, contradictions and conflicting objectives.

CONSOLIDATING THE STRATEGY

The first draft of a Soil Strategy was ready by the end of 2017. An intensive phase of consultations and consolidation followed in which the other federal offices, the cantons and relevant associations were asked for their input. The Soil Strategy was received quite well, and met with relatively little opposition, except for the goal of reaching the no-net-soil-loss target by 2050. Even though the stated target specified the fact that it would still be possible to build on soil, but if this resulted in functions being lost, they had to be offset elsewhere by improving the soil there, the opinions differed strongly: on the one hand environmental protection organisations deemed it "an important and urgent federal task" and the Swiss Society of Engineers and Architects praised it as "visionary" while on the other hand representatives of the economy feared that "if this goal were to be pursued, the use of the soil and thus the further development of construction in Switzerland would be made impossible." This controversy led to a lot of publicity and may have been one of the reasons that helped the issue of soil protection finally being acknowledged by the broader public.

The Swiss Soil Strategy was finally approved by the Federal Council in May 2020 together with a package of other measures to sustainably safeguard soil as a resource.


Elena Havlicek

FACTORS OF SUCCESS

In retrospect, one of the main factors that led to the adoption of the Soil Strategy by the Swiss Federal Council is probably the "strategic" level of the Soil Strategy, the fact that it contains no concrete measures yet. This allowed the discussion about objectives and agreement on targets with less chance of having a stakeholder opposing the whole strategy because they were against a particular measure.

Another decisive factor was that the strategy was developed from the beginning in close co-operation with the federal offices FOAG and ARE. Having the two offices with the most impact on soil use on board led to contents of the strategy that were well balanced and proof against opposition from farmers and planners.

Having the support of the minister in charge for the environment and for spatial development was one of the tipping points in the final approval phase, when opposition from the side of economic associations was raised against the goal of no-net-soil-loss objective.

The controversially discussed goal of no-net-soil-loss served as an attention-gathering topic that led to a lot of publicity and may in the end have helped the strategy and the cause of sustainable use of soil.

Finally, there was a door of opportunity opened by several national and international activities such as the International Year of Soil 2015, the establishment of the National Research Programme 68 "Sustainable Use of Soil as a Resource" (NRP 68), and the activities triggered by the Agenda 2030 or the Global Soil Partnership.

All these factors – and some more – contributed to the success of the Soil Strategy and to the fact, that in 2022 Peake and Robb classified Switzerland as one of six "global standard bearer of soil governance".

KNOWLEDGE COMMUNICATION: A TRANSFORMATIVE MECHANISM

In 2021, during the last EUROSOIL conference of the European Confederation of Soil Sciences, the event *Connecting People and Soil* brought together soil scientists and stakeholders from diverse backgrounds (policy, agriculture, financial sector, food industry). Among the conclusions of the wrap-up sessions of this event, one deserves to be highlighted: Technical and scientific innovations will help to achieve soil protection objectives but the key is social innovation – fostering true dialogue between stakeholders.

The adoption of sustainable soil management practices requires a multilevel process and depends largely on the transfer of appropriate and comprehensible information along the policy development pathway (Fig. 4 overleaf). While awareness raising is a process that seeks to inform and educate people about an issue with the aim of influencing their behaviour, communication in the broad sense can be seen as an effective and necessary tool leading to transformation, to the development of policies and implementation of sustainable soil management practices.

Each stakeholder of the policy development pathway, whether scientist, citizen, farmer, politician or policymaker, has their own language and understanding of the issues and priorities. Therefore, messages and information addressed to each of them require a different focus, an adapted approach, and specific emphasis. Two aspects are particularly decisive to consider:

- Overcoming the **knowledge asymmetry**: the stakeholders from the different levels do not always fully understand or perceive the framework conditions of another level or miss the specific expertise from another level that is required to make an informed decision (Sharma 1997, Watson 2004).

- Overcoming the **knowledge paradox**: scientific results that could contribute to the policies development and sustainable soil management are not heeded or implemented (Bouma 2010).

Appropriate and tailor-made knowledge communication is therefore a strategic tool and should be a priority in policy development activities. Stakeholders from each level (scientists, farmers, policymakers, etc.) with the ability to translate their specific knowledge to commonly understandable information, messages and indicators are essential in policy development. Especially, scientists with an ability to translate often complex science-based data and facts into terms that can be understood by other scientists and other stakeholders are

SOIL PROTECTION IN SWITZERLAND: STEPS, HURDLES, SUCCESSES, AND SOIL STRATEGY

Elena Havlicek and Ruedi Staehli - Swiss Federal Office for the Environment (FOEN) Soil and Biotechnology Division (continued)

instrumental in delivering key messages and advising policy development (Hartemink and McBratney 2008; Mol and Keestra 2012).

SOIL POLICY: SMART REGULATION

Binding legal instruments at international, national, regional and sub-regional levels are needed to fully protect available soil resources for future generations. However, a vast array of regulatory non-binding instruments complements the legal framework (Fig. 5 below).

The concept of smart regulation (Gunningham and Sinclair 2017) applies to different types of instruments. Along direct government regulations (hard law), smart regulation encompasses other regulatory mechanisms, such as financial interests (market-based instruments) or self-regulation by non-governmental organisations or partnerships (e.g. The Global Soil Partnership's Voluntary Guidelines for Sustainable Soil Management) (see Fig. 5 a).

The implementation of soil protection on construction sites in Switzerland has typically involved different levels of regulation (see Fig. 5 b) and has demonstrated the effectiveness of a smart regulation approach. When a project is approved, the construction permit will contain certain measures for soil protection as conditions based on the existing regulations for soil protection stated in the EPA and the two ordinances mentioned above (hard law).

Several federal guidelines (see Fig. 2) outline the requirements and describe the current practices as an aid for the constructors (soft law). A "specialists of soil protection on construction sites" can be hired by the contracting entity to support the planners and construction experts on site. This voluntary measure has been shown to streamline the planning of protection measures and to significantly lead to better soil protection, which in turn saves costs by preventing later correction or remediation measures.

CONCLUSION

The purpose of the Policy Session held during the World Congress of Soil Science was to "provide a platform to discuss and explore the complexities, challenges and opportunities of achieving sustainable soil management and maintaining soil function".

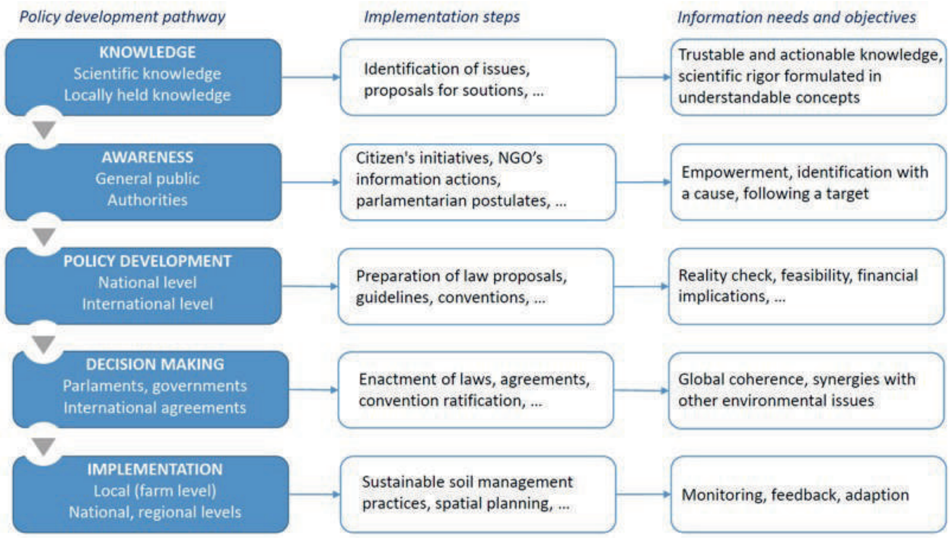

Figure 4. *Policy development pathway: a multilevel process depending on the transfer of appropriate information (adapted from Erdogan et al. 2021)*

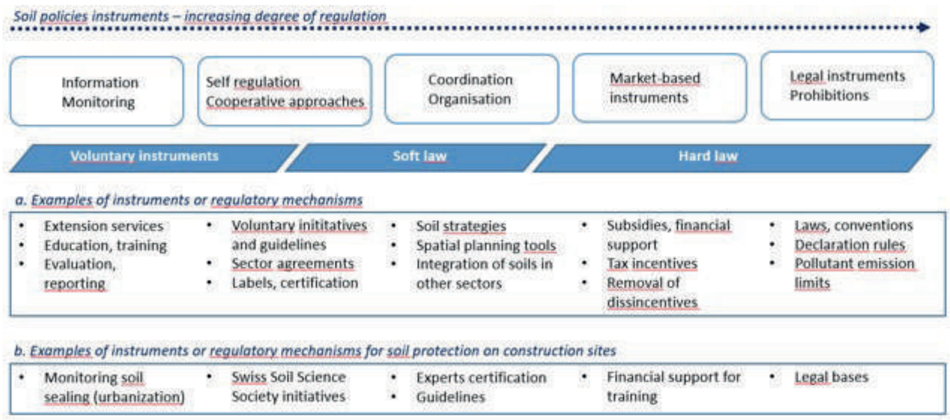

Figure 5. *Regulation through a mix of instruments and policies (adapted from Ecoplan and Leimbacher 2021)*

Implicitly, it emerged that there is no "one size fits all" approach or mechanism to develop soil policies or implement sustainable soil management. In many cases, the use of a mix of approaches will allow for a more effective regulation. Soil is in the center of many different and competing uses and involves a multitude of stakeholders.

Developing and implementing a coherent policy is therefore complex and difficult – but not impossible. As was shown by the two examples of developing a Soil Strategy and establishing the instrument of "specialists of soil protection on construction sites" in Switzerland, successful soil protection efforts need a close collaboration of the relevant stakeholders.

Cooperation, and its corollary communication, although sometimes underestimated, are at the heart of these processes!

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Developing a 'Soil Policy In Practice' Through Researcher-Policy Collaboration

Erik Button, Bangor University, Carmen Sánchez-García, Swansea University, and Jack Hannam Cranfield University, UK

DEVELOPING A 'SOIL POLICY IN PRACTICE' THROUGH RESEARCHER-POLICY COLLABORATION

Erik Button, Bangor University, Carmen Sánchez-García, Swansea University, Jack Hannam, Cranfield University, UK

To develop soil policy that works in practice, effective partnerships and co-production between policy makers, researchers and key stakeholders is needed. Multiple actors and methods, such as embedding researchers in policy teams and co-design with farmers, can create alternative ways of developing, implementing, and revising soil policy. These new methods, coupled with building on what we know from evidence already, can design policy to ensure that soil is managed sustainably for future generations.

There are multiple knowledge spaces and methods needed to develop and implement soil policy making. It is important to accelerate what we know already about soil, soil threats and potential solutions via policy implementation. Multiple approaches are needed to develop soil policy to create effective strategies and develop behavioural change today to ensure soil is managed sustainably for future generations. Social innovation is often needed rather than complex technological solutions and policy is only one instrument to achieve healthy soils.

We are actively developing a 'soil policy in practice' in the Welsh Government through collaboration with the Welsh Government Soils Policy and Land Use Team. We developed a different way of working to engage with different groups to pilot and test approaches, obtain feedback on draft versions and create co-ownership of a new soil policy statement for Wales. Our experience as researchers embedded directly in a policy team, through mechanisms like research fellowships and PhD placements, demonstrated one method of soil policy development in practice. The starting point for the draft soil policy statement was a comprehensive review of evidence to ascertain the current status of soils in Wales and their future threats. The review also identified evidence gaps to signpost future soil policy evidence needs. The work drew on existing soil policy evidence programmes, and was supplemented by additional literature where there was little or conflicting evidence. The evidence was assessed within a Welsh context, to ensure that soil, climate, and land use was relevant to the application of the evidence within the policy area.

We aimed to make the language within the evidence review easily understandable for multiple stakeholders (policy teams, farmers and non-governmental organisations). The review had two outputs: 1) a comprehensive reference document for detail on specific themes, and 2) an executive summary, serving as a concise and digestible overview of key evidence.

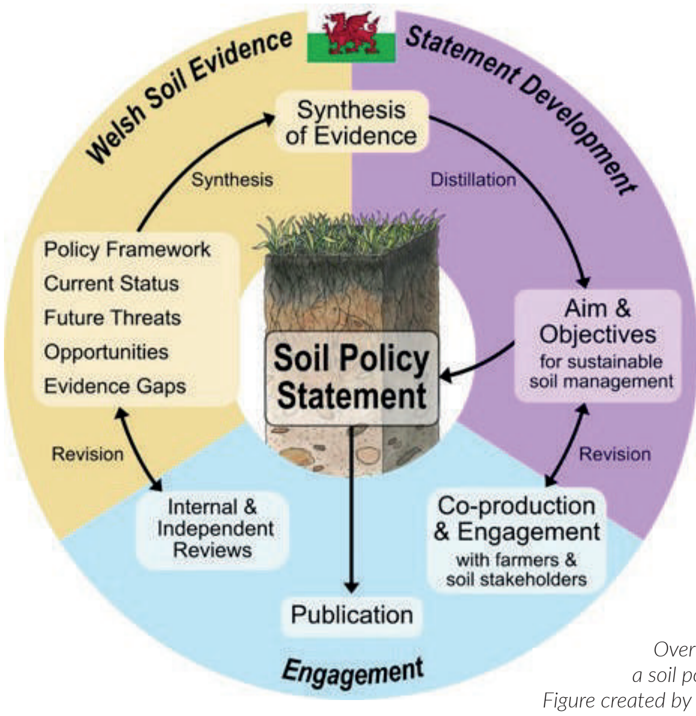
The key themes emerging from the evidence review formed the basis of a draft soil policy statement. The statement is intended as a strategic document to clearly set the vision and direction of travel for the sustainable management of soil in Wales for current and future generations.

From the perspective of the soil policy team the researchers provided impartial interpretation and knowledge advice, where these approaches and insights were lacking in the wider governmental department. This strengthened relationships between government and academia. Rather than commissioning an external contract to complete the evidence review, embedding researchers in the policy team provided an opportunity to engage directly with a range of policy teams to understand the need for the policy development. It allowed greater flexibility in the development of ideas and evidence assessment and a constant dialogue rather than more sporadic communication that is often the case with contracted work. Sitting with the policy team was a direct opportunity to show how research can directly impact and influence public policy and to gain insight into the processes and timings involved in policy development.

The draft soil policy statement emerged from the evidence review, yet it is missing key qualitative local evidence of specific issues on farms in relation to soil threats or management, or evidence that is relevant in a Welsh specific context. The next step for the development of the soil policy statement is a co-production approach with farmers, other Welsh Government policy teams, and wider unions and environmental non-governmental organisations. This aims to co-develop the statement and add additional granularity to the evidence from different contexts.

This different approach to soil policy development demonstrates that, despite differences in skills and approaches, the close collaboration between researchers and policy teams from early in the process, can be a productive mechanism to develop policy based on sound evidence.

The evidence review and draft soil policy statement have already been used in the Welsh Government for Ministerial correspondence and briefings to inform responses to evidence, specifically in scoping legal instruction in the new Agriculture Bill (Wales) to seek powers to regulate soils. These emerging reviews and draft statements have accelerated what we know already about soil in Wales - what is the current status and what should be done - to inform and shape emerging policy development. The next steps are to develop a strategic soil policy statement that sets out the ambition for sustainable management of soil in Wales, reflecting current knowledge, future threats, and opportunities.



Overview of creating a soil policy in practice: Figure created by E. Button 2022

Using Baselines and Data to Deliver Positive Land Change from Farmers and Land Managers; A Case Study - The Northern Ireland Soil Nutrient Health Scheme

John Gilliland, Director of Agriculture and Sustainability, Devenish Nutrition

USING BASELINES AND DATA TO DELIVER POSITIVE LAND CHANGE FROM FARMERS AND LAND MANAGERS; A CASE STUDY- THE NORTHERN IRELAND SOIL NUTRIENT HEALTH SCHEME

John Gilliland, Director Of Agriculture And Sustainability, Devenish Nutrition

In October 2021, Northern Ireland Minister for Agriculture, Environment and Rural Affairs (DAERA), Edwin Poots, announced the setting up of the World's first scheme to baseline every field, tree and hedge at a regional level. It is called "The Soil Nutrient Health Scheme," and would be a public investment of £45m over four years. Designed to give farmers better information about their own farms, it is hoped that this will empower them to make better quality management decisions, which would ultimately lead to positive improvement in both efficiency and environmental challenges.

The Vision for such an ambitious scheme was laid out in the 2016, Sustainable Agriculture Land Management Strategy (SALMS) for N. Ireland, created by a public private partnership through a diverse expert working group, commissioned by the then Department of Agriculture & Rural Development. The Strategy was presented to the Minister having already secured key buy in from N. Ireland Environment Link and the Ulster Farmers' Union.

Based on the premise that if you can't measure, you will never be able to manage, the expert working group recommended that the whole of N. Ireland's landscape be baselined, at individual farm and field levels. The resultant new information would then be given to farmers and land managers, to allow them to deliver on a collection of efficiency and environmental challenges below.

In 2014, only 18% of N. Irish soils were at optimal fertility; average grass utilisation was only 5.1t of dry matter, per hectare, per year; 62% of water bodies were failing Good Water Status; 80% of phosphate entered water courses over the top of the land during extreme rainfall; and 32% of all greenhouse gases came from agriculture.

The concept of digitally measuring and managing, at both the field and landscape level, was initially explored by Belfast based livestock nutrition and research company, Devenish, in 2014. This was done at their beef and sheep research farm, The Lands at Dowth, where three digital surveys, aerial LiDAR, ortho imaging and soil sampling were carried out. Results were then collated on a combined GIS platform which allowed subsequent systems based analysis to be carried out to determine accurately soil fertility and carbon stocks; quantities and qualities of above ground biomass and habitats; and routes of overland flow of water during extreme rainfall. The results were then able to be graphically displayed through a collection of maps for easier interpretation.

The SALMS expert working group built on this Devenish experience and recommended that this should not only be carried out across the whole of N. Ireland, but that it should be repeated every five years so that change, at both the field and landscape level, could be measured reported and verified (MRV) with integrity.

The SALMS report was well received but deemed to be very ambitious. Compromise was reached and using Exceptional Emergency Aid from the EU Commission, three river catchments were selected in 2018, to pilot the recommendations and see whether farmers and land managers would actually improve their practices and would key objectives like improving water quality be achieved.

Commissioned by DAERA, the AgriFood & Bioscience Institute (AFBI) led the three pilots. 1,091 farms on 41,644ha joined the pilots which was 73% of all the farmers in the catchments. Precision soil sampling, aerial LiDAR surveys and water sampling were all carried out. Results were then presented to participating farmers and training was offered with an uptake rate of 50%.

In 2020, one on one interviews and behavioural change surveys were carried out and found that upwards of 80% of the participating farmers were changing their behaviour in key areas. In 2021, the phosphate levels in Upper River Bann dropped significantly for the first time, verifying the observed behaviour changes with a tangible improvement in water quality.

With this success in the pilots recorded and verified, DAERA made the decision to build the business case to role these pilots out right across N. Ireland, leading to Minister Poots announcement in October 2021.

Northern Ireland is not big. At roughly 880,000ha it is small enough to fit inside the county of Yorkshire. But scaling up from the 41,644ha used in the pilots is a huge logistical exercise, not just in carrying out the surveys, but in managing, handling, interrupting and communicating all the data and results. A decision was taken to spread this over four years, by creating four distinct geographic zones, taking one zone per year. It was decided that the scheme would be voluntary, but if a farmer chose to remain outside this voluntary scheme, the farmer would be limited to what future funding schemes he or she could apply to.

In May 2022, the Minister opened the application process for zone one, which was subsequently closed at the end of August 2022. Take up was slow at the start. A public private liaison group was set up, and with a collective effort, from the Minister, to NGOs, the Ulster Farmers Union and supply companies all engaging. By the time the application processed closed, an extraordinary 92% of all eligible farmers had applied.

At the heart of this success, has been the principle of talking with farmers and not talking at farmers. Farmers told us they wanted to change but had no idea on just where they were on their journey. They wanted good credible independent information about their own land, not their neighbours. With training they are now learning how to interrupt the data, use it in their decision making to drive the efficiency in their business, minimise the waste and enhance their profitability, with an understanding that this process will be repeated in five years' time and they would be informed, accurately, of their change.

In return, soils, habitats, water are robustly baselined for the first time, through one process, working to one common framework and procedure, and overseen independently.

In five years' time when this is repeated, the N. Irish agrifood industry will be the first place in the World to be able to inform consumers, with integrity, of their journey of positive change. N. Irish Farmers and Land Managers are passionate that this will allow them to better position their product for sale and that it will secure them a better return from the market place, while restoring their self esteem, now knowing that they are not just the problem, but that they are actually, very much the solution.

Audience Reflections

Cairo Robb,
Legal Research Fellow, Centre for International
Sustainable Development Law

AUDIENCE REFLECTIONS

Cairo Robb - Legal Research Fellow, Centre For International Sustainable Development Law

First, congratulations to the IUSS, BSSS and all those involved in initiating and organising the first WCSS Policy Programme. This is an important and positive step towards bridging the gap between our knowledge of soil science and improvements in soil use and management on the ground.

This comment, made more briefly in person at the WCSS22 policy session, follows on from another comment raised towards the end of the session about the lack of voices representing soils from across the globe in the Policy Programme. In addition to the points made by that commentator, I would add that not only do the speakers presenting at the first ever IUSS policy session appear to hail almost exclusively from the 'global north' – it is notable, also, that in discussing 'national soils policies' there has been a focus only on policy regarding 'national soils' – i.e. soils within a particular national state. We need to make sure that 'national soils policies' deal not only with safeguarding our 'national soils' but also with our own state's impact on soils globally.

National soils policy should include 'external relations' aspects – dealing with international trade, investment, procurement, and the operations of multinational corporations, with a view to fostering sustainable soil management everywhere, and not just in our own backyard. We must take into account international supply chains, and the global problems arising from over-consumption, unsustainable production and linear economies. We must address the international dimensions of our national choices. We must ensure that our national soils policy, and other national policies, are working towards safeguarding, and reducing our impacts and increasing the resilience of our, and others', dependencies on, soils across the globe.

National soils policies should, in addition to addressing national priorities, also reflect regional and global needs relating to sustainable soil management. They should as a minimum promote implementation of international commitments. This includes, for example, the commitment under the United Nations Framework Convention on Climate Change (UNFCCC, Article 4) and Paris Agreement (Article 5) to promote and cooperate in conserving and enhancing GHG sinks and reservoirs, including biomass, forests and oceans, as well as other terrestrial, coastal and marine ecosystems, which encompasses the management and conservation of soils, including in wetlands, peatlands, grasslands, saltmarshes and mangroves. They should also demonstrate commitment to contributing to the Paris Agreement's global goal on climate adaptation (Article 7), which aims to enhance adaptive capacity, strengthen resilience and reduce vulnerability to climate change, including by cooperation and transfer of funds, and likewise to the objectives of the United Nations Convention to Combat Desertification (UNCCD). National soils policies should also reflect international commitments to the conservation and sustainable use of biodiversity, which includes soil biodiversity, under the Convention on Biological Diversity (CBD).

There are, in addition, countless ways in which national soils policy and commitment to the Sustainable Development Goals (SDGs) can be mutually reinforcing, and this should be used to advantage. There are opportunities for multiple soil-related co-benefits even beyond the most obvious direct and indirect references to soils in SDGs 2, 3, 6, 11, 12, 13, 14 and 15. SDG 4.b, for example, aims at expanding the number of scholarships available to developing countries, in particular least developed countries, small island developing States and African countries, for enrolment in higher education, including vocational training and information and communications technology, technical, engineering and scientific programmes, in developed countries and other developing countries.

National soils policy should attend to important global 'blind spots' in soils research, and gaps in soils governance, by facilitating research on soils from across the globe, recognising, respecting and valuing traditional knowledge and practice of indigenous peoples and other local communities, and supporting and strengthening local capacities in soil science research and interdisciplinary soil-related projects for the achievement of sustainable soil management and just and effective soils governance within and beyond national borders.

See e.g. Carlos Guerra et al., Blind spots in global soil biodiversity and ecosystem function research, Nature Communications 11.1 (2020) 1-13, https://doi.org/10.1038/s41467-020-17688-2, highlighting the need for funding mechanisms that include higher flexibility for the involvement of local partners from different countries in global soil research projects, and pointing out that some soil ecological research requires cross-border initiatives and expensive laboratory infrastructure, as well as proper knowledge transfer mechanisms to sustain global soil macroecological research, which will in turn contribute to advancing our understanding of macroecological patterns of soil biodiversity and ecosystem function, thereby fulfilling national and global conservation goals; and the SoilBON project. See also ITPS Soil Letters, No. 4, Spectroscopy: towards eco and human friendly soil analysis, FAO, 2021, https://www.fao.org/3/cb6821en/cb6821en.pdf, highlighting the need for developing more comprehensive soil spectral libraries, and the work of the Global Soil Partnership (GSP) and its technical networks. See e.g. Harald Ginzky, Soil governance: the case of implementation and enforcement, Soil Security 6:100040, https://doi.org/10.1016/j.soisec.2022.100040 and Lewis Peake & Cairo Robb, The global standard bearers of soil governance, Soil Security 6:100055, https://doi.org/10.1016/j.soisec.2022.100055, and the work of the GSP in this area. See CBD, Article 8j and website at https://www.cbd.int/traditional/intro.shtml.

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WCSS Soil Policy Session Summary

Francesca Osowska,
NatureScot

WCSS SOIL POLICY SESSION SUMMARY

Francesca Osowska - NatureScot

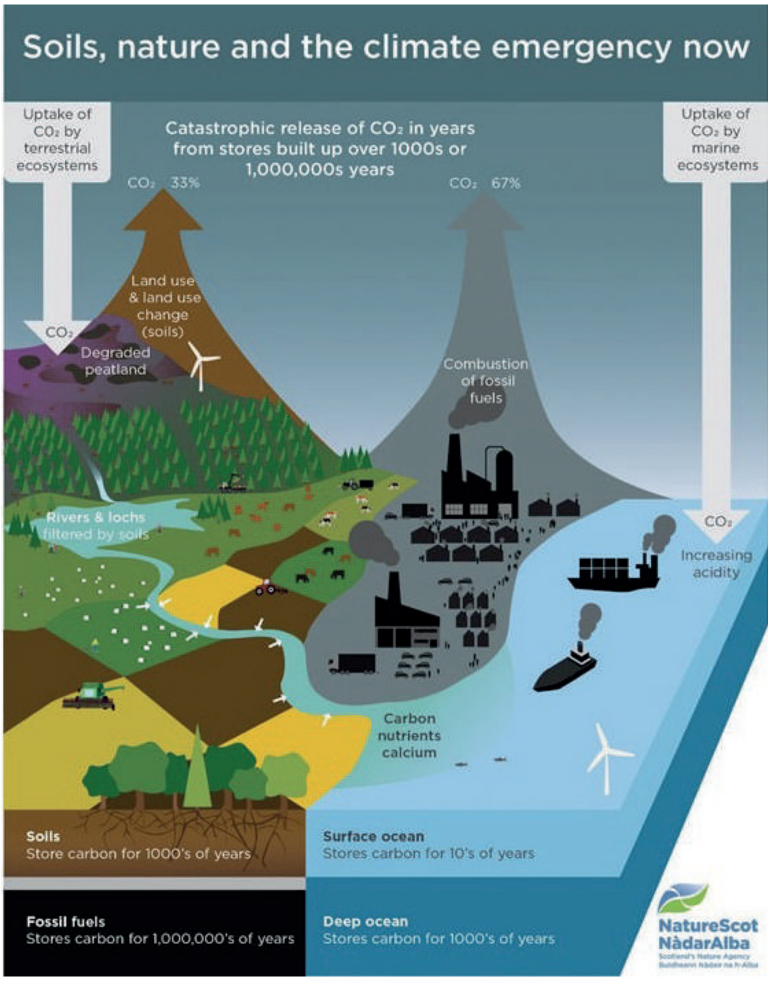
The 1st World Congress of Soil Science Policy Session held at the 22nd WCSS was introduced and closed by Francesca Osowska from NatureScot.

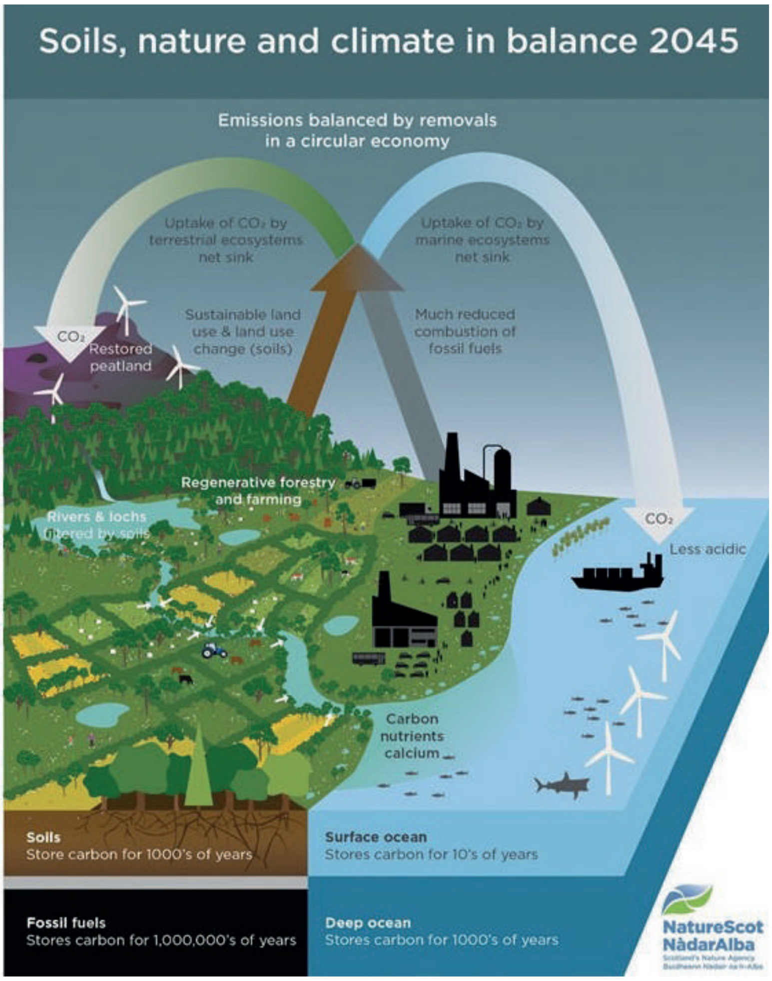
Introducing the session, Francesca highlighted the importance of soils and their position at the heart of the global carbon cycle. With the climate-nature crisis a direct result from short-circuiting this cycle, many opportunities sit with the soil, including solutions such as:

- simple messages to support effective policy and its delivery
- exchange knowledge and ideas across disciplines and viewpoints
- soils and soil health an essential part of the transition to net zero and turning the loss of biodiversity to nature-positive
- nature fixes the broken bits of the carbon cycle on land
- nature central to all land use policy and practice.

Bringing the session to a close, Francesca reflected on the discussions throughout the day, which clearly illustrated that **all soils everywhere** have to contribute to a net zero and nature positive future. There was a need for stakeholders to consider:

- soils central to mitigation, adaptation, and the state of nature
- actions informed by *(but not constrained by)* the past with an eye to the future
- policy fostering diversity
- the need to tread lightly and bring all stakeholders on the journey
- feed the soil (but not too much, and organically)
- soil governance (who gets a say?)
- societal needs at a range of scales for a range of interests
- knowledge exchange, including social sciences and behaviours, sustainable consumption bounded by sustainable production and soil health.





WCSS SOIL POLICY PROGRAMME 2022

Sustainable Natural Systems And Effective Global Policies: How To Protect A Resource That Supports Life On EARTH

SESSION 1 CHAIR: Dr Eleanor Reed Senior Environmental Specialist – Soils (Natural England)	
Francesca Osowska - NatureScot	Opening
Cristine Morgan - Chief Scientific Officer, Soil Health Institute, USA	Impacting Adoption of Soil Health Management in the US
Ronald Vargas - FAO Global Soil Partnership	From advocacy on global soil governance to consolidation into national soil policies/legislation
Arwyn Jones - Joint Research Centre European Commission	Soil in the European Green Deal
Elly Fay - Founder & Executive Director, Sustainable Soils Alliance	The Sustainable Soils Alliance raising soil's political profile

SESSION 2 CHAIR: Clive Mitchell (NatureScot)	
John Gilliland - Director of Agriculture & Sustainability, Devenish Nutrition	N. Ireland's Soil Nutrient Health Scheme: A World first
Phil Jarvis - Chairman of Environment Forum NFU	The NFU's vision for soils policy: from a farmers perspective
Mathew Williams - Chief Scientific Adviser (CSA) Environment, Natural Resources and Agriculture, Scottish Government	The need for soil monitoring frameworks to underpin robust environmental policy development
Arwyn Jones - Joint Research Centre European Commission	Soil in the European Green Deal
Ruedi Stähli - Federal Office for the Environment FOEN	Developing a national soil strategy: before and after?
David McKay - Head of Policy (Scotland) , Soil Association	What restoring soil health means from the level of the farm up to the level of the food system
Jack Hannam and Carmen Sanchez-Garcia - Welsh Government Soil Policy Team (Cranfield University; Swansea University)	Finding common ground: A case study on academic, government and stakeholder collaboration on a soil policy statement for post-Brexit Wales

SESSION 3 CHAIR: Jack Hannam, Welsh Government Soil Policy Team (Cranfield University)	
Elena Havlicek - Scientific Officer Federal Office for the Environment FOEN	From soil policy to soil Protection: a matter of cooperation and communication
Johan Bouma - Emeritus Professor of Soil Science, Wageningen University	Effective land use policies in the information age
Panel Discussion: Johan Bouma, Elena Havlicek, David McKay, Cristine Morgan	How do we best share good practice and good ideas globally? How do we better link the farming, research and policy maker communities? Why is it so difficult to introduce soil protection measures?
Francesca Osowska - NatureScot	WCSS Policy Session Closing Remarks

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