Developing the Indicator Framework for the 25 Year Plan

Soil Workshop Report

9 October 2018

1. *Background and agenda*

The workshop was organised by The Sustainable Soils Alliance on behalf of Defra.

In the draft Indicator set for Defra's 25 Year Plan for the Environment (25 YEP), *Soil Health* (H29) is referred to as a *Condition of Assets* Indicator under the Headline Indicator list. It currently sits within Headline Group 11 which linked to the goals of the 25 YEP under *Production and harvesting of natural resources*. Soil health is also highly interconnected as both cause and effect of other Systems Indicators, including both *Benefit*s (carbon sequestration, sustainable food production, flood mitigation, water quality, farming and forestry income) and *Pressures* (waste, pollution, chemical and greenhouse gas emissions, biosecurity threats etc).

The purpose of the 9 October workshop was to discuss the draft Indicator set and soils' position within it. The first session examined the clarity, coherence and value of the framework and underlying data sources in general, and asked:

- Whether the proposed framework described the environment in a meaningful way
- If there were gaps in the Headline/System Indicators that needed filling
- If the overall number of Headline and System Indicators was appropriate
- How the framework might be used and if it is scalable between local and national levels

The second session focused on the 'soil health' indicator, and in particular:

- What data sources should be included/excluded in a 'soil health' Indicator
- Spatial and temporal scale and gaps in knowledge
- Relevant existing and ongoing R&D activities that aim to develop a 'soil health' Indicator
- The use and availability of soil-specific data sources which might be relevant to the framework and any of the proposed Indicators

The workshop gathered together a range of professions and sectors with a direct interest in the condition of the environment. This included representatives from the following organisations:

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• ADAS	• G's Growers	• Sainsbury's
• Agrii	• Game & Wildlife Conservation Trust	• Soil Association
• AHDB	• Innovation for Agriculture	• Soil Security Programme/NCC
• AIF	• LEAF	• Sustainable Food Trust
• CEH	• Marks & Spencer	• Tesco
• CPRE	• National Trust	• University of Sheffield
• Cranfield University	• NFU	• Vidacycle
• Durham University	• NIAB	• West Country Rivers Trust
• Environment Agency	• Rivers Trust	• WWF
• Fera Big Soil Community	• Rothamsted	• Yeo Valley
• Four per Thousand	• RSPB	

The first session of the workshop consisted of a brief introductory presentation by Robert Bradburne, Defra's Deputy Director for the Environment Analysis Unit, on the 25 YEP and the draft Indicator set; a group discussion followed. During the second session attendees were divided into five sub-groups to share experiences and insights on potential data sources which could contribute to the soil health Indicator set, which were then shared with the workshop as a whole.

2. *Trajectory and rationale for the 25 Year Plan for the Environment*

- Dr. Bradburne introduced himself as the person responsible for the design of the Indicator systems model. He explained that the overriding objective for the 25 YEP was to measure and monitor how the natural environment performs and changes over time, using the Natural Ecosystem Assessment Framework to evaluate the benefits it contributes. The 25 YEP aims to integrate the environment and its various elements into live policy thinking rather than ring-fencing it as a siloed entity.
- The move towards an integrated environmental policy builds upon the Millennium Ecosystem Assessment (2005), the NEA (2011), Natural Environment White Paper (2011) and the Natural Capital Committee (2015) reports.
- The 25 YEP looks to create a clear steer for environmental policy but not necessarily all the answers - i.e. it dovetails with other policy instruments (the Agriculture Bill etc). It looks to establish the means to help "the natural world regain and retain good health" and includes 10 high-level 25-year goals. These are distinct from specific policies because they recognise that nature operates as a series of systems, an approach that enables any interventions to tackle these complex problems effectively and efficiently.
- Defra will report annually on the progress of the 25 YEP, and with that in mind 15 Headline Indicators have been developed (reduced from an original 65 System Indicators) that will enable

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them to assess and communicate the nature and quality of environmental change to key Natural Capital Assets and progress towards achieving the 10 high-level 25 YEP goals.

- The framework approach is designed so as to avoid unintended consequences from pursuing goals in isolation, or from adopting too narrow a focus, i.e. on Indicators that reflexively inform only about themselves and not the broader system, e.g. salmon populations rather than river health.

3. Discussion Session: The 25 Year Plan

- Whilst there was widespread support for the systems approach and the framework, the relationships and interactions between Causes, Pressures and Conditions that are integral to the 25 YEP need clarity and understanding. The systems framework approach marks a departure from previous EU Directives towards a Natural Capital approach focused on Pressures, Assets and Benefits.
- The classification of an Indicator will be influenced by the principles of the circular economy and performance in relation to the 25-year goals – Waste, for example can be transformed from a Pressure into an Asset delivering goods and benefits.
- The question arose as to whether the Headline Indicators were weighted equally, and specifically whether climate change/GHG emissions should be a priority as representing the most 'existential threat'. To this point it was explained that GHG emissions were a top government priority, and addressed by other policy mechanisms (Green Growth Strategy etc), while other Indicators/Pressures were more critical in terms of timing/need for immediate remediation.
- There is a need for fluidity between Asset classes, such as where land categorised as 'nature' might need to transfer to the built environment because of development. This raises questions about classification, e.g. in what context might 'development' be considered a Pressure and when might it become a new Asset?

4. Discussion Session: The Place of soil

- When it comes to soil, the challenge is to generate the data that provides both an accurate picture of soil health, and how soil fits with the broader environment and how it is changing. Delivering soil health not only mitigates a range of Pressures but provides multiple benefits including clean water and better air quality.
- The picture of soil health Indicators is complex and uneven, and there are gaps. While some Indicators are significant and well-studied, others are less so or even as yet unavailable. The strategy set out by Defra requires the research community to contribute to filling the gaps and agreeing the methodologies.
- The term 'Healthy Soils' is thought to be more useful than 'Soil Health' (in line with the vocabulary used for Healthy Seas) and reflects the different contexts and functions of soils (such as nature conservation, urban, contaminated, farming and woodland).
- There was also broad consensus that soil should be considered within distinct Asset categories (Mountain, Moor and Heath, Woods, Farms, Towns and Cities) and that Indicators could change then to reflect the different Pressures within those Asset categories.

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- Soil health is not currently allocated as a Headline Asset but within a Headline Group (G11) 'Production and harvesting of natural resources' alongside three other production Indicators (farming productivity, wood harvesting and sustainable seafood harvesting).
- There is a good case for allocating the soil Indicator according to functionality as long as this increases clarity and guards against redundancy and duplication (such as where three Indicators point to the same thing). This approach reflects Natural Capital principles of accounting for quality, quantity and location.
- Dr Bradburne agreed that there might be an argument that soil should be a Headline Indicator and not a Systems Indicator (under Natural Resources) as long as a data set could be found that:
    - is robust and accounts for a meaningful change over time - reflecting changes to functionality and delivery of benefits
    - helps policy makers to demonstrate performance and success
    - facilitates communication of information in a newsworthy way that people can understand and relate to

- In addition, an agreement was advanced that soil should be added to the seven Natural Capital Assets, alongside Air and Water.
- Determining an appropriate and reliable soil health Indicator data set is a challenge as soils vary spatially and in granularity and generally change slowly over time, and data collection in the local context differs significantly from the national picture. It is nonetheless possible and necessary to agree certain core/essential Indicators, e.g. for carbon capture, water storage, infiltration etc, to add coherence between local (e.g. on-farm) and national measuring.
- Ultimately there are three separate elements of soil monitoring and measurement that need to be accounted for: 1) National monitoring (the 25 YEP) is needed to track our progress as a nation; 2) ongoing experiments are needed to identify solutions; and 3) farmers need to track their own outcomes and take responsibility for looking after their 'Assets'.
- Getting land owners to test and reliably report on their soils is a key, but separate, challenge (for the future farming policy) if farmers are to receive money for delivering public goods. If data collection fails in reliability and credibility, re-testing with costly implications will be needed. While measurement is fundamentally important, it does not necessarily guarantee active management is taking place.

5. Soil Indicators

- The Indicators that are agreed will need to be clearly outcomes-focused and help to forge the connection with the bigger picture, an integrated system and positive or negative trends. Past studies generally converge on a relatively small set of likely candidates of Indicators.
- Soil health Indicators should satisfy a requirement to provide a clear, relatable narrative that can demonstrate to a stakeholder or the public why particular data indicate a soil is healthy and returns benefits to society and the farmer (or otherwise): demonstrating, for example, a decreased likelihood of flooding, improved nutrient holding, etc.
- For logistical reasons, metrics appropriate for on-farm assessment may be different to those for national assessment

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- According to the 2016-7 Environmental Audit Committee Soil Health Inquiry, the economic costs of current damage to soils has been estimated to be £1.2-1.4 billion a year (with 80% of costs experienced away from the site where the degradation takes place). Despite this – and the fact that this is likely an underestimate - it has proved impossible to translate soil condition change into clearly monetisable benefits based on direct and indirect market values. This had been an obstacle to the development of a viable Indicator set.

I. Structure:

- Soil structure: Essential for understanding the holding capacity of soil for flood prevention, pollutant and nutrient mobilisation and availability.
- Evaluating soil structure: Includes assessing water holding capacity, the presence of standing water, aeration, porosity, bulk density etc. The National Trust operate a tiered Indicator model (1-5) for soil compaction (5 = worst, where standing water, runoff, erosion are visible). Technology for recording compaction currently includes use of penetrometers and remote sensing (currently only for the top 2-5cm). Satellite technology can identify standing water (compaction hotspots) after heavy rainfall and estimate the amount of land that is sealed or soil that is bare; however, there are limitations to the ability of this approach to measure compaction - spatial scale and obscuring by vegetation.
- Soil compaction: Generally seen as the most important soil structure Indicator. Infiltration and permeability are considered a better measure than bulk density. Infiltration and permeability need to account for soil type, e.g. sandy soils rates v. clay soils rates.
- Water holding capacity: Agreeing a metric to understand soil's ability to hold water is significant because it enables a direct correlation to be made with the costs associated with flooding.
- Nutrient holding capacity and soil chemistry: Soil structure affects nutrient bioavailability and soil chemistry, and will inform chemistry data and therefore management decisions.
- Soil erosion: This is not necessarily a useful Indicator – and not directly related to structure since even well-structured soil erodes. Erosion also happens too rarely over space and time to justify including it as a national Indicator.

II. Soil Chemistry: Carbon / Organic Matter

- Monitoring change in carbon/organic matter: Monitoring trends is key to understanding soil health and function for public goods (and measuring GHG emissions), on-and off-farm benefits and as a proxy for biodiversity.
- Nationally accepted methodology: A national sampling scheme is needed to measure any increase or decrease in soil carbon, whether undertaken by land managers or via a commissioned survey. To monitor an accurate picture nationally the methodology and number of samples need to be agreed, as well as how sampling needs to relate to the geology and soil species diversity across the country.
- Tests: Tests are available to measure SOM, but there are a range of different methodologies used which need to be better standardised. Particular mention was made of RB209 guidance for sampling for soil fertiliser-need assessment which clearly defines sampling methods. The

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challenge is that the approach outlined is not routinely followed by farmers and very few farmers ask for carbon to be included in their sampling.

- On-farm standard testing: An agreed methodology is needed to ensure consistency and to measure trends over time. The cost of labs designed to carry out the testing is a potential obstacle to consistency and implementation. This cost needs to be considered in the context of the cost of damaged soil both on-farm and for the wider environment.
- SOM and soil depth: Views vary as to the depth carbon should be measured: whether at top-soil level or at 1m depth, or both, to reliably track change over time. Depth is a particularly important Indicator for carbon as it determines soil stock of carbon.
- SOM and fertility: Soil organic matter is an Indicator of soil fertility because it points to the cycling of other nutrients (plants access carbon directly from carbon dioxide). The question of mineralisable/cycling carbon as an Indicator was raised but not supported.

III. Soil chemistry: pH, N, P and K

- Existing Guidance: Particular mention was made of the need to reference the 2006 Environment Agency report *The development and use of soil quality Indicators for assessing the role of soil in environmental interactions,* which evaluated the tools to determine the state of our national soils and develop ways of monitoring them.
- Chemical Indicators: Key soil health Indicators are generally agreed to include pH, N, P and K and these have an impact on-farm for soil nutrient properties and off-farm, downstream, for biodiversity, water, climate change etc. Soils need to have the chemical qualities that reflect what is required from them and relevant to their context, and soil health Indicators should reflect land use and function. Information on soil chemistry levels of input can be linked to water quality metrics collected by water companies.
- Indicators and reading trends: Higher levels of chemical inputs do not always lead to higher crop productivity or soil quality. High reactive N, while good for crop productivity, is not good for habitats and is a Pressure threat to water systems, from GHG emissions and to tree health. In the past, thresholds for this have been explored for different habitat and crop types and change also reported within different habitat classes recognising these differences.
- Soil health vs. management and yield: Farmers will likely collect better and more reliable data when it is considered useful to them, therefore there will be considerable variation in motivation to measure depending on the purpose and land user's interest. Since pH, N and P tend to be management/yield-related rather than soil health related, and since farmers should already be monitoring them (in line with RB209 recommendations), there are arguments that either a) they should not be included in nationwide monitoring and/or b) nationwide efforts should double up on this work for a clearer picture.
- Farmer recording and responsibilities: There are practical challenges in leaving chemical measurement to farm managers with highly variable results according to the time when a sample is taken.
- Measuring standards: There is no reliable advice on reactive N (Nr) – in the soil, while P pollution levels are a growing issue, including legacy P.
- Nationwide soil chemistry: There is general agreement of the need to establish thresholds below and above which levels must not go and to benchmark such Indicators across the country

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according to mapped soil types, land use etc. A key objective would be to measure trends and identify resources necessary for improvement to reach a state of no decline and stable balance.

IV. Soil biology

- General: Soil microbiology and biodiversity are hugely complex to measure and monitor over space and time. They are therefore poorly accounted for. This leads to a reliance on easy to measure Indicators such as earthworm counts.
- Biodiversity: Some organisations are currently developing a molecular benchmarking approach but none are sufficiently developed for general use as a worthwhile, meaningful Indicator and it will be a challenge to link these to soil functions and the benefits which are the primary focus of the 25 YEP.
- Earthworms and complexity: Land use and function are a relevant consideration in the reliability of using earthworms as Indicators of soil biological health. For example, general intensification of farming practices decreases numbers – evidence of a negative Indicator of soil health. However, earthworms are not useful for assessing soil condition in woodlands, uplands and peatlands where the soil pH is too low for them.
- Earthworms as tool for public engagement: Earthworms as a soil biological health Indicator 'resonate' with the public and so enable communication. The Natural History Museum and Oakwell lead on earthworm studies. There are limitations to the 'citizen science' approach to earthworm counting in that timing and drought can cause significant variation – although this gives an opportunity for land-user training to help ensure an accurate picture is delivered. Earthworms are already included in the 25 YEP 'functional biodiversity' set (H8) which would be better described as 'functional species'.

V. Contaminants

- Contaminant Indicators: The purpose of a contaminant Indicator is to understand how much of what is applied (agricultural, industrial etc) is transferred to wildlife and water courses and impacts upon ecosystem services. As a nation we should understand if we are getting fertilizer rates right for the right amount of production and in the right place. Soil is the reservoir for inputs (pesticides), and an event (e.g. erosion) can swiftly release those that have been in the soil for a long time.
- Risk based assessment: Indicator evaluation should be based on assessment of both acute and chronic risk. Some Indicators, including metals, are simpler to measure than others, e.g. pesticides.
- Quantification: with respect to inputs, approximate quantification can be made through measuring sales (notwithstanding amounts still in storage); however, in the case of pesticides weight does not take into account the toxic load Indicator for human health or the environment. Exploitation of archived samples can also help with retrospective assessment as new contaminants emerge.

6. Connection with policy making

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- There is a need to 'rebrand' soil and the concept of healthy soils, to be able to communicate to ministers and the public a clear vision and understanding of the breadth of environmental and social benefits delivered across the goals of the 25 YEP.
- Land management: The Indicators chosen will impact on farming and other land use techniques and vice versa. Incidents of bad land management (e.g. bare soil on steep slopes, maize production on vulnerable soil) that are picked up by the ELM process might be considered an Indicator in itself. The impact of slurry and anaerobic digestate would have a significant, though local, impact on other soil Indicators. Consideration also needs to be made to the impacts from management, e.g. in woodlands, as well as impacts of indirect Pressures linked to many other policies such as air quality, emissions and climate change, which have had major impacts on our soils to date and are likely to continue to do so in the future.
- Policy change and perception of waste: As 100m tonnes organic waste are produced per year nationally but only 70 million tonnes are returned to the soil, this results in a 30m tonne deficit in SOM that is continuing to drop, as long as waste for biofuels is continued to be used. This is an example of the need for broader policy change.
- Defra will need to be able to report on change over the duration of the 25 YEP within ministerial-lifespans and across governments. The slowness of change in some soil Indicators needs recognition in order to be able to interpret benefits delivered from soil across all other Natural Capital Assets and relevant Headlines.
- Soil is not the only environmental Indicator that moves slowly, and the detection of change in many other Indicators related to biodiversity and other Assets will also not be robust at annual levels. In fact, in comparison with some Indicators (vegetation, pollinators) soil's data versus rate of change, e.g. over 5 years, gives much clearer signals.
- Our ability to detect and report change will also largely depend on the effort and funding available - for example, our ability to detect variable and dynamic changes in water quality reflects the major investment in monitoring – and not necessarily its inherent responsiveness. In addition, in some areas the loss of soil health (e.g. soil erosion, compaction) may be extremely rapid.

7. Data collection

- National scale, long-term data collection: Nationwide soil monitoring reports can and should be ensured as intrinsic to measuring the delivery of public good performance. A rolling approach would be best to maintain the budget line in the relevant department - and more likely to increase detection limits as long as there is consistency in site sampling. Sample numbers need to be sufficient to detect trends within land use categories and be possible to aggregate up to provide an unbiased national picture.
- Optimising existing monitoring and data: Many metrics are available through work undertaken by the soils community over recent decades. In Wales a set of soil Indicators similar to those recommended at this workshop are reported on a 5-year cycle from a rolling monitoring programme with one Indicator (soil carbon) included as a high-level national Indicator for

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sustainable development and the Wellbeing of Future Generations alongside economic, social and cultural Indicators. In this respect Wales is ahead of England.

- Soils archive: A combination of dried and frozen archived soil samples are now in place for Scotland and GB by JHI, CEH which can help track new and emerging threats (e.g. micro-plastics) from stored samples. These archives are also critical to allow comparison between old and new analytical methods.
- National datasets: New datasets with enhanced granularity would support national monitoring of soil health performance.
- Remote sensing: Satellite data is considered a 'constant variable' and helpful for recording what was grown and identifying risk, but not for establishing the condition of soil. Bare soil and sealed soil are already being captured by Defra.
- Land-user data recording: Land-user data should employ the same Indicators as stratified data, although not necessarily collected in the same manner and there needs to be careful consideration as to how the data is used to motivate change (e.g. via ELM).
- There are also important considerations regarding data collected for statutory reasons (to release public payments or enforce regulation) versus that used for guidance and support to improve land management practices. For example, soil data collected by Natural England cannot be used for any other purpose (farmers' contract). GDPR will make these issues even more important to resolve and clarify.
- Farmer training: There is a considerable need for improved farmer training and support to implement on-farm public goods assessment and delivery systems.
- Resource comparisons in monitoring: Decisions about investing in soil monitoring should use as a point of comparison the costs associated with implementing and monitoring the EU Water Framework Directive – which have delivered high levels of investment in monitoring water quality. The case needs to be made for the benefits which would flow from better managed soils and the need to track progress in delivering improvements - 'what we don't measure we can't manage'. These benefits impact on many issues beyond soil condition per se e.g. for water quality, biodiversity, climate mitigation etc: these benefits need to be highlighted, communicated and pushed throughout government and its departments.
- There needs to be more public ownership of soils, and greater engagement of other stakeholders – the supply chain, supermarkets etc.

8. Next Steps

- In his conclusions, Robert Bradburne confirmed that the workshop had succeeded in engaging the soil community and in raising the vital nature of understanding the Indicator Framework and System; and that this initiative is the start of an ongoing conversation, alongside research projects that are already underway.

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