Reflection on the Dutch points of interest regarding the proposed EU Directive on Soil Monitoring and Resilience

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Introduction

On July 5 2023, the European Commission presented a proposal for an EU Directive on Soil Monitoring and Resilience (European Commission, Directorate-General for Environment, 2023). The objective of this proposal is achieving healthy and resilient soils by 2050, which can provide multiple ecosystem services and meet existing ecological, social and economic needs.

The Netherlands has welcomed the goal of the proposed Directive: healthy soils by 2050 by continuously improving the soil through sustainable soil management as well as reducing contaminants. The government endorses the importance of healthy soils for climate mitigation, climate adaptation, (ground)water quality and improving underground and above-ground biodiversity. There are however several aspects of the Directive that the Netherlands is critical of. The Dutch Ministry of Agriculture, Nature and Food Quality has asked Wageningen Environmental Research to reflect on the points of interest regarding the proposed Directive, and to provide an inventory of the available scientific information relating to these points. The following aspects are covered in this note:

1. Classification of soil as healthy or unhealthy (often referred to as the "one out - all out" principle)
2. Phosphorus
3. Ratio soil organic carbon / clay of 1/13
4. Combating soil degradation
5. Land take and soil sealing

1. <u>Classification of soil as healthy or unhealthy (often referred to as the "one out - all out"</u> principle)

Healthy/unhealthy based on soil threats

The European Commission states that a soil is assessed as healthy if it fulfils the criteria (i.e. thresholds) set out in Annex I, sections A (EU-level criteria) and B (MS-level criteria) of the EU Directive on Soil Monitoring and Resilience. These are meant to be a 'minimum common set of measurable criteria' that facilitate a common definition of healthy soil across all member states. The minimum descriptor (indicator) set is defined in terms of soil threats, in line with the original assessment carried out by Veerman et al. (2020), where the commonly cited estimate: "60-70% of soils in the EU are unhealthy" originated. That estimate has been widely cited in news releases, reports, projects and scientific literature. Using the soil threat categorization in future EU-level soil health assessments will allow for a consistent comparison against that initial estimate. However, apart from healthy/unhealthy, the soil health assessment misses the inclusion of a third soil health category and a recognition of soil complexity leading to context-specific variations.

In addition to 'healthy' and 'unhealthy', a third soil health category was named in the goal set by Veerman et al. (2020): by 2030, 75% of EU soils should be healthy or significantly improved. The use of that third category of soils, 'improved' (but presumably not yet healthy), is not included in the text of the Directive. This is a serious deficiency in the current description of soil health assessments and has led to widespread concerns about the so-called 'one-out all-out' principle. An intermediate categorization provides a tool to recognize shifts to sustainable management practices that may not be immediately reflected in a shift to 'healthy' soil descriptor values. Historical legacies may take a long time to work through soil systems and it is critical to acknowledge relative improvements or trends. The Netherlands would like the basic soil health assessment (healthy/unhealthy) to be adapted to include the well-defined use of an intermediate category that reflects positive changes in management practices and related positive trends in soil health.

The text of the Directive clearly makes an effort to account for soil complexity and how that may lead to context-specific variations in what can be expected of soils. Nevertheless, it does set EU-level criteria for four soil descriptors, and those criteria have already been strongly criticized. While a harmonized minimum soil descriptor set at the EU-level is possible, setting threshold values at the EU level is not realistic. There is significant natural variation across soils in the EU, and those past and current contexts matter when measuring reference data and assigning thresholds. Therefore, values for thresholds must be set at a level that can account for those differences. Suggested starting values, such as the threshold values currently in the Directive text, can be included, but only with the caveat that member states can adjust those based on their context. The Netherlands would like that caveat (that all suggested thresholds may be corrected to reflect natural circumstances) to be ascribed to all soil descriptors in the minimum EU-level set.

Acknowledgement/inclusion of soil ecosystem services

Defining soil health based on criteria that describe soil threats does not reflect the capacity of soil to provide multiple ecosystem services simultaneously, even if one of the threat-based indicators is suboptimal. Moreover, a minimum common set of soil descriptors is not robust enough to capture the potential for soil ecosystem service delivery, as having single descriptors may result in misleading results without further contextual information. Inclusion of ecosystem-service-based descriptors may not be possible in the harmonized EU-level minimum descriptor set, but there is potential to provide an expanded set of descriptors that member states choose from to monitor ecosystem services relevant to their soils. This second level of soil assessment could be linked to the proposed voluntary soil health certification, as it provides the opportunity to describe a soil in more nuanced detail. The Netherlands would therefore like to propose that the Directive elaborates on an approach that links ecosystem services to land use. A possible approach the Netherlands could consider for agricultural soils would be to use the science-based 'soil navigator' tool (Debeljak et al. 2019).

2. Phosphorus

Phosphorus has no negative effect on soil ecology or human health. However, a high phosphate status in soils can have a negative effect on water quality (e.g., Schoumans, 2015).

The Water Framework Directive and the Nitrate Directive are already aimed at achieving the desired water quality and are normative for the national phosphorus policy in agriculture (e.g. Groenendijk et al., 2016).

Double regulation at EU level must be avoided and the Netherlands wants confirmation that its phosphate policy can be continued. In addition to that, the proposed measurement method for phosphorus (P-Olsen), the range for phosphorus concentrations and the proposed reference method are not suitable for Dutch soils with a lower acidity (pH) (CDM, 2023).

Therefore the Dutch government is of the opinion this method cannot be implemented in the Netherlands. We would prefer not to include set phosphorus values in the Directive for Soil Monitoring and Resilience as an individual endpoint for environmental assessment, but to restrict use of data on soil nutrients in a multi-indicator approach for ecosystem service appraisal.

The national phosphorus policy consists of a system of phosphate use standards, based on the phosphate status of the soil. Plots are classified based on P-Al (as capacity indicator) and P-CaCl2 (as intensity indicator). This system has been recommended by the Fertilizer Act Experts Committee (CDM) and works towards balanced fertilization, whereby the extraction for the crop is in balance with the supply through fertilization (CDM, 2023). There are presently no conversion formulas available to translate the P-CaCl2 number and the P-AL number into P-Olsen for the Dutch soils with lower acidity. It is also undesirable to use different analytical methods at the same time on a national scale and the reference method deviates from what the CDM has recommended and is legally established.

Historically, due to intensive agriculture the Phosphorus values in the Netherlands are very high (often higher than 50 mg P-Olsen/kg; CDM, 2023). It is unlikely that the proposed P-Olson ranges can be reached for all agricultural land by 2050, even if balance P fertilization is applied in which the P input via fertilizer is equal to the crop P uptake.

At the very least, the value for phosphorus should be coordinated with the goals of guidelines for surface water. There shouldn’t be an individual ’stand-alone’ value for phosphorus. A target value is strongly depending on factors as climate and soil type, and should correspond to the desired values for surface water.

If the European Commission implements P-Olsen as an indicator within the EU Directive on Soil Monitoring and Resilience, it is recommended to build up a dataset with measured phosphate indicators P-CaCl2, P-AL and P-Olsen for grassland and arable land on different soil types. This database can be used to derive conversion formulas with which P-Olsen can be calculated from the P-CaCl2 and P-AL values.

3. Ratio soil organic carbon / clay of 1/13

As outlined in Section 1 of this text, assigning soil descriptor criteria at the EU-level does not account for soil complexity and context. While suggested starting values can be given, member states need to have the freedom to define these based on natural variation that occurs in their soils.

The proposed organic matter/clay ratio of 1/13 in marine clay areas poses a problem for the Netherlands. Due to the natural background values of, for instance, the Zeeland clay, the IJsselmeer polders and the Northern clay shell, the proposed criteria for a healthy level of carbon cannot be met. This is due to natural background values as a result of natural sedimentation processes. The optimal value is strongly depending on the context, the ecosystem and the ecosystem-services desired. It will be virtually impossible to meet the ratio with measures for sustainable soil management. The Dutch government is of the opinion that natural background values should be leading. We therefore suggest, as described above, that the SOC/clay ratio of 1/13 be defined as a suggested starting value, and that all member states be given the freedom to deviate from that value, with relevant science-based support, based on their context.

Scientific underpinning:

Changes in this SOC stocks are difficult to measure on a short-term, because of the relatively high soil organic carbon stock. Long-term monitoring or the use of organic carbon turnover models can provide information on changes in SOC stock over time and the effect of land management. An alternative method to indicate the effect of SOC management on SOC stock (and on soil structural quality) is to use a SOC:clay ratio (Johannes et al., 2017). Johannes et al. (2017) concluded that a SOC:clay ratio of 1:10 can be a reasonable goal in organic carbon for soil management, a ratio of 1:8 can be an optimal value of organic carbon for soil structure quality, and a ratio of 1:13 is a lower threshold of organic carbon for soil structure quality. This study is based on a limited number of samples taken under Swiss agriculture. Within the Netherlands, and other parts of Europe, there are soils that do not meet these criteria. Especially in the marine clay southwest of the Netherlands, the threshold cannot be met (Table 1, Reijneveld et al., 2009). Similar results were shown by Pulleman et al. (2003), although this study showed clearly the effect of farming system on SOC:clay ratio. Depending on land management, the SOC:clay ratio was 1:14 for conventional farming systems, 1:11 for organic farming systems, and 1:3 for farming systems that have permanent pastures (Pulleman et al., 2003).

To meet the threshold of 1:13, the SOC organic carbon content needs to increase from 1.2% to 1.5% in the case of marine clay in southwest Netherlands (Reijneveld et al., 2009). To reach the goal of a 'healthy soil' by 2050, this area needs to receive 0.4 t C/ha/yr extra (based on a bulk density of 1.2 g/cm^3 and a soil depth of 30 cm). However, a study of Slier et al. (2023) showed that after optimal implementation of carbon sequestration measures, a potential extra CO_2 sequestration of 79,5 kton CO_2 is realistic for this region. This is equal to 0.18 t C/ha/yr (based on an agricultural area of 119922 ha for the province Zeeland).

Table 1. Clay contents and related SOC contents of three marine clay regions in the Netherlands (Reijneveld et al., 2009). Note: differences under grassland and arable land can be caused by differences in sampling depth.

	Land use	Clay (%)	SOC contents (%)	SOC:clay
Marine clay north	Grassland	29±9	5.7	1:5
	Arable		1.3	
Marine clay southwest	Arable	20±7	1.2	1:17
Marine clay west-central	Arable	22±10	2.1	1:11

Realistic targets are needed, accounting for soil variation and land use (Prout et al., 2022).

The study by Mäkipää et al. (2024) that assessed the feasibility of the proposed soil carbon loss indicator by analysing EU-wide 2009 LUCAS soil survey data and comparing it with the soil carbon stock changes reported by countries to the climate convention (UNFCCC). Results revealed that differences in the soil organic carbon (SOC) and clay content at European scale is in fact greater than that of the data used to develop the proposed indicator. Furthermore, the variation in SOC content was influenced not only by clay content but also by climate and land-use. Other observations included discrepancies between the soil carbon stock changes reported by the national GHG inventories and the proportions of degraded soils identified by using the soil health indicator. Mäkipää et al. (2024) concluded that the indicator proposed by the European Commission for the Directive cannot adequately monitor the loss of soil carbon. A single indicator such as SOC:Clay ratio, with one threshold value for all soils across various land covers, management practices, and climatic conditions, is unable to respond to the variety of soils, climates and uses across Europe, and is thus inappropriate for monitoring soil carbon loss.

Poeplau and Don (2023) also showed the difficulty of reaching the ratio in certain regions in Germany. The proportion of soils with SOC levels above the threshold increased exponentially with clay content. They argued that the SOC:clay ratio is not a suitable SOC level metric because it is strongly biased, misleading and partly insensitive to SOC changes. Poeplau and Don provided an alternative method: the ratio between actual and expected SOC (SOC:SOCexp), where expected SOC is derived from a regression between SOC and clay content. The quartiles of this ratio were used to derive threshold values. This method accounts for bulk volume (inverse of bulk density) (i.e., an important parameter for soil structure), whereas the SOC:clay ratio does not.

4. <u>Combating soil degradation</u>

The proposed EU Directive on Soil Monitoring and Resilience is unclear about whether the assessment of soil health should be considered per plot, per soil district or per Member State. For the Netherlands, it is preferable that the assessment of land degradation applies to the average of all soils (within one soil district) and not to each soil separately. Given the intensive Dutch land use, some variation in soil quality within an area is inevitable. If land degradation is assessed at plot level, it becomes virtually impossible to allow (temporary) changes in land use that are necessary for, for example, agricultural management (e.g. conversion of grassland to arable land), nature development (e.g. excavating highly fertilized top layer) and the maintenance of the water system (for example depositing sediment).

If the assessment is carried out per Member State then maximum compensation is created and crop rotation (from grassland to arable farming) remains possible. It is proposed that soil degradation be assessed per Member State or, if necessary, at NUTS-1 (the four parts of the country).

Scientific underpinning:

One of the specific objectives of the EU Directive on Soil Monitoring and Resilience is "to stop soil degradation and achieve healthy soils across the EU by 2050, so ensuring that EU soils can supply multiple ecosystem services at a scale sufficient to meet environmental, societal and economic needs, and reducing soil pollution to levels no longer considered harmful to human health and the environment". We are questioning what 'at a scale sufficient to meet environmental, societal and economic needs' means.

Over the period 1990 to 2004, the total area of land use change was about 16% in the Netherlands (Kramer et al., 2009). Largest changes in land use were seen in the conversion of cropland to grassland and grassland to cropland. Because of crop rotation, a common practice in the Netherlands, agricultural land use is dynamic. Crop rotation can take place at fields of one farmer or a group of farmers. In general, intensive land use (e.g., potato, sugar beet) alternates with less intensive land use (e.g., grain crops, grass), i.e., land degradation alternates with land regeneration. Improving crop rotation schemes to combat soil degradation is an ongoing process in the Netherlands (Silva et al., 2017; Timmermans et al., 2022). Therefore, the EU Directive on Soil Monitoring and Resilience should allow dynamics in land use change by monitoring at national or generic level.

Monitoring of soil health indicators at generic level should preferably be defined in context, and not (as suggested) by political boundaries. Faber et al. (2022) suggests to define soil health criteria or, even better, reference, target and threshold values, in the context of soil type, land use, climate zone, and management practice. Besides, flexibility in the one-out-all-out principle should be considered. We recommend to use a traffic light system or a multi-indicator value scoring system.

5. Land take and soil sealing

Land take and soil sealing must be limited, the effects should be minimized and, if possible, compensated and monitored. No net land take – which was a hot topic in the EC proposal for an EU Soil Strategy for 2030 – has been replaced by the 'ladder' (limiting land take, minimizing the effects and compensating if possible) above. The Netherlands could focus on a triad such as compensating – mitigating – justifying/substantiating.

Land take is the process of land conversion to artificial surfaces. Often it is the conversion from agricultural land into artificial land, which takes place primarily in cities and commuting zones. Artificial land is land used for constructions and infrastructure or as direct source of raw material. Soil sealing is often used to describe the covering or sealing of the soil surface by impervious materials by, for example, concrete, metal, glass, tarmac and plastic and making the soil impermeable. Land take impairs the ecological functions of land and makes ecosystems less resilient due to the fact that soil is becoming sealed.

At European level land take is defined as the conversion from non-urban land (i.e. agricultural areas, forest and semi natural areas, wetlands and water bodies) into artificial surfaces. Those conversions are grouped into land cover flows urban residential sprawl (land uptake by residential buildings altogether with associated services and urban infrastructure from non-urban land) and sprawl of economic sites and infrastructures (land uptake by new economic sites and infrastructure (including green urban areas and/or sport and leisure facilities) from non-urban land).

As greenhouses in Europe are seen as arable land the conversion of land into greenhouses are not seen as land take. However, in the High Resolution dataset Imperviousness greenhouses are mapped as highly impervious areas, i.e. a high degree of soil sealing. Another example showing the contradiction between soil sealing and land take is the conversion of land into green urban areas and/or sport and leisure facilities. This conversion is seen as land take but the change in soil sealing degree can be minimal. However, the conversion from green urban areas and/or sport and leisure facilities into e.g. residential buildings (urban fabric), roads or airports) is not seen as land take while the soil degree will change.

The degree of soil sealing can be completely different between the centre of cities, suburbs and residential areas /"villawijken" (discontinuous urban areas). However, the conversion of non-urban land into city centres, suburbs or "villawijken" is in all cases seen as land take. So, land take can have a different impact on the soil (ecological) functions (e.g. vulnerability for floods and/or intensity of heat island effects) depending on the level of soil sealing.

To comply with the EU Directive on Soil Monitoring & Resilience regarding land take and soil sealing, for the Netherlands, the interaction between land take and soil sealing degree is important. Options to justify land take in the Netherlands could possibly be found in managing the degree of soil sealing:

- Greening of the cities by converting sealed areas into less sealed areas (e.g. converting sealed tarmac city squares into greener squares, more tree cover, mitigate house yards (sealed areas) to green gardens (e.g. foundation Steenbreek), etc.)
- Focus more on high-rise buildings instead of single-family homes (less artificial land area/number of households)

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