Llywodraeth Cymru
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An analysis of the extent and severity of soil degradation in Wales: executive summary

Takes account of Wales' specific landscapes, soils, climate, land use/cover and habitats.

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The processes of soil degradation can impact adversely on soil functions and the ability of soils to deliver vital ecosystem goods and services. These processes include: climate change effects on soils; loss of soil organic carbon/ matter; loss of soil biodiversity; soil erosion; soil compaction; and loss of soil to development (soil sealing). The objective of this review was to source and analyse the evidence on the severity (magnitude) of each of these degradation processes and their spatial extent in Wales. The vulnerability and resilience of Welsh soils to each degradation process is also discussed. The review is set against Wales' specific landscapes, soils, climate, land use/cover and habitats. The review builds on a previous report (CEH, 2002) on the state of and pressures on Welsh soils, by updating the evidence base where possible.
To meet the objective, a rapid evidence assessment (using the principles of a systematic review) was carried out primarily using three sources: Defra/Welsh Government funded research reports; peer reviewed papers; and grey literature

articles. Whilst focus was put on Welsh data, it is recognised that much of the current evidence originates from UK-wide studies, which may not represent the soils, land uses and landscapes specific to Wales.

1. Climate change

Predictions of future climate change scenarios inevitably involve some uncertainty. However, the evidence reviewed suggests predicted climate change in Wales will not significantly change the duration of soil wetness (field capacity days) or potential soil moisture deficits until 2080. However, there will be a shift in the seasonal distribution of the field capacity period, which will mean drier autumn and wetter spring periods. Consideration of drought criteria in the Agricultural Land Classification (ALC) under future climate change scenarios indicates Welsh soils may become more droughty. As a result, many sites will be downgraded, although the extent in Wales is not reported specifically. Additionally, some sites may have improved ALC grades. Increased grassland productivity would lead to higher stocking densities that could be associated with more extensive soil compaction. Modelling (unvalidated) indicates the severity and extent of soil erosion by water will increase in upland areas, particularly in autumn. Changes in soil microbial community structure are expected as a response to drying of water-saturated soils (e.g. wet upland organic and organo-mineral soils). Only soil carbon in organo-mineral and peat soils shows a response to climate change. There is little evidence on the vulnerability and resilience of different soil types to climate change in Wales.

2. Loss of soil organic matter

There is conflicting evidence from two national monitoring programmes (Countryside Survey CS + Glastir Monitoring and Evaluation Programme GMEP and the National Soil Inventory -NSI) for the extent of soil carbon change in topsoils in Wales. CS and GMEP report no significant change overall in soil carbon from 1978-2007 for topsoils in Wales. The NSI reports losses in topsoil carbon for England and Wales over the same period, but does not discriminate

for Wales specifically. The CS and GMEP data also indicates no change in soil carbon in improved grassland systems in Wales between 1978-2013. Differences in intensive and extensive systems are anticipated and reporting on this is pending. Both monitoring programmes report a loss of organic carbon in arable topsoils in England and Wales but evidence is not reported for Welsh soils specifically. An increase in topsoil carbon in woodland sites was observed between 2007 and 2013 (GMEP). NSI data reported the largest rate of decline in organic matter in topsoils in England and Wales was on peat soils, bog and upland heath, although this conclusion was not supported by the CS data. The lack of change in soil carbon for Welsh topsoils may be related to the limited land use change in Wales over the monitoring period. The resilience of Welsh soils to loss of organic carbon/ matter is not reported in the evidence explicitly.

3. Loss of soil biodiversity

There is no evidence on the loss of soil biodiversity in Wales. A recent study aimed to ascertain baseline conditions of soil microbial community structure in broad habitat types in Wales. European-wide evidence suggests that intensely managed systems are at greater risk of loss in soil biodiversity than semi-natural habitats. Changes in soil biodiversity are likely to be related to i) land use change (both intensification / extensification), ii) loss of soil organic matter and/ or iii) climate change. Reported low rates of change in land use and/or organic matter levels in Wales could infer little change in soil biodiversity.

4. Soil erosion

There are no studies that directly quantify the severity or spatial extent of soil erosion (by water, wind, co-extraction and/or tillage) in Wales. Existing modelled estimates of soil erosion by water in Wales have not been validated with observed erosion rates. Peat / organic soils are particularly vulnerable to erosion by wind and water, especially the latter process in upland areas due to high rainfall. As soil erosion represents an absolute reduction in soil volume / depth, shallow soils will be less resilient to the impacts of soil loss compared to deeper

soils.

5. Soil compaction

Although the relative risk of soil compaction can be estimated from soil wetness classes and land use / management, little is known of the actual severity or extent of soil compaction in Wales. Studies on compaction in grassland soils reported for England and Wales combined show 10-15 % of sites were in poor condition and 50-60% in moderate condition. The study did not report conditions for Welsh sites specifically. Severe structural degradation in arable sites (with late harvested crops) and moderate degradation in permanent grasslands was reported in SW England, which could be used as a reasonable soil and climate analogue for parts of Wales. No data exists on compaction in arable land in Wales specifically. No Welsh specific data exists for the vulnerability and resilience of different soil types (or land uses) to compaction.

6. Loss to development

There are no statistics on the increase in artificial surfaces post 2007 from land cover data. This data is required to produce a national estimate of the current severity or spatial extent of soil loss to development. There is no evidence that has collated land use change statistics at sufficient resolution to identify the extent of soil sealing in Wales on different soil types or land uses.

7. Interactions between threats

Many of the threats are interconnected by two primary drivers: climate change and land use change. Shifts in the seasonality and duration of the field capacity period under climate change will impact on the timing of field operations and livestock grazing periods, and associated increased risk of soil compaction, particularly for slowly permeable soils. Soil biology is responsive to changes in

soil water regimes, with specific shifts in microbial community structure in water saturated soils that will experience more frequent drying episodes. In catchments dominated by slowly permeable soils, the increased frequency of extreme rainfall events will lead to greater incidences of lateral and overland flow especially when soils are at or beyond field capacity, so increasing surface water flood risk. Likewise, these extreme rainfall events will also increase the risk of soil erosion by water in susceptible areas. The small areas of high grade agricultural land (Grade 1 and 2) are likely to be downgraded in response to increased summer drought. However, drier conditions may be beneficial for other marginal areas that could see an improvement in ALC grade (i.e. shift from Grade 4 to 3b). This could initiate a land use change in response to drier summer conditions but it is uncertain how this will manifest in the future. Conversion of non-arable to arable land has the most significant impact on soil threats. It is plausible that areas of improved grassland, that are currently marginal for arable agriculture, may be converted to arable and horticultural uses in the future. This change will mean a loss of soil organic matter, change in the microbial community structure and function, and increased risk of compaction and erosion, particularly if late-harvested crops are adopted. Expansion of improved grassland and increased grass productivity (potential responses to a changing climate) could have implications for soil carbon loss, change the soil microbiology and also subject land to increased compaction risk. Expansion of woodland would potentially increase topsoil carbon but it is uncertain whether this would mean overall carbon sequestration as this trend might not be reflected in soil below the topsoil.

8. Key knowledge gaps and recommendations

Climate change

The seasonal shift in the water balance and specific saturation period warrants further investigation, particularly where this will impact on areas with slowly permeable soils.
The hydrological response of slowly permeable soils requires specific assessment in response to extreme events. This could provide indications of the

likely surface water flood risk in catchments where these soils are common.
A shift in ALC grade due to increased limitations of summer drought criteria under climate change needs to be extracted specifically for Welsh NSI sites. A clearer picture of areas affected by downgrading or upgrading of ALC will emerge.

Loss of soil organic matter

An analysis of topsoil monitoring data from CS +GMEP and NSI programmes should be extracted for sites in Wales specifically. Further analysis of topsoil carbon changes stratified by soil type and land use should be determined for this sub-set.
A significant carbon store exists in soil below the topsoil and the change in carbon stock of the whole soil profile should be taken into account in monitoring programmes.
Changes in soil carbon between improved and unimproved grassland in Welsh soils requires further investigation This information could offer insight into changes in land management that could occur in response to a changing climate.
Critical thresholds of soil organic matter loss should be defined regionally and for specific soil types given the environmental constraints on soil systems in Wales.

Loss of soil biodiversity

Building on the baseline survey, characterisation of microbial community structure should also be extended to key soil types within the broad habitats in Wales.
Continued monitoring is required to ascertain any changes in soil biodiversity over time (GMEP programme). This should also be extended to areas where land use change has occurred.
There is incomplete understanding of the change in the functional response of soil biological communities and impacts on soil functions, although there is emerging evidence for a shift in microbial community structure under different land use types at a European level.

Soil erosion

An understanding is needed of the severity and spatial extent of soil erosion by water, wind, co-extraction and/or tillage across Wales, as currently no UK data exists.
Modelled estimates of the severity and extent of different processes of soil erosion in Wales need field validation through surveys and monitoring. This also requires better resolution of erosion prediction models to enable local scale predictions.

Soil compaction

Current knowledge has been generalised from England and Wales data. A focus on systematic assessment of structural degradation in arable and grassland soils in Wales is required.
Review of forestry compaction mitigation measures is required to ascertain the true extent and vulnerability of compaction from forestry operations.
A greater understanding of soil resilience to compaction is required in key soil and land use combinations in Wales.

Loss to development

The extent of soil loss to development needs to be collected systematically at the national level and an understanding of potential resilience of soils subject to development is required.
The loss of good grade agricultural land (Best and Most Versatile) and other soil types that support nationally significant habitats should be assessed.

About this document

This document is a copy of the web page **An analysis of the extent and severity of soil degradation in Wales: executive summary** downloaded.

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