



Llywodraeth Cymru
Welsh Government

PUBLICATION

Appraisal of state, pressures and controls on the sustainable use of soils: executive summary

Identify the required components and targets for a national soil protection strategy.

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Background to project

Soil is the weathered surface layer of the earth within which soil organisms live and plants root. Extending to one or two metres, it is the interface and mixing zone between living ecosystems and mineral rock.

Soil is one of Wales's most valuable natural assets and, through its natural functions it underwrites and supports significant components of the Welsh economy. It is also the foundation for its environment, landscape and wildlife. Without soil, land is infertile and barren. The condition and therefore performance of Welsh soils is key to achievement of the Welsh Assembly Government policies for farming, the wider economy, rural development and sustainable development.

Soil protection is now regarded as a key but previously under-resourced area of policy. Following a Royal Commission on Environmental Pollution report, England is developing a soil protection strategy and, after previous leadership

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from the Council of Europe, the European Commission is now taking the lead in developing policy and draft legislation for the whole of Europe. Key targets will be the control of waste to land, loss of soil organic matter, erosion and desertification processes, and the introduction by member states of adequate national soil monitoring networks. More sustainable soil management, driven by a Welsh soil protection strategy, will be essential to the achievement of compliance with a number of key European environmental directives such as the Water Framework, Groundwater and Environmental Liability Directives. This aim of this project is to inform Welsh Assembly Government (WAG) staff of the required components and targets for a national soil protection strategy for Wales.

Project objectives

This project was commissioned by the Welsh Assembly Government, Environment Department and managed by the Environment Agency Land Quality Department. The objectives were to:

- Provide a document for use by the WAG in producing their strategy for the sustainable use of soil that summarises the state of Welsh soils, both current and likely future pressures on soil, reviews current response and recommends new ones.
- Conduct a critical appraisal of the current quality, use and diversity of Welsh soil and identify the pressures, conflicts and relevant policies and guidelines. The work will identify gaps in existing controls, and consider options for a more sustainable use of soils and advise on how this might be achieved.

Project team

The project was managed by the Centre for Ecology and Hydrology (CEH), Bangor and conducted by CEH, the National Soil Resources Institute, Institute for Grassland and Environmental Research, North Wyke with specialist assistance from the Geoenvironmental Research Centre in Cardiff University

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and Cynefin Consultants.

Approach

The contractors were asked to:

- Report on the nature and functioning of Welsh soils;
- Identify the key issues that threaten the soil resources of Wales;
- Consider options for better soil conservation.

For each issue, the scientific background is described, sources of information identified, and current state and likely future scenarios described. Impacts are described on the basis of their effects on the key soil functions. Present and potential future policy responses are described.

Findings

The soils resource in Wales

With the exceptions of the Snowdonian volcanics and younger rocks of the north and south coastal fringes, Wales is underlain by hard sedimentary rocks that are overlain by a characteristic suite of acid soils. About a quarter of Wales is underlain by impermeable and therefore poorly drained soils. While thin peaty surface layers are characteristic of soils on the main hill tops, thicker peat covers less than 5 per cent of the land area of Wales.

The nature of soil development and many of the properties of Welsh soils are the product of several millennia of human occupation. Clearance of the original forest cover had a major impact and resulted in extensive acidification, exacerbated by acid deposition. Wales's industrial past has left a legacy of gross and more widespread chronic contamination of the soil. There is very little information about the biological properties of Welsh soils.

There is a national soil map for Wales at reconnaissance scale but the more detailed information required to inform land management planning and actual

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decisions is patchy. Various soil monitoring schemes hold information on the state of soils in Wales and the largest is the National Soil Inventory conducted by the Soil Survey of England and Wales in the early 1980s. The number of soil scientists with practical experience of Welsh soils is very small (single figures) and even fewer are active in Wales. Education and training is therefore an issue to be addressed at an early stage.

The following threats to soil were identified:

Soil loss to development

Less than 5 per cent of the land area of Wales is developed and most of this is located in the southern coastal zone and the northeast. Information on rates of new development are not collected at national level and methods used locally are inconsistent. The productive capacity of soil is the only function that receives formal protection under planning law and guidance. Legislation is still in place to protect the Best and Most Versatile agricultural land in Wales but, because of the small extent of grades 1, 2 and 3a in the Principality, these measures are less effective at protecting the soil resource as a whole compared to other parts of the UK. Ecologically valuable soils of lower agricultural productivity, which are widespread in Wales, and are not specifically protected by the legislation.

Modification to these measures to include a wider variety of soils would better protect the productive land resource of Wales if new Greenfield development is considered a risk. One local planning authority, Conwy UDP, has a stated policy of protecting the quality of soils through development control.

The treatment of stripped soil materials is covered in guidance to the mineral extraction industry but no such guidance is given to the building and construction industry. Such an extension to guidance would seem sensible.

Soil loss to mineral and peat extraction

While there is an active minerals industry in Wales, no peat has been taken in recent years. Planning guidance specifies that progressive restoration of mineral sites should take place if possible thus reducing soil storage time. The experience of whole turf stripping of herb-rich swards has been mixed possibly because of failure to recreate appropriate soil water and mineral regimes at the

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Soil loss by erosion

There can be confusion in the definition of soil erosion. Here it is taken to include all forms of particulate loss and all issues associated with the resulting sediment gain by other parts of the environment. Soil erosion is occurring throughout Wales as a result of land use and management practices. The majority of upland soil erosion is the result of over-stocking with sheep and of the over-use of footpaths on vulnerable soils. In terms of impact, the 'off-site' effects of sediment on water quality and the resulting eutrophication of freshwater ecosystems, far exceed any loss of productive capacity in the source soil. Insufficient information exists to accurately assess whether erosion is a growing problem and whether particular practices are driving it.

Codes of Practice exist but only the forestry and construction industries pay heed to these. Current responses to soil erosion from farmland and grazed moorland are inadequate. Better education and extension services are required. Soil conservation should become a basic requirement of agri-environment schemes such as Tir Gofal. Minimum standards of soil husbandry and conservation should be required of all beneficiaries of subsidies. Soil erosion almost certainly should be a key target for Wales's Soil Protection Strategy but more research and monitoring is required to better understand the precise nature, scale and drivers of this process.

Soil structure

The soil's physical structure is important to its functional performance. It affects productivity in the agricultural context, is a factor in soil biodiversity and influences soil hydrology. The degradation of soil structure is most likely to be an issue in agricultural soils. However virtually no data exist on the structural condition of Welsh soils and no reliable conclusions can be drawn as to whether action is required. Anecdotal information, largely from England, suggests that soils may be becoming less permeable through a combination of surface capping of arable soils, poaching of grassland soils and topsoil compaction in both.

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The acquisition of more information on Welsh soil structural condition is the primary recommendation. Advisory leaflets on soil management exist but mechanisms are required that will encourage farmers to adopt better practice, if monitoring proves that this is needed. The inclusion of soil management obligations in Tir Gofal is identified as one option along with a network of demonstration farms on different soils and land types to act as beacons of good practice.

Soil organic matter

The gradual accumulation of organic matter in the surface layers of soil is one of the processes that forms soil. In climate change, the soil can be both a source and a sink for carbon. The total organic matter content of Wales's soils is unknown but their topsoil contains 37Mt of organic carbon. The best source of information on organic matter is the National Soil Inventory. The mean concentration of 10.8 per cent organic carbon reflects the widespread occurrence of peaty surface layers in moorland soils. There are significant differences in similar soils under different forms of land use. Non-peaty farmland soils lost 0.5 per cent organic carbon content during the period 1980 to 1996, including those under permanent grass. This has implications for Wales's contribution to the Kyoto Protocol on greenhouse gas controls. Declining organic carbon also has implications for structural stability, erodability and the soil's ability to adsorb organic and inorganic contaminants. Some organic matter can be lost from the soil in solution. The growing incidence of discoloured 'dark water' presents a problem to water supply companies. There is an urgent need for more information to be collected on soil organic matter in Wales. Current data are inadequate and old.

Soil nutrient issues

Soil nutrient status is a two-edged sword. Nutrient depletion of farmland soils results in the lowering of yields while uncontrolled losses of nitrate through leaching and of phosphorus, principally on eroding particles, present a threat to the water environment where they cause eutrophication (nutrient enrichment). Nitrogen (N) and phosphorus (P) controls will be strengthened under the

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emerging Water Framework Directive. In general however Wales's wet climate purges the river systems of nutrients and result in water of high quality. There is evidence of a gradual but accelerating enrichment of lakes. Many of Wales's freshwaters are naturally poor in nutrients and therefore particularly vulnerable to damage from nutrient losses from soil.

Various codes of practice have been produced that address nutrient management but better advisory and technology transfer mechanisms are needed.

Diffuse soil contamination

Diffuse contamination is distinct from contaminated land sites. The concentrations of particular contaminants in diffuse contamination is not necessarily any lower but the sources of contamination are different and principally aerial deposition, land spreading of wastes, mining and smelting activity and the use of low-grade fertilisers. There is widespread diffuse contamination in Wales. The chief contaminants are heavy metals (lead, zinc, cadmium, copper, chromium), man-made organic compounds (PCBs, PAHs and dioxins), antibiotics, radiocaesium and a range of pathogens and sub-viral particles from faecal and food wastes applied to land. The extent of heavy metal contamination is clouded by the natural variability of background levels.

There is reasonable information on heavy metals at a national level from the National Soil Inventory but little or no information on organic contaminants.

Radiocaesium fall out from Chernobyl is still at a level to maintain restrictions on livestock from 360 holdings in North Wales.

While inorganic contaminants are of very low solubility, indestructible and therefore extremely long-lasting, organic contaminants are of varying degradability and longevity. Inputs of zinc have been exceeded by off-take and concentrations have fallen since 1980. The toxicity of contaminants is complex but one estimate is that Lead concentrations in upland soils exceed critical limits for soil biota. Soil conditions are influential in determining the bio-availability of metals, rates of degradation of organic compounds and the viability of pathogenic particles. Metal solubility is strongly influenced by soil acidity. Radiocaesium has cycled between soil and vegetation in peaty upland soils, and thereby remained available for uptake by stock. Persistently moist

conditions favour bacterial survival in soil. Insufficient information is available on the durability of particles such as prions (BSE and scrapie).

Controls over the spreading of wastes containing contaminants and pathogens are increasing. There are legal limits. However there is insufficient understanding of the fate and behaviour of these materials and organisms in soil, and inadequate information on current concentrations of most of them.

Gross contamination of soils

Past industrial activity in north and south Wales has left a legacy of grossly contaminated land. The extraction and smelting of metal ores has contributed to this throughout Wales. There is a new regulatory framework for dealing with contaminated land that involved the local authorities and the Environment Agency.

A 1988 Welsh Office report suggested that there were 749 potential contaminated land sites, more than 40,000 ha, in Wales. Some of this land has since been reclaimed. This survey excluded sites in current use and small sites of less than 0.5 ha extent. The full extent of contaminated land is unknown. A three-pronged approach to land contamination through development planning, the regulation of potentially polluting industry through integrated pollution prevention and control (IPPC), and the risk-based clean up of contaminated land will provide effective future control. The extent of gross land contamination should decrease into the future. Existing contamination will be cleaned up on a 'fitness for purpose' basis.

Acidification

Soil acidity reflects the balance within the soil's cation exchange complex between hydrogen ions and acidic forms of aluminium on the one hand and basic metal ions on the other. In the absence of counter-measures such as liming, the natural process is for soil to become gradually more acid if for no other reason than the fact that rainfall is weakly acidic. Welsh topsoils are acid with mean values from various sampling programmes ranging around pH 5.0 to 5.5. Land use has a major influence and under coniferous woodland, for instance, soils are more acid at pH 4.2.

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Soil acidification and the associated release of aluminium into Welsh rivers became an issue because of acid deposition of sulphur and nitrogen oxides from industrial production sites and the burning of fossil fuels. Ammonia released from livestock wastes adds to the problem locally. Increased soil acidification has major impacts on moorland vegetation and on freshwater ecosystems and fish stocks. International emission control strategies have sought to deliver reductions in emissions. Much research was carried out in Wales and models predicted gross exceedance of the acid neutralising ability of soils throughout the 1990s. The recent and continuing decline in acid deposition suggests some recovery from that position although high moorland soils will still receive excessive acid inputs well into the current millennium. The impact of certain forms of nitrogen (NH_x) on the acid load is critical to the outcome. If they are included then the future appears much more bleak.

Implementation of the Gothenburg protocol will deliver further reductions in acid deposition loading in the future which will result in a reduction in critical load exceedance for soils. There are very few predictions as to the timescale and degree of recovery from acidification expected as a result of reducing emissions.

Climate change

There is increasing evidence that the UK climate is changing driven by increased emissions of greenhouse gases. Within Wales, the mean temperature of Wales has increased a rate of about 0.3 oC over the last century whilst annual precipitation has increased by 3%. These trends are expected to continue with predictions of increased temperature of 2 - 4 oC by 2080 together with increased seasonality in rainfall and a net change in sea-level change of 11 – 71cm.

Assessing the impact of these changes on soil is highly problematic, as climate is just one anthropogenic factor which affect the state and function of soils.

Other factors which will have had a major influence on soil in the last century include agricultural and forestry practices and atmospheric deposition. Many potential impacts of climate change on soils have been proposed and these may have profound implications for agricultural and forests systems, infrastructure and the natural environment. However, the direction and magnitude of change is frequently uncertain and the complexity of feedbacks between plants, soil and the atmosphere are poorly quantified. Examples of proposed changes include

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altered rates of greenhouse gases emissions from soils and soil carbon storage, an increased risk of erosion and poaching, reduced stability of infrastructure slopes and increased risk of contaminant transfer to streams and rivers. The current policy driver is the Kyoto protocol adopted by the United Nations Framework Convention on Climate Change which set new greenhouse gas emission reduction targets. The UK has a commitment to reduce emissions by 12.5% by 2010 and a domestic goal of cutting carbon dioxide emissions by 20% by 2010. As carbon sinks may be used as a component of the Kyoto targets, soil carbon stocks and sinks have been estimated for the UK. The greenhouse gas inventory for the UK provides estimates for carbon dioxide sinks specifically for Wales. However, these inventories have many uncertainties and there is a need to significantly enhance the monitoring and survey of soils in Wales, and to increase our understanding of underlying controls of key soil functions if the reliability of future assessments are to improve.

Protection of representative soil systems

Precedents have been set by legal duties to designate the best representatives of the full range of floristic, faunal, geological and physiographic features in Wales, not just those forms that are rare or least disturbed. There are strong reasons for extending the principle of designated sites to soil, even if such designations are voluntary and lack legal status. While the existing biological sites (SSSIs and nature reserves) have been shown to include a wide range of the soil types identified on the National Soil Map of Wales, this is not thought to be adequate. It is concluded that land in certain classes of ownership and in schemes such as Tir Gofal offer opportunities to protect representatives of the full range of soil landscape systems that incorporate soil types, soil biological communities, soil heritage sites and soil features. A recognised network under the management of CCW and with standard recording formats is recommended but will require a comprehensive study of the target sequences, types and features to be included.

Less disturbed soils are more likely to support species-rich ecosystems, and are therefore of value to nature conservation. However this is seen to be a separate issue from the scientific and educational interest and value of designating and protecting a representative range of all soil landscape systems and their

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component parts, not just those that are rare or least disturbed. All soils should be seen as possessing intrinsic value, not just those that are considered rare or that support semi-natural vegetation.

General conclusions regarding Welsh soil protection policy

A number of overall conclusions are identified.

Education of the wider community

The importance of soil and its significance to the economy and environment is not widely appreciated even in professional circles. The numbers of qualified soil scientists employed in relevant organisations is testament to this lack of understanding.

Soil management will play a vital role in the future achievement of sustainable development. It will impact on the rural economy, agriculture, forestry, land development, nature conservation, landscape management, environmental protection and water and waste management. Training materials and programmes will be needed that cover all these professions. Better provisions for school-age children, for tertiary education and for the general public will also yield a valuable return.

The proposed network of designated soil landscape sites will be a valuable education resource.

Better information and greater knowledge

Throughout the report, the need for more and better, up to date information on the nature and state of soils in Wales is brought up. There is insufficient information and inadequate numbers of trained professional soil scientists to interpret it.

A small Wales Soil Resources Unit staffed by field soil scientists and engaged in

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the collection of relevant information about the soils of Wales would provide both the information and expertise that is urgently required.

The need to integrate soil protection into other relevant policies

A Welsh Soil Protection Strategy alone will have little impact unless it is clearly integrated into other existing and future strategies and policies. It seems vital that the relevance of the strategy's objectives to policy for a sustainable economy, farming industry, forestry sector, tourist industry and system of development planning is underlined and clearly stated. Management of the Welsh environment, wildlife and landscape is an essential part of sustainable development and pivotal role of soil management in these activities will also need clearly stating.

Most of the threats to soil quality are driven directly or indirectly by other WAG policies (agricultural development, economic investment and growth). It is important that these linkages are understood and parameterised through appropriate strategic environmental impact assessment. Soil is a cross-cutting policy issue, and cross-compliance with other policies will be key to the success of the future soil protection policy.

Immediate opportunities to improve soil protection in Wales

The WAG is well-placed to exploit the following opportunities and to make some early gains in the sustainable management of Welsh soils:

- The incorporation of good soil husbandry measures as a condition of awards under Tir Gofal will fit in with ideas coming from Europe regarding mid-term revision of the CAP.
- The offer of soil management advice through Farming Connect and development of a set of good practice leaflets attuned to Welsh conditions and soils.

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- The development of a network of educational facilities in conjunction with establishment of a set of soil landscape sites in partnership with host landowners such as the National Trust and RSPB, the Forest Enterprise, MoD and the water companies.

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