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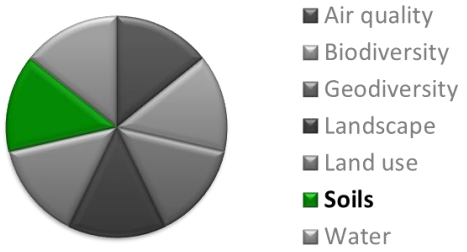
Environmental evidence base: Soils



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Overview

- Introduction:
  - A systematic review has been undertaken to characterise the impacts of the GB regulated energy system (primarily transmission and distribution) on the natural environment
  - There are seven issues that are seen to be important to address: Air quality, Biodiversity, Geodiversity, Landscape, Land use, Soils, and Water.
- Purpose of the evidence bases:
  - The intended use of the evidence bases is: to inform development of regulatory policy proposals, support internal/external advocacy, and support internal implementation of Ofgem's strategic and sustainability assessment framework
  - This evidence base describes: the current state of soils in GB, wider pressures on soils in GB, and potential impacts from any pressure on soils, factors leading to such impacts and relevant statutory legislation/regulation
  - The evidence base provides an initial ranking of the impacts and also gives more detailed consideration to those individual elements of the GB regulated energy system likely to have greatest impact on soils and/or to arise most frequently
  - The evidence base identifies: how the significance of impacts may be affected by climate change, existing statutory legislation/regulation intended to prevent or minimise impacts, and management actions that prevent or minimise impacts and can be undertaken by a range of actors
- How to use:
  1. The environmental evidence bases should be used to identify the impacts associated with the policy/project using the matrix, 'flag' those that are high impact with high/medium confidence and those that are medium impact with high confidence requiring scrutiny / additional analysis.
  2. Undertake more detailed consideration of the significance of these impacts
  3. Undertake more detailed analysis of the interactions with climate change
  4. Consider potential prevention and mitigation measures
  5. Undertake additional qualitative and quantitative analysis, as required
- Case study:
  - A worked step-by-step case study has been included, considering the pressure on soils with the most significant impacts, in order to help you use this evidence base

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Contents

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The state of soils

- Like air and water, soil is a fundamental natural resource on which life depends.
  - Soil provides us with food, timber and essential provisions.
  - It filters and stores water and contains a substantial amount of carbon.
  - It underpins our infrastructure and cultural heritage, shapes our landscapes and supports habitats and species.
- Hence, soil use and management influences land, water and air quality, as well as biodiversity. This means that soil degradation not only has a direct impact on immediate land users but also has wide-ranging indirect impacts.
- Our soils have been degraded over the last 200 years due to intensive agricultural production, industrial pollution, and urbanisation.
- The EU Thematic Strategy for Soil Protection identifies the following key threats to soils:
  - Erosion
  - Reduction of soil organic matter
  - Contamination
  - Sealing
  - Compaction
  - Salinisation
  - Landslides
- *The Soil Strategy for England* identifies that soils in England have been degraded over the last two centuries by agricultural production and industrial pollution, and continue to be threatened by: erosion, compaction and organic matter decline, all of which may be magnified by climate change.
- *The Scottish Soil Framework* highlights that soils in Scotland have been well-managed over a prolonged period but that climate change and loss of organic matter are significant threats, soil sealing is a serious issue, and erosion, compaction and contamination by heavy metals and pesticides are all locally significant.

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Potential impacts on soils

- The following slides:
  - Identify and broadly categorise potential impacts arising from any pressure on soils
  - Identify factors that lead to such impacts
  - Highlight relevant statutory legislation or regulation intended to prevent or minimise such impacts
- This information is then used specifically to consider impacts on soils arising from individual elements of the GB regulated energy system.

For more information on roles and responsibilities of regulators for soils, please refer to Annex 1.

For more information on relevant legislation, please refer to Annex 2

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Potential impacts on soils

Impact	Factor	Relevant legislation
Erosion	Factors that lead to soil erosion (e.g. construction activities or land management). Erosion rates are very sensitive to climate, land use, soil texture, slope, land cover, and rainfall. Soil formation is very slow, so loss of more than one tonne of soil per hectare per year is considered irreversible within 50-100 years. Soil erosion can lead to: suspended sediments and turbidity in watercourses that seriously diminish water quality and aquatic life; and eutrophication of watercourses, as soil eroded from farmland is often rich in nutrients.	• Framework directive for the protection of European soil • Wildlife and countryside act 1981 • Rural development programmes in England, Wales and Scotland
Soil organic matter (SOM)	Factors that promote soil erosion or landslides may lead to the rapid removal of SOM. However, changes in SOM resulting from agricultural cultivation, deforestation, or conversion of permanent ground cover to open ground (or vice versa) are slow. In general, soils under permanent grassland or woodland gain SOM over time, whereas, depending on management practices, cultivated and disturbed soils tend to lose SOM. A decline in SOM reduces soil fertility, soil strength, water storage capacity, pollutant absorption and soil biodiversity.	• Environmental impact assessment directive • Strategic environmental assessment directive
Contamination	Release of chemicals that lead to: • Acidification (deposition of chemicals that make soils more acid) • Eutrophication (an increase in nutrients, usually compounds containing nitrogen) • Toxic pollution (immediate or cumulative) Soil contamination can be localised or diffuse (i.e. covering large areas) and have lasting implications. Acidification can deplete soils' ability to neutralise acids, and may lead to declines in agricultural productivity, water quality and biodiversity. Eutrophication can have a negative impact on biodiversity and water quality. Pollution by heavy metals and organic contaminants may be irreversible and have direct or indirect impacts on human health.	• Thematic strategy for soil protection • National emissions ceilings directive • Air quality strategies for England, Wales, Scotland and Northern Ireland • Good agricultural and environmental condition (GAEC) standards • The soil strategy for England

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Potential impacts on soils

Impact	Factor	Relevant legislation
Sealing	Factors that lead to the destruction or covering of soils by completely or partially impermeable materials (e.g. concrete, tarmac etc.), which is essentially an irreversible process. Soil sealing reduces land available for other uses (e.g. agriculture, forestry), natural temperature regulation in urban areas, water retention and groundwater recharge, and soil biodiversity. More importantly, it can indirectly lead to increased flood risk, contamination (through collection of unfiltered water), and habitat fragmentation for above-ground biodiversity.	• The Scottish soil framework
Compaction	Factors that lead to compaction (e.g. the passage of heavy machinery, especially in wet conditions) and thereby to a reduction in soils' biological activity, porosity and permeability. The sensitivity of soils to compaction depends on their properties (e.g. texture, moisture, SOM), climate and existing land use. Compaction can affect water infiltration capacity and increase soil erosion by accelerating run-off.	• The UK forestry standard, forests & soils guidelines and country forestry strategies • Natural environment framework – a living Wales • The natural environment white paper
Salinisation	Factors that lead to an accumulation of salt in soils. Salt levels can threaten agricultural and ecological potential.	
Landslides	Factors acting together or alone that lead to slopes becoming unstable, including removal of vegetation, deforestation, construction, and changes to landform. Landslides in the UK are generally restricted to coastal cliffs and steep slopes and can be rapid or slow-moving. Landslides may lead to loss of topsoil, restrict land use, cover soil down slope, and increase soil erosion entering watercourses.	• Water framework directive • EU floods directive

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Instructions

- Case Study:
  - The steps are illustrated using a 'real-life' case study.
  - This considers the pressure "New electricity transmission lines overhead"
  - Steps 2 to 5 have been applied to this case study. For general use, you will need to tailor these steps to your own policy/project
- Step 1: Initial rankings of impacts
  - This step applies to all policies/projects
  - The matrices illustrate the severity of each pressure on the various impacts and so can be used to highlight areas for additional scrutiny
- Step 2: Significance of rankings
  - In this step you develop a matrix specific to your given policy/project
  - This allows you to consider the significance of the identified impacts
- Step 3: Interactions with climate change
  - Another case-specific matrix is developed here analysing the interactions with climate change
- Step 4: Preventing or minimising the impacts
  - A final case-specific matrix is developed in order to consider potential prevention and mitigation measures
- Step 5: Qualitative/quantitative analysis
  - Within your policy/project development, you should undertake further analysis of the relevant impacts and mitigation measures

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Step 1: Initial ranking of impacts on soils

- Having identified and broadly categorised potential impacts arising from any pressure on soils, the following tables provide an expert initial ranking of each of the individual elements of the GB regulated energy system:
  - Independent of other energy system-environment interactions
  - At the likely scale of an individual pressure (e.g. an individual transmission line or sub-station)
  - Irrespective of existing statutory legislation and regulation, and
  - Irrespective of potential timing
- Cumulative effects are considered in the same way in relation to each individual element of the GB regulated energy system
- The matrices should be used to 'flag up' significant impacts. This will allow you to conduct further investigation on those significant impacts, for which we have a high degree of confidence in the evidence available

- Impact is defined as:

High: national, permanent, irreversible

Medium: regional, semi-permanent, difficult to reverse

Low: local, temporary, reversible

- Confidence in evidence of such impacts is defined as:

H	High: robust evidence, high agreement
M	Medium: medium evidence, medium agreement
L	Low: limited evidence, low agreement

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Initial ranking of impacts on soils (electricity transmission)

Driver: Electricity transmission	Impact							
Issue: Soils Pressures	Erosion	Soil Organic Matter (SOM)	Contamination	Sealing	Compaction	Salinisation	Landslides	Cumulative
New transmission lines – Overhead*	L	H	L	H	H	N/A	L	M
New transmission lines – underground	L	H	L	H	H	N/A	L	M
New distribution lines	L	H	L	H	H	N/A	L	M
New/extended substations	L	H	L	H	H	N/A	L	M
New marine interconnection	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Marine interconnection – land base connection	H	H	M	H	H	M	H	H
Marine sub-sea lines	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Marine sub-stations	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Series compensation installations	L	H	L	H	H	N/A	L	M
Electricity storage – hydro	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Electricity storage – compressed air	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Electricity storage – batteries	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Electricity storage – cryogenic systems	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Smart grids	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

* This is the pressure that is considered in the case study

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Initial ranking of impacts on soils (gas transmission)

Driver: Gas transmission	Impact							
Issue: Soils Pressures	Erosion	Soil Organic Matter (SOM)	Contamination	Sealing	Compaction	Salinisation	Landslides	Cumulative
New gas transmission network	L	H	L	H	H	N/A	L	M
New compressors	L	H	L	H	H	N/A	L	M
New distribution network	L	H	L	H	H	N/A	L	M
New port infrastructure – gas reception facilities	H	H	L	H	H	L	H	H
New port infrastructure – LNG import	H	H	L	H	H	L	H	H
Marine interconnection	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Biogas upgrading for injection to grid	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Gas storage – underground storage in caverns or gas and oil fields.	L	H	L	H	H	N/A	H	L
Gas storage – above ground connection	L	H	L	H	H	N/A	H	H
CCS – connection to gas grid	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
CCGT – district heating	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Biomethane injection to grid	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Shale gas – connection to grid	L	H	L	H	H	H	L	M

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Initial ranking of impacts on soils (carbon capture and storage)

Driver: CCS	Impact							
Issue: Soils Pressures	Erosion	Soil Organic Matter (SOM)	Contamination	Sealing	Compaction	Salinisation	Landslides	Cumulative
Redeployment of gas pipelines for CO_2	L	H	L	H	H	H	L	M
New CO_2 pipelines	L	H	L	H	H	H	L	M
CCS process	N/A	L	N/A	N/A	N/A	N/A	N/A	L

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Case study – new electricity transmission lines – overhead

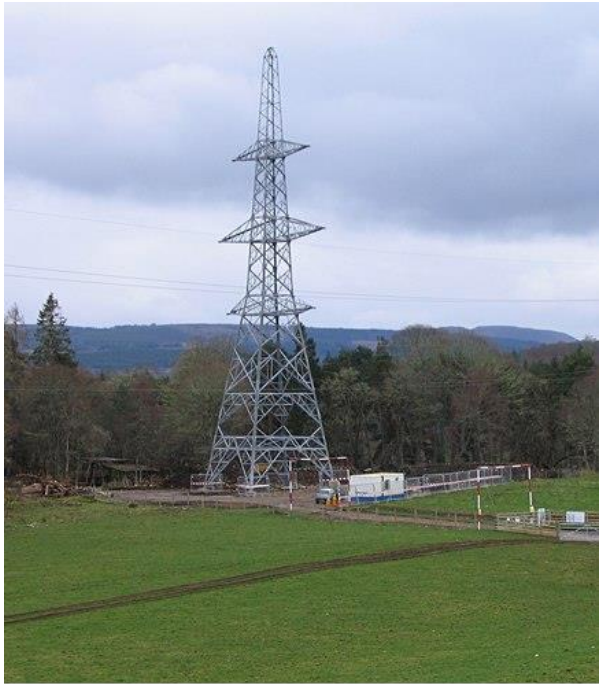
The pressures with the most significant impacts, identified in the previous matrix are:

–New electricity transmission lines - overhead

The case study hence considers an example of those pressures.

The ongoing upgrade of the overhead line between Beauly and Denny in Scotland involves the replacement of a 132kV overhead transmission line with a 400kV transmission line along a 220km route. The *Environmental Impact Assessment (EIA) Directive*, made an assessment mandatory. The significance of the following potential impacts was assessed and mitigation measures were identified to ensure residual effects are minor:

- Loss of superficial deposits through extraction for construction
- Increased erosion of soils following removal of surface cover
- Compaction of soils and peat during construction works
- Damage to geological exposures and designated areas
- Destabilisation of slopes through cutting of soils
- Effects on human health of workforce where contaminated land encountered
- Impacts on soils and waters from exposure of contaminated land or pollution during construction
- Mobilisation of contaminated soils e.g. by windblow on nearby receptors
- The assessment informed conditions attached to the planning consent. Pollution and siltation prevention measures have to be agreed with the Scottish Environment Protection Agency.



First new pylon completed on the Beauly-Denny power line

More information can be found in:

The Environmental Statement – geology and soils.
http://www.scotland.gov.uk/Resource/Doc/917/0090009.pdf

Consent documents

http://www.scotland.gov.uk/Resource/Doc/917/0092854.pdf

http://www.scotland.gov.uk/Resource/Doc/917/0092855.pdf

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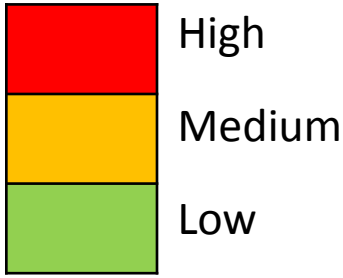
Step 2: Significance of impacts on soils

- Now you will need to undertake further analysis, which is illustrated here utilising the case study on the previous slide
- The following tables go on to provide more detailed consideration of the significance of impacts from those individual elements of the GB regulated energy system initially ranked highest and/or that are likely to arise most frequently
- To do this you use a case-specific matrix. An example is shown on the next slide.
  - This allows you to see which impacts should be given priority in your analysis
  - In this case, compaction, soil organic matter, sealing and cumulative effects are the main impacts to be considered
- Ranking of magnitude is based on extent, duration, reversibility and frequency of impact
- Confidence in the evidence is defined in the same way as for the initial ranking

- A combined ranking of the significance of impacts is based on magnitude x confidence:

- Significance:



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Significance of impacts on soils

Issue: Soils	Impact							
Pressure: New electricity transmission lines overhead	**Erosion**	**Soil Organic Matter (SOM)**	**Contamination**	**Sealing**	**Compaction**	**Salinisation**	**Landslides**	**Cumulative effects**
Positive or negative	-	-	-	-	-	N/A	-	-
Extent	Local	Local	Local	Local	Local	N/A	Local	Local
Duration	Permanent	Permanent	Permanent	Permanent	Permanent	N/A	Permanent	Permanent
Reversibility	Difficult to reverse	Difficult to reverse	Difficult to reverse	Irreversible	Irreversible/ difficult to reverse	N/A	Irreversible	Irreversible/ difficult to reverse
Frequency	During construction and possible during operation	During construction	During construction and possible during operation	During construction	During construction and possible during operation	N/A	During construction and possible during operation	During construction and possible during operation
Magnitude	High	Low	Medium	Low	Medium	N/A	Medium	Low
Confidence	Low	High	Low	High	High	N/A	Low	Medium
Significance						N/A		

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Step 3: Interactions with climate change

- Having provided more detailed consideration of the significance of impacts from those individual elements of the GB regulated energy system initially ranked highest and/or that are likely to arise most frequently, the evidence base goes on to review their potential interactions with climate change.
- This is done through developing another case-specific matrix
  - This allows you to see how the impacts of your policy/project relate to climate change and whether they are going to be amplified, remain neutral or reduce with climate change
  - In the case that is being considered here, it is shown in the matrix on the next slide that climate change is likely to amplify the soils impacts
- The following tables identify how the significance of impacts may change as a result of:
  - Direct impacts of climate change on soils
  - Climate change adaptation actions identified by key energy infrastructure providers under the Climate Change Act 2008 adaptation reporting power

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Interactions with climate change

Issue: Soils	Impact							
Pressure: New electricity transmission lines overhead	**Erosion**	**Soil Organic Matter (SOM)**	**Contamination**	**Sealing**	**Compaction**	**Salinisation**	**Landslides**	**Cumulative effects**
Significance						N/A		
Climate change	>	>	=	=	=	N/A	>	>

Reference

- Adaptation Reporting Power received reports (2012) Adaptation plan reports: electricity distributors and transmitters and gas transporters. https://www.gov.uk/government/publications/adaptation-reporting-power-received-reports

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Step 4: Preventing or minimising the impacts

- Finally, the evidence base considers prevention of impacts from those individual elements of the GB regulated energy system initially ranked highest and/or that are likely to arise most frequently, and whose significance and interactions with climate change have been reviewed
- The following tables identify:
  - Relevant existing legislation or regulation
  - Management actions that prevent or minimise impacts and can be undertaken by a range of actors
- The prevention and mitigation measures should be considered in any analysis undertaken in your policy/project development

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Preventing or minimising the impacts

Issue: Soils	Impact							
Pressure: New electricity transmission lines overhead	**Erosion**	**Soil Organic Matter (SOM)**	**Contamination**	**Sealing**	**Compaction**	**Salinisation**	**Landslides**	**Cumulative effects**
Significance						N/A		
Legislation/ Regulation *(numbers are referenced in annex 3)*	**1, 2, 3, 4**	**2**	None	None	None	N/A	None	
Management	**5.** Minimise removal of plant cover which holds soil in place	Minimise removal of plant cover which provides the source of SOM	Minimise littering site with construction materials	Do not cover more soil than is needed for support and maintain	Minimise the area of land subject to traffic during construction	N/A	Minimise removal of plant cover, which holds soil in place	Effects can be reduced by care during construction and operation.

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Step 5: Qualitative/Quantitative Analysis

- After using the matrices to identify relevant impacts for your policy/project, identifying their significance, considering their interactions with climate change and potential prevention and mitigation measures, you should undertake further analysis to feed into any Impact Assessment being developed
- The analysis can be either qualitative or quantitative (if available)

- For the case study we are considering, further analysis should be given to the following impacts:
  - Compaction
  - Sealing
  - Soil Organic Matter
  - Cumulative effects

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Conclusions

- Individual elements of the GB regulated energy system likely to have the greatest impact on soils and/or to arise most frequently are:
  - New transmission lines - overhead and underground
  - New distribution lines
  - New/extended substations
  - Marine interconnection – land base connection
  - Series compensation installations
  - New gas transmission network
  - New compressors
  - New gas distribution network
  - New port infrastructure - gas reception facilities and liquid natural gas (LNG) import
  - Gas storage - underground storage in caverns or gas and oil fields
  - Shale gas – connection to grid
  - Redeployment of gas pipelines for CO_2 and new CO_2 pipelines for carbon capture and storage
- Their most significant potential impacts relate to:
  - Erosion
  - Contamination
  - Sealing
  - Compaction
  - Salinisation
  - Landslides
- Climate change is likely to amplify many of these impacts.
- Existing statutory legislation or regulation preventing or minimising such impacts includes:
  - *Environmental Impact Assessment (EIA) Directive*, requires an EIA for "*Construction of overhead electrical power lines with a voltage of 220 kV or more and a length of more than 15 km".* (http://ec.europa.eu/environment/eia/eia-legalcontext.htm)
- Management actions to prevent or minimise impacts that can be undertaken by a range of actors can be identified as follows:
  - Defra (2005) Controlling soil erosion. Defra, London. (http://archive.defra.gov.uk/environment/quality/land/soil/documents/soilerosion-combinedleaflets.pdf)

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Annexes

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Annex 1: Roles and responsibilities of regulators for soils

Responsibilities for development and implementation of policies that relate to soil functions or impacts on soils are spread across many policy areas and organisations. For example:

- Agriculture – Defra, Scottish Government, and Welsh Government
- Biodiversity – Natural England, Natural Resources Wales, and Scottish Natural Heritage
- Environmental protection (including pollution prevention and control, waste management, water management) – Environment Agency, Scottish Environment Protection Agency, and Natural Resources Wales
- Forestry – Forestry Commission
- Planning:
  - National planning policy guidance – Department for Communities and Local Government (in England), the Welsh Government and the Scottish Government
  - Land-use planning decisions – Local planning authorities.

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Annex 2: Relevant legislation and regulation

The statutory legislation and regulations identified here provide the legal framework in relation to soils. Relatively few policies are specifically targeted at soil protection.

Europe

- *Thematic Strategy for Soil Protection*: sets out threats to soils in Europe and aims to promote soil protection measures amongst Member States. In addition, a *Framework Directive for the Protection of European Soil* has been proposed to establish a statutory mechanism to address soil degradation, although this has yet to be agreed
- *Water Framework Directive*: creates a unified approach to water legislation and is relevant given the close links between soil protection and maintenance and improvement of water resources
- *EU Floods Directive*: requires Member States to assess if all watercourses and coast lines are at risk from flooding, map the flood extent and assets and humans at risk and take adequate and coordinated measures to reduce this flood risk. It is relevant, given that soil sealing and compaction exacerbate flooding
- *National Emission Ceilings Directive*: the main policy tools to reduce diffuse impacts on soil acidification and eutrophication
- *Environmental Impact Assessment (EIA) Directive*: an EIA is mandatory for all projects listed in Annex I, which includes projects relevant to the UK regulated energy system
- *Strategic Environmental Assessment (SEA) Directive* : SEA is mandatory for public plans, programmes and strategies that set the framework for future development consent of projects listed in the EIA Directive or that require an SEA under the *Habitats Directive*

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Relevant legislation and regulation

UK

Examples of where soil protection is considered are:

- *The Soil Strategy for England*
- *The Scottish Soil Framework*
- *The Natural Environment White Paper*
- *Natural environment framework – a living Wales*
- *Good Agricultural and Environmental Condition (GAEC) standards*
  - England
  - Scotland
  - Wales
- *Rural Development Programmes*
  - England
  - Scotland
  - Wales
- *The UK Forestry Standard, Forests & Soils Guidelines and country forestry strategies*
- *Wildlife & Countryside Act 1981*: although soil itself is often not directly protected by conservation designations, management agreements and operations often offer soil protection
- *Air Quality Strategy for England, Scotland, Wales and Northern Ireland*
- *EIA regulations*
  - England
  - Scotland
  - Wales
- *Water policies, legislation and regulation*

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Annex 3: Preventing or minimising the impacts

Pressure: New electricity transmission lines – overhead

References

Legislation/regulation

Relevant examples include**:**

1. Environmental Impact Assessment (EIA) Directive. Article 4(2) makes an EIA mandatory requirement for all projects listed in Annex I including *"20. Construction of overhead electrical power lines with a voltage of 220 kV or more and a length of more than 15 km".* (http://ec.europa.eu/environment/eia/eia-legalcontext.htm)
2. Good Environmental and Agricultural Condition. Farmers who receive CAP payments are required to keep agricultural land in Good Environmental and Agricultural Condition (GAEC). In England, GAEC 12 states that it is important that soils are protected on land that is not in agricultural production. Thus, care is needed where land used during construction of transmission lines is be returned to farmers. (http://rpa.defra.gov.uk/rpa/index.nsf/0/2ba694d4a8a991478025768e005e67c0/$FILE/Cross%20Compliance%20Guide%20to%20Soil%20Management%202010%20edition.pdf).
3. Water Resources Act 1991, England (Sections 85 and 161). The Environment Agency can take legal action in situations where soil erosion causes water pollution and can also do work to prevent or clear up pollution and recover the cost from the person responsible. (http://www.legislation.gov.uk/ukpga/1991/57/contents)
4. Highways Act 1980, England (Section 151). Local authorities can serve a notice requiring works to prevent soil being deposited on the highway. (http://www.legislation.gov.uk/ukpga/1980/66/contents)

Management

5. Defra (2005) Controlling soil erosion. Incorporating former advisory leaflets on grazing livestock, wind, outdoor pigs and the uplands. Defra, London. (http://archive.defra.gov.uk/environment/quality/land/soil/documents/soilerosion-combinedleaflets.pdf)

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