

## Main sources of soil contamination, sealing, erosion and structural changes and their effects on the environment

### Main sources (causes) of effects on soil

### Description of typical effects

#### Soil contamination

- **Atmospheric deposition:**
  - Nitrogen
  - Oxides of sulphur or nitrogen as acids
  - Heavy metals
  - Persistent organic pollutants
- **Agriculture**
  - Pesticides
  - Fertilisers
- **Waste management and recycling including sewage sludge**
  - Heavy metals
  - Persistent organic pollutants
- **Industry, mining and historic land contamination**
  - Heavy metals
  - Persistent organic pollutants

- **Soil acidification** through **deposition** of oxides of sulphur or nitrogen affecting the production of biomass, biodiversity and the buffering capacity of soils. May contribute to water acidification.
- **Direct contact, inhalation and ingestion** of contaminated soils and uptake through **plants** causing adverse effects on human health.
- **Surface runoff, migration and leaching through soils** of contaminants causing adverse effects on the water environment.
- **Direct contact** with soil contamination causing adverse effects on the built and historic environment.
- **Direct contact and uptake through roots** causing various adverse effects on soil organisms, plants, ecosystems and biodiversity.

#### Soil sealing/ loss

- **Town & Country Planning/ Land use – Built environment**
  - Soil stripping, storage & reuse
  - Soil replacement
  - Soil sealing with impermeable surfaces e.g. concrete and asphalt
- **Mining & mineral extraction**
  - Soil removal/ replacement

- Soil sealing has a **highly negative** impact on all soil functions (apart from functioning as a building platform). The following are some of the key effects:
  - **Biodiversity & crops:** When soil is sealed with impermeable surfaces it can no longer be used for biomass, food and fibre production and therefore its capacity to support ecosystems, habitats, biodiversity and crops is affected.
  - **Reduction in infiltration of water** caused by soil sealing can cause changes in hydrological regimes in rivers, e.g. rate of runoff and peak flows which can affect flood risk).
  - **Groundwater recharge** reduced, with implications for the quantity of water and supply to surface waters.
  - **Damage or loss of archaeological features and cultural soils.**

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#### Soil erosion and stability (including water and wind erosion and landslides)

- **Agriculture:**
  - **Removal of vegetation cover** for crops or through excessive grazing
- **Construction and development**
  - Stripping and storing
- **Mining & mineral extraction:**
  - Stripping & storing
- **Transport network**
  - Road and rail cuttings

Other sources include **tourism** and **recreation** (e.g. trampling)

- **Loss of fertile topsoil** can cause a reduction in biomass production of the soil affecting ecosystems and biodiversity. Large scale erosion of peat represents a major threat to the soil's function in providing raw materials.
- **Loss of carbon storage function** of soils and peat due to erosion of more organic topsoil layers.
- Material eroded from soils is a major contributor to the **sediment load** carried by streams and rivers affecting water quality and resources. Possible effects include silting up and reduced capacity of water-supply reservoirs, loss of fish spawning areas through the deposition of fine sediment on riverbed gravels and contamination of water by nutrients (mainly phosphorus) or pesticides adsorbed on eroded sediment particles.
- **Soil erosion can damage built infrastructure** by undermining foundations and the deposition of sediments.
- **Soil erosion poses a threat to the historic environment**, including archaeological features such as buried cropmarks and shallow buried artefacts and structures.

#### Soil structural degradation & compaction

- **Agriculture/ forestry**
  - Arable cultivation
  - Heavy machinery
  - Work on wet soils
- **Town & Country Planning/ Land use – Built environment**
  - Heavy machinery
  - Work on wet soils
  - Stripping and storing
  - Reinstatement
- **Loss of soil organic matter** (see sources below)

- **Increased surface runoff from compacted soils** may increase transport of sediment and adsorbed nutrients and pesticides leading to greater pollution of aquatic ecosystems.
- **Loss of habitat for larger soil fauna** (e.g. earthworms).
- **Reduced/ restricted root growth** arising from soil compaction is a key issue for tree growth in the built environment.
- **Water retention capacity** will be reduced in compacted soils.
- **Possible increases in the flux of greenhouse gases** such as nitrous oxide to the atmosphere from compacted soils affecting climatic factors.
- **Reduced gas exchange/ aeration** in compacted soils affecting functioning of the soil ecosystem.
- **Damage or loss of the historic environment** (e.g. cultural soils).

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<b>Soil organic matter</b>	
<ul style="list-style-type: none"> <li>• <b>Agriculture</b> <ul style="list-style-type: none"> <li>▪ Intensive agriculture with removal of most biomass from the field</li> <li>▪ Arable cultivation</li> <li>▪ Devegetation through overstocking</li> </ul> </li> <li>• <b>Construction and soil movement</b> <ul style="list-style-type: none"> <li>▪ Stripping and storing</li> <li>▪ Reinstatement</li> </ul> </li> <li>• <b>Town &amp; country planning/ landuse, energy generation</b> (e.g. soil disturbance and removal/ drainage of soil during construction of wind farms), <b>agriculture and forestry</b> leading to drainage of carbon rich soils (e.g. peat, wetlands)</li> <li>• <b>Soil erosion</b> (see sources above)</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Reduced capacity to store nutrients</b> thus increased risk of leaching and water eutrophication.</li> <li>• <b>Carbon loss to the atmosphere</b> as carbon dioxide through oxidation of exposed organic soils resulting in feedback to climate change.</li> <li>• <b>Increase of dissolved organic carbon concentration</b> in surface water courses leading to discolouration of drinking water supply.</li> <li>• <b>Potential for increased water pollution</b>, as many pollutants (e.g. heavy metals, pesticides) are bound to organic matter.</li> <li>• <b>Potential for biodiversity loss</b>, as most soil organisms require organic matter as a substrate. <ul style="list-style-type: none"> <li>▪ <b>Reduced water holding capacity</b> thus increased risk of erosion and flooding.</li> <li>▪ <b>Decline of aggregate stability</b> thus increased risk of erosion and run-off.</li> </ul> </li> </ul>

**Source:** Adapted from the Scottish Government (2006) Scotland's Soil Resource – Current State & Threats