Department for Transport

Met Office

BGS

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Transport hazard summary series

Subsidence and soil degradation

Subsidence and soil degradation can cause the ground beneath transport infrastructure to shift or weaken, creating issues such as cracks, uneven surfaces and drainage problems. These effects increase repair costs, cause delays and can make parts of the network unsafe to use, creating growing challenges for planning and maintaining transport infrastructure. Careful management of these risks is needed, particularly in the face of climate change.

The Department for Transport, Met Office and partners, including the British Geological Survey, have created this series of transport hazard summaries to explain natural hazards and other hazards that are not the result of malicious acts, their impacts and how they may change in the future.

This summary will introduce what is meant by subsidence and soil degradation, and how these hazards can impact transport. It offers further information to help decision makers manage and adapt to these risks.

In the UK, 22% of Category 1 rail lines, 29% of major railway stations and 9% of the major road network are in areas that are highly susceptible to shrink-swell subsidence as defined on page 2.*

* Climate Change Committee, 'Transport briefing: Findings from the third UK Climate Change Risk Assessment (CCRA3) evidence report 2021', available at: **https://www.ukclimaterisk.org/wp-content/uploads/2021/06/CCRA3-Briefing-Transport.pdf**

What is subsidence and soil degradation?

Subsidence is a lowering or collapse of the ground. It can crack and distort roads and other infrastructure, causing delays, closures and costly repairs. In the UK, the main types of subsidence are **shrink-swell**, **compression** and **sinkhole formation**. Subsidence can occur gradually or in the case of sinkholes suddenly.

Shrink-swell occurs when soils absorb or lose moisture, causing the ground to shrink or expand and become uneven.* Clay-rich soils are the most susceptible. This often impacts areas around London and the east of England. Shrink-swell is a natural seasonal process, as soils are commonly drier in summer and wetter in winter. Other factors can influence the process, including vegetation management, drainage, land use and leaking water pipes.

Compression occurs when moisture is lost from the ground, leading to downward movement of the ground.† This can happen naturally, due to changes in natural water springs, or through human activity such as removal of groundwater for irrigation or water supply. It can also be caused by the weight of objects such as buildings and vehicles.

Sinkholes occur when an underground cavity is formed, and the material above it collapses or is washed into the cavity.‡ They often form when water erodes soluble rocks, such as chalk, beneath the ground surface, and can be triggered by heavy rain or flooding. They can also be caused by human activity such as mining, leaking water pipes or engineering failures.

Soil degradation is a decline in soil health which causes harmful changes to the environment it supports.§ It occurs when soil is eroded by water or wind, is compacted, or loses vegetation and nutrients. These processes can weaken the soil's structure and reduce its capacity to absorb water, increasing the risk of natural hazards such as flooding.

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* British Geological Survey, 'Swelling and shrinking soils', available at: **https://www.bgs.ac.uk/geology-projects/shallow-geohazards/clay-shrink-swell/**

† British Geological Survey, 'BGS GeoSure: Compressible ground', available at: **https://www.bgs.ac.uk/datasets/bgs-geosure-compressible-ground/**

‡ British Geological Survey, 'Understanding sinkholes and karst', available at: **https://www.bgs.ac.uk/discovering-geology/earth-hazards/sinkholes/#triggers**

§ United Nations Office for Disaster Risk Reduction and International Science Council, 'Hazard information profiles: 2025 update', available at: **https://www.undrr.org/media/108789/download**

Are subsidence and soil degradation changing due to climate change?

The UK is projected to experience hotter, drier summers and warmer, wetter winters in future.* These conditions are expected to worsen soil degradation and are projected to increase susceptibility to subsidence in parts of the UK.†

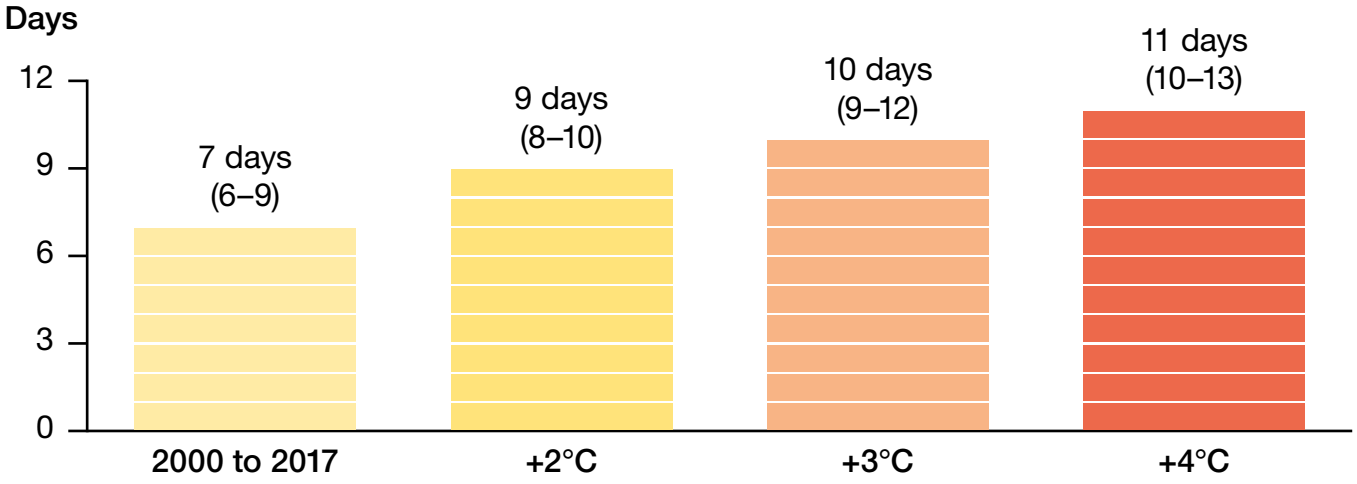
Dry weather

- The severity of droughts is expected to worsen for all lengths of drought, whether they last 3, 6, 12 or 36 months.‡ See the 'Drought' transport hazard summary for further information.
- Soil degradation could increase as soil dries and becomes more easily eroded.
- Hotter, drier summers dry out clay soils, causing them to shrink and boosting the risk of subsidence and ground cracking beneath transport infrastructure.

Wet weather

- With increasing global warming, an increasing number of days on average each year are projected to see intense or prolonged heavy rainfall, as shown in Figure 1.‡
- Intense rainfall can overwhelm soil and drainage systems, which could lead to sinkholes occurring more frequently.
- Intense rainfall could increase soil erosion, causing soil degradation.

Figure 1: The projected average occurrence of heavy rainfall days of more than 80mm per day for different global warming levels.‡



* Met Office, 'UKCP18 climate change over land', available at: **https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-infographic-headline-findings-land.pdf**

† British Geological Survey, 'GeoClimate UKCP18 Open', available at: **https://www.bgs.ac.uk/datasets/geoclimateukcp18-open/**

‡ Hanlon, H.M., Bernie, D., Carigi, G. and others, Climatic Change, 'Future changes to high impact weather in the UK', volume 166, article number 50, 2021, available at: **https://link.springer.com/article/10.1007/s10584-021-03100-5**

Case studies

Subsidence: railway service disruptions, 2025*

Railway services in the south of England were disrupted by shrink-swell subsidence in summer 2025. A very dry spring and summer caused clay soil under railway tracks to shrink, causing the railway track to become uneven.

Speed restrictions were introduced, with a reduced timetable in operation, leading to delays and cancellations for passengers.

Subsidence: train derailment, 2024†

A passenger train derailed at Grange-over-Sands, Cumbria, on 22 March 2024. No-one was injured, but the train and the railway infrastructure both suffered significant damage.

Prior maintenance had damaged a pipe beneath the railway, causing embankment material under the track to be carried away by water leaking from the pipe, which created a hole. This led to rails beneath the train losing support, causing the derailment.

Soil compressibility and associated degradation: roads in East Anglia, 2024‡

In 2024, plans were announced to repair more than 150 roads in the Fens of East Anglia.

The repairs were needed because the peat soil beneath the road surface had expanded and contracted as temperatures changed, causing the road surface to buckle and break.

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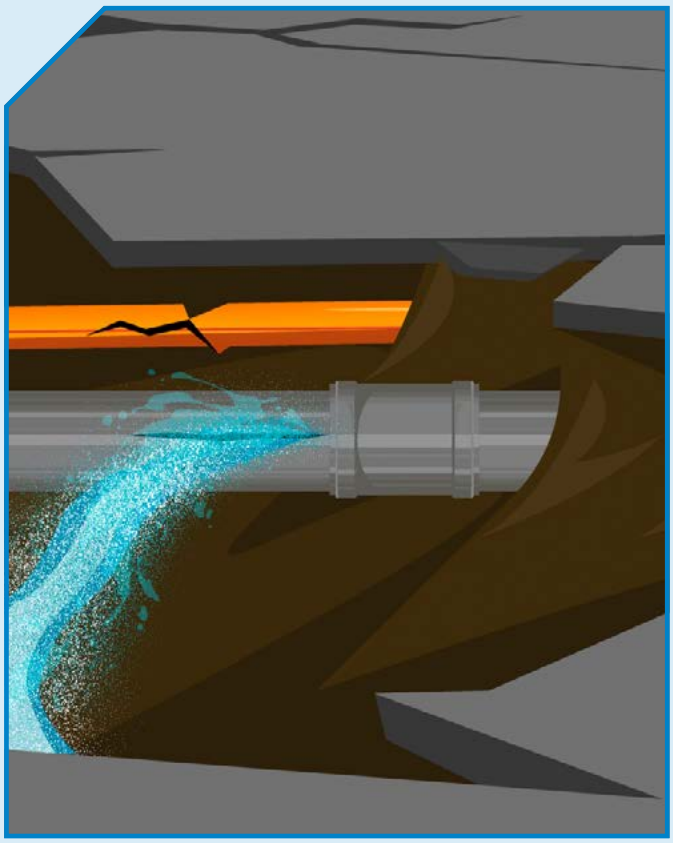
* BBC News, 'No trains to stop at station due to dry weather', 2025, available at: **https://www.bbc.co.uk/news/articles/ceq742wzj8ro**. BBC News, 'Trains affected as work on uneven track starts', 2025, available at: **https://www.bbc.co.uk/news/articles/c0e99d14ngpo**

† Rail Accident Investigation Branch, 'Report 02/2025: Derailment of a passenger train at Grange-over-Sands', 2025, available at: **https://www.gov.uk/raib-reports/report-02-slash-2025-derailment-of-a-passenger-train-at-grange-over-sands**

‡ BBC News, 'More than 150 Fens roads to be repaired as lower speed limits considered', 2024, available at: **https://www.bbc.co.uk/news/uk-england-cambridgeshire-68074533**

Direct transport impacts due to subsidence and soil degradation



Infrastructure

- Subsidence can cause structural damage by cracking and warping road surfaces and runways, misaligning rail tracks, weakening bridge supports and tunnel linings, and creating drainage problems that make routes unsafe.
- Soil erosion can destabilise embankments and slopes and increase maintenance needs, such as clearing debris from roads, railways and blocked culverts.
- Eroded soil can be carried by the wind and deposited on roads and other infrastructure, leading to significant clean-up costs.
- Sinkholes caused by subsidence can damage or block sections of transport infrastructure, leading to disruption.
- Subsidence, erosion and other types of ground instability can increase the need for inspections to monitor the safety of assets.

Interdependencies: Burst water or gas mains caused by subsidence or sinkholes create additional hazards and compound disruptions, affecting utilities and emergency services. When combined with events such as flooding or extreme heat, they make it harder to plan, maintain and operate the transport network safely.

Human health and safety

- Subsidence can cause sudden ground collapses or leave road and rail surfaces uneven, increasing the risk of injury and accidents for people using the transport network.
- Subsidence and soil erosion can make the ground around transport infrastructure unstable, increasing the risk to staff during inspections and repairs.

Vehicle and service operations

- Road and railway deformation or disrupted routes can force speed restrictions, diversions or closures, delaying public transport, emergency response and freight operations.
- Vehicles can be damaged by uneven or collapsed surfaces, increasing accident risk and repair costs.
- Degraded soil absorbs less water, increasing surface runoff during heavy rain. This can cause pooling and debris on transport routes.

Hazards associated with subsidence and soil degradation

Extreme heat and drought

Prolonged hot, dry weather can reduce soil moisture, causing shrinkage and destabilisation of the ground.

Groundwater flooding

Repeated flooding and severe drying cycles can lead to shrinkage and destabilisation of the ground.

Landslides and earthwork failures

Subsidence can undermine or weaken the ground beneath slopes and embankments, making them more likely to fail during heavy rain or under load.

Reservoir dam collapse

Subsidence can weaken a dam by causing the ground beneath or around it to sink or shift, increasing the chance of cracks or leaks forming.

River flooding

Floodwater can soften clay soils or wash fine material from beneath roads, leading to surface cracking, minor ground movement or, on rare occasions, sinkholes after the flood.

Storms

Repeated cycles of heavy rainfall and drying can contribute to subsidence and soil degradation, weakening the ground supporting transport infrastructure.

Surface water flooding

Surface water flooding can contribute to soil erosion and destabilisation, potentially leading to subsidence.

Wildfire

Wildfires can burn away vegetation, leaving soil exposed to erosion by wind and water.

Further information on these hazards can be found in our series of Transport hazard summaries: **https://www.gov.uk/government/collections/transport-hazard-summaries**

Risk mitigation and adaptation

Reducing the impact of subsidence and soil degradation on transport networks can be difficult, requiring complex or innovative engineering and technological solutions. The mitigation of impacts often requires co-ordinated action between transport providers, local authorities, government agencies and other infrastructure owners. Examples include:

- using hazard maps to spot high-risk ground and adapt, reroute or strengthen new and existing transport links
- maintaining and upgrading drainage to keep soils stable, clearing culverts and fixing leaks to prevent sinkholes or subsidence
- strengthening foundations, adding flexible surfacing and filling cavities to prevent the surface becoming unsafe due to subsidence
- installing ground-movement sensors and linking them to weather alerts so engineers can intervene before cracks or collapses occur

Questions for decision makers

- Which parts of your transport network are most at risk from subsidence or soil degradation?
- What systems are in place to monitor ground conditions and catch early warning signs of ground subsidence?
- Do emergency plans consider that a subsidence event could cut off not just transport but also utilities or access for emergency services?
- Are new transport projects and upgrades accounting for future climate change-driven ground changes?

Further reading

GeoClimate UKCP18 Open, a shrink-swell dataset showing potential change in subsidence due to changes in climate – British Geological Survey

The state of the environment: soil – Environment Agency

UK and global extreme events: Drought – Met Office

UK and global extreme events: Heavy rainfall and floods – Met Office

UK Climate Risk Independent Assessment (CCRA3), Chapter 4: Infrastructure, providing summary of infrastructure climate risks from the UK government's **third mandatory Climate Change Risk Assessment** – Climate Change Committee

Climate information and risk assessment

See 'The changing climate' and 'Transport hazards, risks and resilience' transport hazard summaries for more information on identifying and planning for risks to transport and where to find climate data, including more detail on projected changes on a regional level.