Department for Transport

Met Office

BGS

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Transport hazard summary series

Landslides and earthwork failures

Landslides and earthwork failures can cause soil and rock on slopes to move or collapse, depositing material onto roads and railways or weakening the ground beneath them. These movements can block routes, damage infrastructure, and create dangerous obstructions for vehicles and trains. 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 landslides and earthwork failures and how they can impact transport. It also offers further information to help decision makers manage and adapt to these risks.

On average, from the year 2020 to 2021 to the year 2024 to 2025, there were 151 earthwork failures per year on the British railway network.*

* Network Rail, 'Annual return 2025: data tables', available at: **https://www.networkrail.co.uk/wp-content/uploads/2016/11/Network-Rail-Infrastructure-Limited-%E2%80%93-annual-return-2025-data-tables.xlsx**

What are landslides and earthwork failures?

Landslides and earthwork failures are both types of slope collapse that can disrupt transport routes. Landslides involve natural slopes giving way, while earthwork failures involve the collapse of man-made structures such as embankments or cuttings.*

Both cause ground movement that can block or damage roads, railways and supporting structures. Collapses can spread debris across transport routes or leave roads and tracks unstable. Even once movement stops, slopes often remain weak and prone to additional failures. Clearing soil and rock and stabilising the slope can take time, meaning disruption often continues well beyond the initial failure.

Factors influencing landslides and earthwork failures in the UK

Several factors make slopes more likely to collapse. These include weather conditions, the type of soil or rock, the shape and steepness of the slope, as well as outside influences such as vegetation or human activity. Failures can happen suddenly or develop gradually over time, depending on these conditions.

Weather

Heavy rainfall: Landslides and earthwork failures are most often triggered during or soon after intense or prolonged rainfall.† Saturated ground loses strength and can slip, wash away or collapse. Long spells of wet weather can slowly soak the ground, building up water inside slopes and making them weak, which can lead to slow-moving landslides or earthwork failures.

Prolonged hot, dry weather: Dry conditions can make clay-rich soils shrink and crack, weakening slopes. When rain returns, water can rapidly seep into these cracks, making failure more likely. Dry spells can also kill vegetation that normally binds soil, further raising the risk.

Cold weather: Freeze-thaw cycles can break down rock and soil as water seeps into cracks, freezes and expands, increasing the risk of rockfalls or slope failures.

Wind and storms: Strong winds can strip vegetation or uproot trees, leaving loose soil that raises the risk of failure.

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* British Geological Survey, 'Understanding landslides', available at: **https://www.bgs.ac.uk/discovering-geology/earth-hazards/landslides/**

† British Geological Survey, 'Landslides and rainfall', available at: **https://www.bgs.ac.uk/geology-projects/landslides/landslides-and-rainfall/**

Factors influencing landslides and earthwork failures in the UK

Structure

Rock type: Hard rocks with natural cracks can split further when water seeps in and freezes, while softer rocks weather more easily in rain and wind, and with temperature changes.

Soil type: Sandy soils drain quickly and can wash away easily, while clay soils swell when wet and shrink as they dry. Different soils fail in different ways after varying amounts of rainfall.

Slope angle: Steeper slopes, such as older embankments and cuttings, are more prone to failures.

Operational and external factors

Age: Many UK transport routes rely on old earthworks built before modern design standards, so their exact makeup and construction are often uncertain.

Maintenance and drainage: Well-maintained earthworks with good drainage are less likely to fail, while inadequate upkeep or poor drainage can leave slopes saturated and unstable.

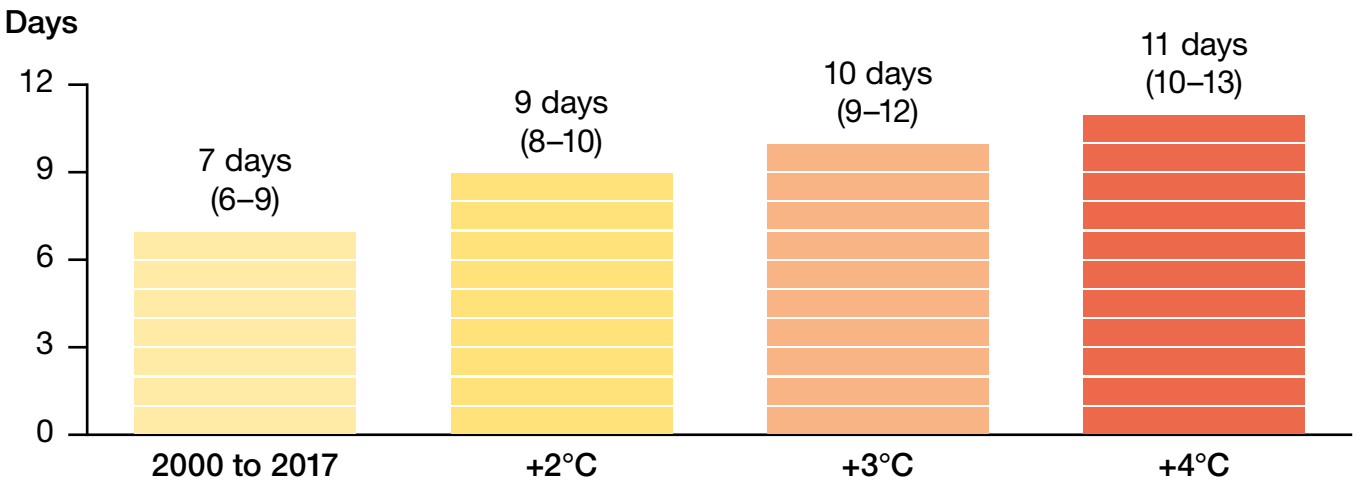
Are landslides and earthwork failures changing due to climate change?

The UK climate is projected to become more variable, with more extremes of hot, dry and wet weather, which are often linked to instability of the ground.*

Projected hotter, drier summers will dry out some soils, causing them to shrink and become more unstable. With climate change, the severity of droughts is expected to worsen for all lengths of drought – whether they last 3, 6, 12 or 36 months.†

Extreme UK rainfall events, a major cause of landslides, are becoming more frequent with global warming (Figure 1).† Increased heavy rainfall combined with periods of dry weather and subsequent cracking of the ground are expected to lead to an increase in failures across transport assets, which will require additional inspections and maintenance to ensure safety.‡

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



- Between now and the middle of the century, continued climate change is largely inevitable.
- Global warming of 2°C is reached by most emissions scenarios by the middle of the century.
- In the second half of the century, a wide range of global warming levels remain possible.
- 4°C of global warming is reached only by the higher emissions scenarios, and not until later in the century.§ Emissions scenarios are explained in 'The changing climate' transport hazard summary.

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* 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**

† 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**

‡ 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**

§ Climate Change Committee, 'Proposed methodology for the Fourth Climate Change Risk Assessment – Independent Assessment', 2024, available at: **https://www.theccc.org.uk/publication/proposed-methodology-for-the-ccra4-advice/?chapter=3-proposed-methodological-approach-for-ccra4-ia**

Case studies

On 28 January 2025, a landslide caused disruption to passengers travelling to Gatwick Airport by train, blocking one of the lines on the route.*

In October 2023, heavy rain triggered seven landslides at the Rest and Be Thankful pass on the A83 in Scotland.† This notoriously landslide-prone stretch of road was closed for several days, and 10 people had to be airlifted after becoming stranded. Transport Scotland reported spending £3.6 million clearing landslides on the A83 that year.‡

On 12 August 2020, extreme rainfall overwhelmed a poorly installed and maintained drainage system near Carmont, Aberdeenshire, washing debris onto the railway line.§ A train derailed, tragically causing the deaths of three people and seriously injuring three others. The line was closed for almost three months. An investigation found that the derailment would have been prevented with correct installation and regular maintenance of the drainage system, prompting improvements to the management of earthworks and drainage on the railway network by Network Rail.§

On 31 January 2015, a 350,000-tonne landslide near Harbury blocked a rail line between Southampton and the West Midlands. Freight and passenger trains between Banbury and Leamington Spa were suspended for six weeks.¶

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* BBC News, 'Landslip causes delays for Gatwick rail passengers', 2025, available at: **https://www.bbc.co.uk/news/articles/ckg72p5qjreo**

† BBC News, 'Rest and Be Thankful road hit by seven landslips', 2023, available at: **https://www.bbc.co.uk/news/uk-scotland-glasgow-west-67053999**

‡ New Civil Engineer, 'Transport Scotland has spent over £11M clearing landslides from A83 Rest and Be Thankful since 2014', 2023, available at: **https://www.newcivilengineer.com/latest/transport-scotland-has-spent-over-11m-clearing-landslides-from-a83-rest-and-be-thankful-since-2014-13-11-2023/**

§ Rail Accident Investigation Branch, 'Report 02/2022: Derailment of a passenger train at Carmont', 2022, available at: **https://www.gov.uk/raib-reports/report-02-slash-2022-derailment-of-a-passenger-train-at-carmont**

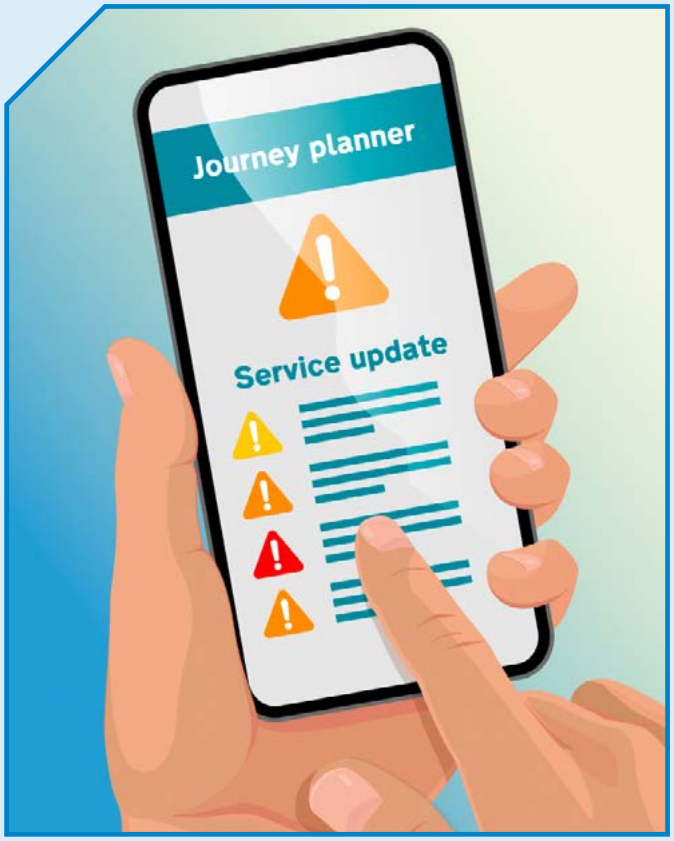
¶ Network Rail, 'Railway between Leamington Spa and Banbury to reopen three weeks ahead of schedule', 2015, available at: **https://www.networkrailmediacentre.co.uk/news/railway-between-leamington-spa-and-banbury-to-reopen-three-weeks-ahead-of-schedule-1**

Direct transport impacts due to landslides and earthwork failures

Infrastructure

- Landslides or damage to earthwork foundations can undermine, bury or destabilise roads and railway tracks, leaving sections impassable and forcing emergency repairs. Some landslides and earthwork failures can occur suddenly, posing a risk of derailment or of vehicles striking unexpected debris.
- Falling rocks or soil can damage bridges and tunnels by striking them or piling up and adding excess weight.
- Debris from landslides or eroded slopes can block drainage systems, increasing the risk of flooding.
- Retaining walls and embankments can fail or collapse when slopes shift or become saturated with water, leading to costly rebuilding.

Interdependencies: landslides and earthwork failures can disrupt power, water and communication networks by damaging pylons, pipelines or buried cables near transport routes. These outages can compound disruption and slow down recovery efforts.



Vehicle and service operations

- When landslides and earthwork failures occur, debris can strike moving vehicles or trains, leading to damage, accidents and even derailment.
- Debris from landslides or earthwork failures can block rail lines or roads, causing major delays while clean-up and repairs are carried out.
- Debris can damage signalling, power cables or safety systems alongside roads and tracks, causing service disruption even if the road or railway track is not impacted.
- Closures or speed restrictions on transport routes to mitigate landslide risk can cause delays and disrupt freight supply chains.

Human health and safety

- People can be injured or killed if vehicles collide with or are trapped by landslide debris, or if a train derails.
- Once a landslide or earthwork failure has begun, the ground is permanently weakened, making repeat failures more likely and placing maintenance staff at increased risk of harm.
- Trains and vehicles may need to be evacuated if stranded due to railway lines being blocked.
- Blocked roads and railways can delay emergency responders, putting communities at greater risk.

Hazards associated with subsidence and soil degradation

Coastal flooding and erosion

Coastal erosion undermines cliffs and embankments, causing landslides and collapses.

Cold weather

Repeated freeze-thaw can break down rocks or soils in slopes, increasing the risk of earthwork failures and landslides.

Extreme heat and drought

Frequent cycles of drying, due to hotter, drier weather, and wetting, due to rainfall, can crack and weaken soil structures on slopes. This makes them more prone to failure.

Groundwater flooding

Rapid changes in groundwater levels and increased saturation can cause instability of soils in slopes and embankments, making them susceptible to failure.

River flooding

River flooding can saturate the slopes that carry roads and rail lines beside rivers, adding weight and weakening the slopes.

Subsidence and soil degradation

Weather-driven erosion or saturation of degraded soils can collapse slopes, blocking routes.

Storms

Intense heavy rainfall or prolonged wet conditions from multiple successive storms can trigger landslides and earthwork failures.

Surface water flooding

Surface water flooding can carry away soil and trigger landslides, as well as undermine earthworks, increasing their risk of failure.

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

There are various methods that can be used to reduce the risks associated with landslides and earthwork failures. Examples include:

- regular inspection, assessment and maintenance, especially of drainage systems and at-risk structures
- upgrading or replacing earthworks to meet modern design standards
- engineering solutions to stabilise slopes and prevent further movement
- active monitoring of high-risk sites using remote sensing methods and other technologies
- implementing operational measures like speed and weight restrictions near vulnerable earthworks
- developing climate change adaptation plans to identify the most vulnerable regions and improve preparedness and resilience

Questions for decision makers

- Which critical transport assets or routes are most vulnerable to landslides and earthwork failures?
- What longer-term investments or operational adjustments are needed given the potential for increasing risk of landslides and earthwork failures due to climate change?
- Are you regularly inspecting, monitoring and maintaining your sites at highest risk of landslides or earthwork failures?
- How would transport operations and services be maintained if a landslide or earthwork failure occurred?

Further reading

A review of earthworks management, one of two reports commissioned following the Carmont derailment – Network Rail

Landslips – Network Rail

National Landslide Database – British Geological Survey

Report 08/2014: Class investigation into landslips – Rail Accident Investigation Branch

Scottish Road Network Landslides Study – Transport Scotland

Understanding landslides – British Geological Survey

Weather Advisory Task Force final report, one of two reports commissioned following the Carmont derailment – Network Rail

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.