Department for Transport

Met Office

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Transport hazard summary series

Transport hazards, risks and resilience

Accessible, safe and reliable transport is fundamental to day-to-day life. Efficiently moving people and goods provides the societal and economic backbone of the UK and future UK growth. The transport network is exposed to numerous hazards, such as flooding, extreme weather and pandemics that have the potential to disrupt services and damage transport assets. It is vital that transport is resilient to these hazards, both now and in the future. The resilience of the transport network is fundamental to the resilience in other sectors too – for example, enabling the movement of stranded people or the delivery of construction materials to make repairs.

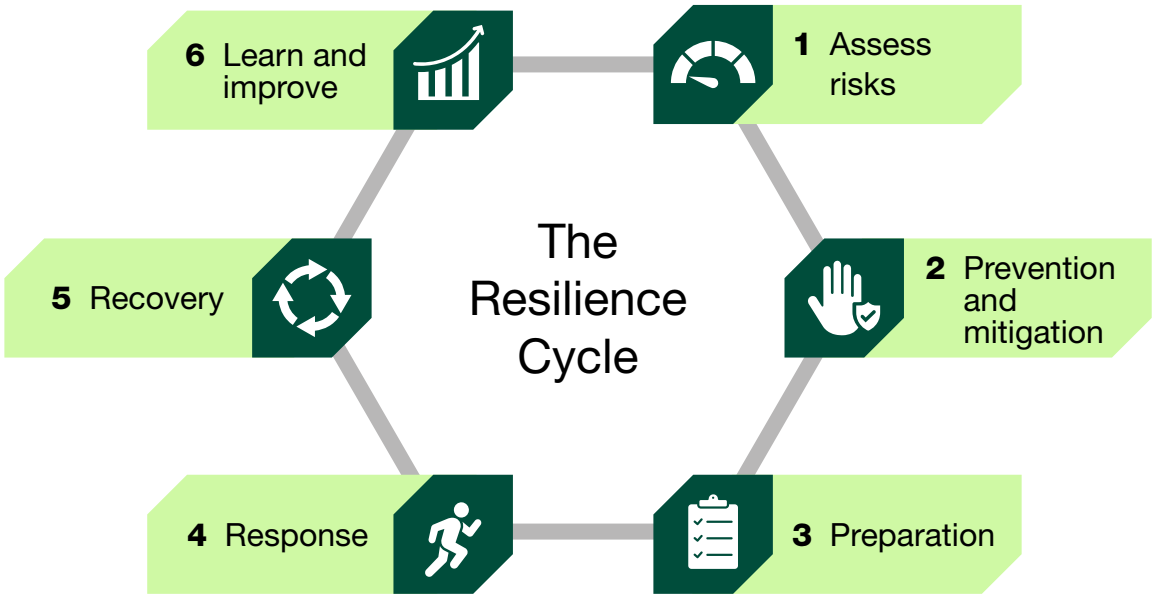
The Department for Transport, Met Office and partners have created a series of **transport hazard summaries** to introduce natural hazards and other hazards that are not the result of malicious acts, their impacts, and how they may change in future. This summary introduces common transport risk and resilience concepts that are used throughout the series. Further transport hazard summaries focus on specific hazards and the impacts that they can have on transport.

The resilience cycle

Through this transport hazard summary, we will describe the different stages of the resilience cycle (shown in figure 1) and how they can be applied to transport.

The resilience cycle describes a process by which transport organisations can prepare for, respond to, and recover from non-malicious and natural hazards. It can also be used to consider resilience to 'business as usual' hazards, such as the weather, and how they will change due to climate change, the changing population and emerging technology.

Figure 1: The resilience cycle. There are different variations of the cycle in use, but all are based on the same principles



1 Assess risks

A **hazard** is a non-malicious event that is dangerous and likely to cause damage, such as extreme weather, accidents or the natural outbreak of disease.* Threats, by contrast include malicious events such as terrorism, espionage and cyber attacks and will not be covered in this summary. The impact of a hazardous event to transport could lead to loss of life or injury, damage to infrastructure or assets, social and economic disruption, or environment degradation.

The **risk** that a hazard poses to transport will depend on the likelihood and nature of the impacts were it to materialise.

This section will consider key concepts needed to assess risks to transport. Links to further information for transport decision makers on assessing risks can be found at the end of this summary.

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* Cabinet Office, 'National Risk Register', 2025, available at: **www.gov.uk/government/publications/national-risk-register-2025**

Anticipate and identify risks

Firstly, all hazards which could impact on the part of the transport system that you are interested in need to be considered, from a pandemic to falling trees and icy surfaces. Examples include:

severe weather · flooding · severe space weather · pandemics · landslides · wildfires · pollution incidents · accidents and collisions

Hazards can **compound** to increase the risk to transport. Impacts can become worse if hazards occur simultaneously or in succession. There is often an interactive or interconnected relationship, for example heavy rain and flooding followed soon after by landslides.

Acute risks describe the risk of a discrete event that usually requires an immediate response, for example a pollution incident or storm.

Chronic risks present continuous challenges that, without intervention, can gradually erode our economy, community, way of life or our national security. An example of this is climate change.

As the climate changes and society and technology evolves, it is important to plan for hazards which may become commonplace and 'business as usual', as well as for more extreme events which may require an emergency response. New hazards may emerge in the future so routine assessment is needed to make sure transport is resilient.

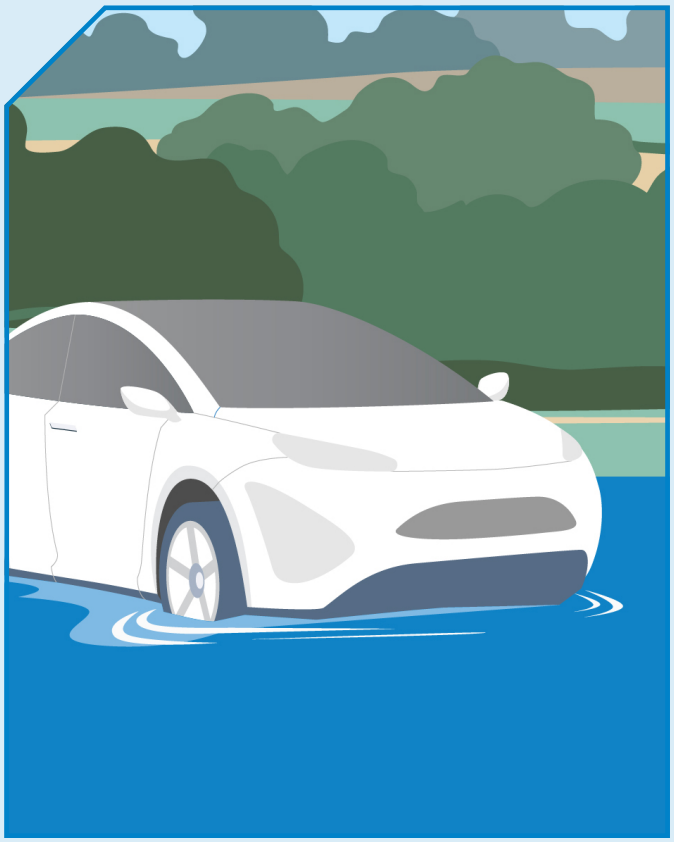
Likelihood

The risk posed to transport from a hazardous event depends on how likely that event is estimated to be and how often it may happen. Even if something is very unlikely, such as the collapse of a dam, the huge potential impact means that plans need to be in place. This is often described as a 'high impact, low likelihood' event. Likelihood can be described or estimated in a number of ways. Some of the most commonly used are:

Chance or probability	The probability of an event occurring within a specific time period, such as a 1 in 10 chance per year. This means the event is expected to occur once for every 10 years.
Percentage chance or percentage probability	The likelihood of an event occurring within a given time period, expressed as a percentage, such as a 10% chance each year. This means the event is expected to occur once for every 10 years.
Return period	The average time between events of a certain size or intensity, usually expressed as a 'return period', such as a 10-year return period. The events may be regularly or irregularly spaced in time and therefore cannot be used as a forecast of when the next event will occur.

Impacts

The risk that a hazardous event poses to transport is also dependent on the potential impact it could have. All the impacts of a hazardous event must be considered to understand the total impact. The length of time that the hazard persists and extent of the transport network affected will influence the size of the impact. Using flooding as an example:



Flooding occurs due to heavy rain:

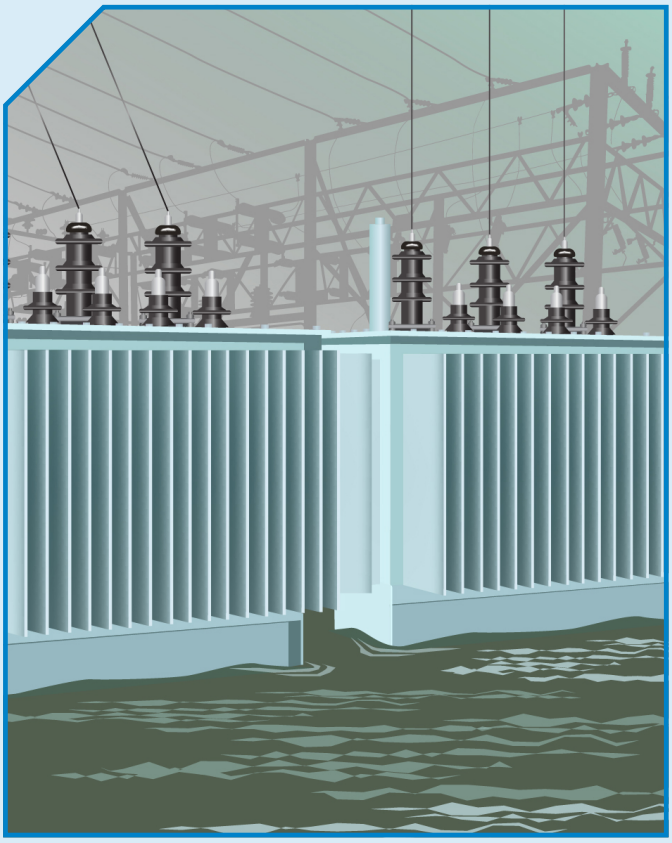
- this is the hazardous event

Direct impacts occur to the transport system, for example:

- closure of roads, stations or airports due to flooding
- danger to human life for those in vehicles
- damage to vehicles or transport buildings

Indirect impacts occur as a result of disruption, for example:

- economic losses from repair costs
- reputational damage and changes in transport users' behaviour



Impacts to other sectors can cascade to give a risk to transport and vice versa, for example an interruption to power supply. The chain is only as strong as its weakest link.

The likelihood and impact of a risk can be influenced by different factors:

Exposure: This can be affected by the location of people or assets, the location of the hazard and the timing, for example whether it is rush hour or a national holiday.

Vulnerability: This depends on how susceptible people or assets are to the hazard. For example, if people have underlying health conditions or an asset is in a poor state of repair.

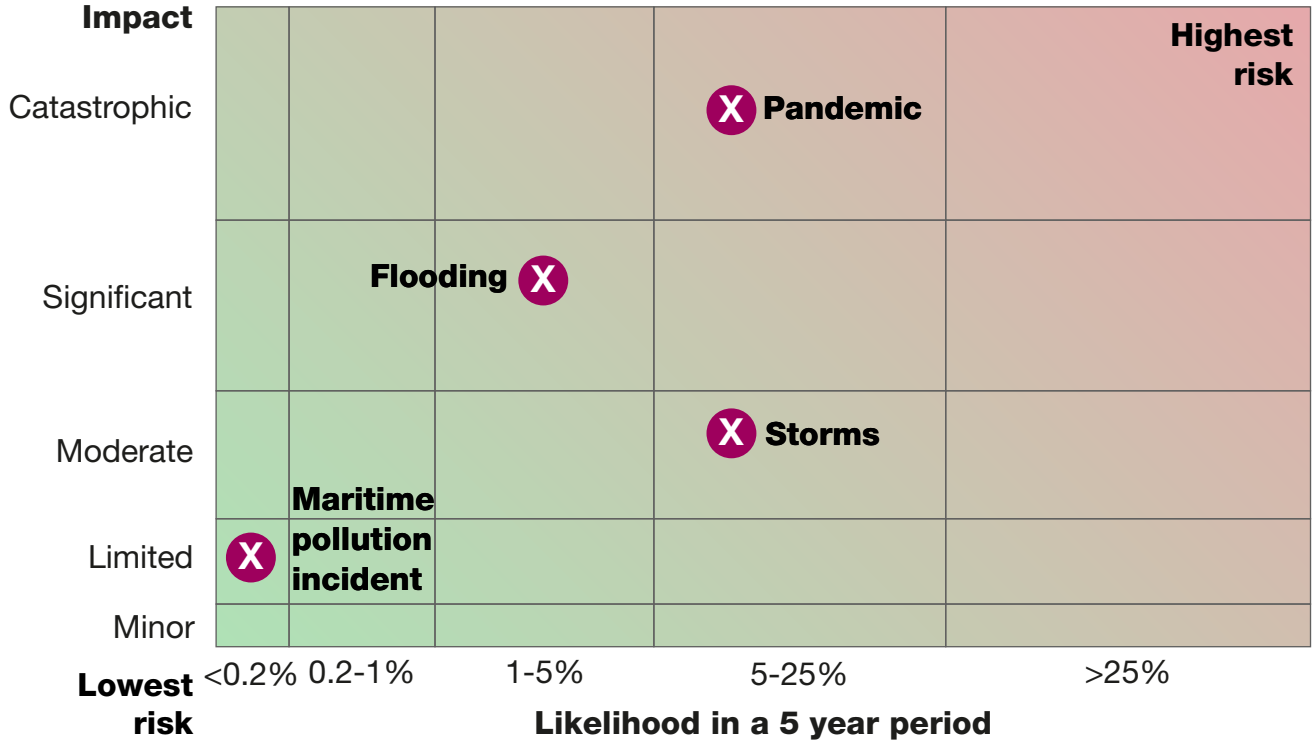
Both of these factors can change due to over-arching factors such as changes to our weather and climate or a local factor, such as changes to neighbouring land use which could impact drainage.

Estimating risk – likelihood x impact

In order to compare risks and identify what the greatest risks are, the likelihood and impact of each hazard can be plotted on a risk matrix. Figure 2 is an example risk matrix based on the National Risk Register 2025 which focuses on 'worst case scenarios' and only risks that are of national significance.*

It is not always possible to be certain of the likelihood or impact of a hazard, for example if something has never happened before. Plausible estimates of likelihood and impact still allow necessary decisions on planning and resilience to be made. The National Risk Register highlights where risks are uncertain by giving a range.

Figure 2: Risk matrix based on the National Risk Register 2025, showing selected examples of major risks facing the UK



Orders of scale

There are many risks that are more likely and less impactful than those on the National Risk Register. These may occur frequently and actions to reduce the impact of them can fall into routine processes, for example monitoring weather warnings so that speed restrictions can be applied in poor weather.

* Cabinet Office, 'National Risk Register', 2025, available at: **www.gov.uk/government/publications/national-risk-register-2025**

2 Prevention and mitigation

Once the risks to the transport network and those travelling have been identified and prioritised, actions need to be taken to increase resilience by:

- avoiding or reducing the likelihood of a risk materialising, or
- by reducing the impacts where risks do arise

For example:

Reduce likelihood of impacts	Monitor the condition of infrastructure and routinely maintain it. Refurbish and adapt assets and infrastructure to increase resilience. Build resilience into new constructions, vehicles or vessels. Have proactive measures available such as temporary flood defences or anti-icing treatments.
Monitor the hazard	Monitor indicators and warnings that the hazard may be imminent to allow pre-emptive actions. Monitor for when a hazard has occurred – a fast response can reduce impacts.
Reduce consequences of hazardous event	Plan pre-emptive actions such as removing people or assets from a risk area or imposing speed restrictions. Co-ordinate processes to re-direct people to alternative methods of transport.

It is not possible to prevent all impacts to transport without prohibitive costs and reducing the efficiency of the transport system. Conscious decisions should be made based on what level of risk can be tolerated.

3 Preparation

Response plans and capabilities need to be ready for when hazardous events occur. This could include plans for additional staff to be brought in, access to equipment such as pumps in case of flooding or snow ploughs in case of snow and making sure there are clear lines of communication for co-ordination. Preparations can also be made for the ‘recovery’ phase. Accountability and responsibility for plans and actions need to be clear.

4 Response

The response is the immediate reaction to a hazardous event, using the plans that have been prepared. This should seek to reduce the dangers, for example applying traffic restrictions in bad weather or co-ordination with emergency services.

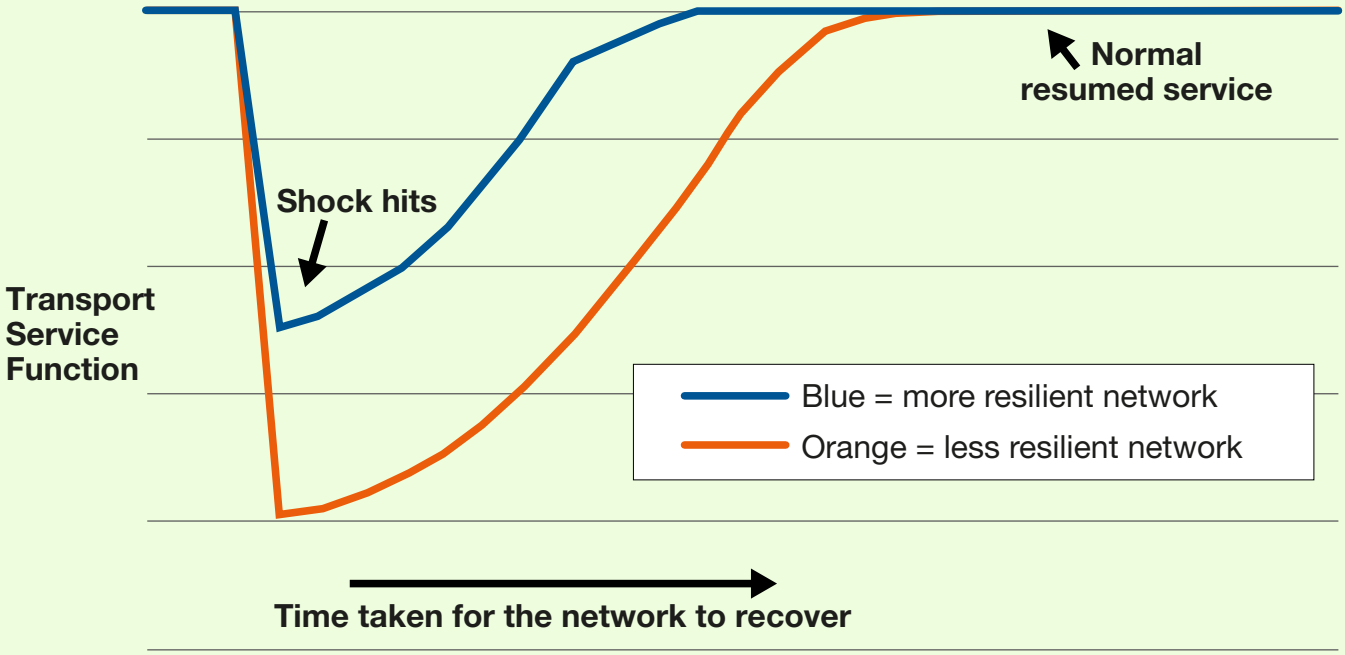
A distinct step following the immediate response is to stabilise. This could mean putting in place temporary measures to allow people to travel. Transport infrastructure could be more vulnerable to further hazards, for example a succession of storms. Measures to ‘shore up’ infrastructure may be needed.

5 Recovery

Recovery is the ability to restore functionality following a hazardous event. Improving the ability for an aspect of transport to recover quickly will increase resilience by reducing the duration of impacts, as shown in figure 3.

Example: Using materials in a transport building such as stations, terminals and depots that can flood without being damaged and recover quickly once floods recede.

Figure 3: Characteristics of a more and less resilient network. If an element of the transport system is more resilient then impacts will be less severe and/or the system can recover to a normal state more quickly*



Having good mitigation and response plans in place may mean that lasting impacts are avoided and recovery to normal services can occur promptly following the hazard, especially for less severe hazards which occur relatively frequently. The investment in risk mitigations and comprehensive plans can significantly outweigh the ongoing and indirect impacts of a slow recovery.

6 Learn and improve

Lessons from responses to hazardous events should be actively sought and shared to allow actions to be taken to embed improvements in planning and responses. Data can be gathered to allow analysis of the impacts of previous events and to prioritise any at-risk elements, areas, locations, or functions for risk reduction.

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* Koren, D., Kilar, V., Rus, K., IOP Conference Series: Materials Science and Engineering 245, 'Proposal for Holistic Assessment of Urban System Resilience to Natural Disasters', 2017, available at: **www.researchgate.net/publication/320860065_Proposal_for_Holistic_Assessment_of_Urban_System_Resilience_to_Natural_Disasters**

Further reading

Climate Risk Assessment Guidance for Transport – A step-by-step approach to completing a CCRA for the UK transport sector

Global Risks Report 2024 – World Economic Forum outlines overarching risks that the world faces, including climate change

Lessons learned from extreme-weather emergencies on UK highways – DfT and the Local Government Technical Advisers – lessons from 2015 to 2020, covering all seasons of weather

National Risk Register 2025 – The National Risk Register outlines the most serious risks facing the UK

Prepare – Emergency preparedness and resilience information for the public and communities including transport specific information.

Responding to weather impacts on the railway – Network Rail – Information on risks to the railway network and their management

Sendai Framework for Disaster Risk Reduction 2015-2030 – United Nations Office for Disaster Risk Reduction has outlined priorities for global disaster risk reduction, introducing useful concepts for risk reduction at any level

UK Roads Leadership Group|UKRLG – Guidance on network management for the road sector

UNDRR-ISC Hazard Information Profiles – Comprehensive directory of hazards which can be used to consider risks to specific areas of transport