Indicators and trends

Monitoring climate change adaptation

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Indicator name				Version
BT12 Flood events affecting the railway network				**14/03/16**
Indicator type:	**Risk/opportunity**	**Impact**	**Action**	
		X		

SCCAP Theme	SCCAP Objective	CCRA risk/opportunity
Buildings and infrastructure networks	B1;B2; B3	FL8b Railways at significant risk of flooding

At a glance

- Climate change predictions suggest that flooding of rail infrastructure in Scotland will become more extensive and more frequent
- Flooding is one of two (wind is the other) high priority impacts in Network Rail's future weather resilience and climate change adaptation planning
- Flooding is the second most costly weather related impact to the rail network
- Between 2006 and 2014, rail disruption due to wind, flooding and snow (in that order) made up the sizeable majority of weather related costs to Network Rail. Other sources of weather related disruption (e.g. cold, heat, fog, earth-slip) were much less costly

Latest Figure	Trend
The annual average Schedule 8 costs of flooding impacts on the Scotland Route for 2006/07-2013/14: **£0.91M**. This is 18.2% of payments for all weather-related impacts.	

Why is this indicator important?

Transport supports many different social and economic functions. In 2013/14, 86.3 million passenger journeys were made by rail in Scotland which represents 16% of all public transport journeys. Rail patronage has increased by 35% since 2004/05 and constitutes a growing share of public transport journeys. In contrast, there has been a decline of 8.2% in the amount of freight (tonnes) lifted by rail between 2002/03 and 2012/13. The modal share of freight (in tonne-km) carried by rail in Scotland in 2010 was 7% (Transport Scotland, 2014).

Flooding of rail infrastructure can cause disruption to rail transport with knock-on consequences for these functions – e.g. preventing or delaying people from reaching work, delaying rail freight. Climate change predictions suggest that flooding of rail infrastructure will become more extensive and more

frequent. Tracking this indicator will therefore provide some insight into the flooding impacts of climate change to the rail network.

Related indicators:
BT8 Railway network at risk of flooding
BT9 Disruption risk to railway services as a result of flooding
BT16 Rail network benefitting from flood protection measures

What is happening now?

The Scotland Route Weather Resilience and Climate Change Adaptation Plan (WRCCAP) (Network Rail, 2014) includes details of Schedule 8 costs[1] attributed to weather for eight financial years covering the period 2006/07-2013/14. Schedule 8 costs provide a proxy for weather related impacts (including flooding) to the rail network. Network Rail incur flooding related Schedule 8 costs due to delays caused by fluvial, pluvial, groundwater and tidal (coastal) source flooding of rail assets. The total Schedule 8 costs for all weather related disruption during the period 2006/07-2013/14 are shown on Figure 1.

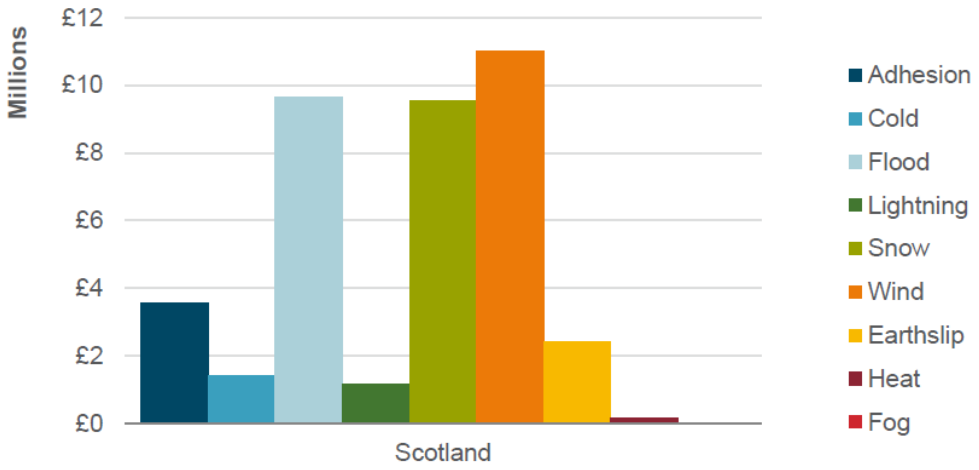

Figure 1 Total weather attributed Schedule 8 costs on the Scotland Route 2006/07-2013/14

(Source: Network Rail, 2014)

The total Schedule 8 costs for flooding related weather impacts during this period were approximately £9.8M. Flooding was the second most costly impact behind wind and was slightly more costly than snow. Together wind, flooding and snow were the three most costly weather impacts for the Scotland Route by some margin (ibid). The annual average costs of flooding related Schedule 8 payments were £0.91M. Over the past eight years, the annual average Schedule 8 costs to the

[1] Schedule 8 of the Track Access Agreement between Network Rail and passenger and freight train operators provides for compensation payments to operators for unplanned service delays and cancellations (Office of Rail Regulation, 2015). These compensation payments are intended to protect operators from risks beyond their control. Compensation payment rates are determined in advance using a set formula. Compensation payments are made when Network Rail's performance "diverges from a benchmark number of minutes of lateness" (para 20.13) and "payment rates are set at a level to reflect the impact over time of performance on fare revenue" (para 20.15) (Office of Rail Regulation, 2013).

Scotland Route as a result of all weather related impacts was £5M (ibid), with flooding related payments accounting for almost a fifth of annual average costs across all impacts.

What has happened in the past?

It was not possible to obtain Schedule 8 payment data disaggregated by year in order to assess this indicator over time. However historic climate data shows how key aspects of climate (rainfall) have changed leading to impacts on biophysical systems (e.g. hydrological response of Scotland's catchments and watercourses) and ultimately changes to the scale and magnitude of relevant climate risks (i.e. risk of rail network flooding). Overall there is a clear upward trend in winter precipitation as well as increasing heavy rainfall in winter (Sniffer, 2014). It is expected that these climatic changes will have contributed to increased frequency and extent of pluvial and fluvial source flooding and associated impacts on the rail network.[2]

What is projected to happen in the future?

The UK Climate Change Risk Assessment (HR Wallingford et al, 2012a; Thornes et al, 2012) assessed changes in flood risk to rail infrastructure as a result of anticipated climate changes. Whilst this assessment was only undertaken for England and Wales (due to data availability) it provides a broad indication of what might happen in Scotland in the future given anticipated climate changes. As such, transport specific aspects from the UK CCRA can be used in conjunction with general aspects from the Scotland CCRA (HR Wallingford et al, 2012b) to understand how flooding related impacts to rail infrastructure might change in the future.[3]

In terms of potential future flooding related climate risks to rail infrastructure, the results of the CCRA for England and Wales indicated that the projected length of railway at significant likelihood of flooding (where significant is defined as a 1.3% annual probability) would be between 2,000km and 2,600km by 2020 compared with a baseline of about 2,000km (Thornes et al, 2012). This equates to a possible increase of between 0% and 30% with the range reflecting the different climate change (emissions) scenarios considered in the assessment. The CCRA also highlighted how in addition to an increase in the overall length of infrastructure that could be affected, the frequency of flooding of infrastructure that is already located in the floodplain is expected to increase (ibid). These projections do not account for any actions that could be taken to alleviate flood risk to railways (e.g. flood defence infrastructure, enhanced maintenance regimes) which may help to reduce overall flood risk (noting that these type of actions are addressed in related indicator BT16). Whilst these projections are focussed on England and Wales (and therefore the specific regional climate projections and rail network issues and configuration therein), they provide a useful proxy of what may happen in Scotland.

In summary therefore the following projected changes are anticipated to take place in the future:

- The proportion of the rail network located in areas at risk of flooding is projected to increase.
- Rail infrastructure that is already located in the floodplain is expected to be affected by flooding more frequently.
- Increased incidence of intense summer rainfall events may result in more frequent pluvial (surface water) flooding.

[2] A fuller account of historic climate trends is provided in indicator BT2

[3] Indicator BT2 provides a more detailed description of the assessment in terms of climate projections and associated impacts on biophysical systems (the precursor of risks and impacts to socio-economic systems).

The possible future changes listed above all have the potential to cause increased flood events on the rail network (and therefore an increase in flooding related Schedule 8 payments too). With reference to UKCP09 climate projections, the Scotland Route WRCCAP highlights flooding as one of two (wind is the second) high priority impacts for consideration in future weather resilience and climate change adaptation planning: *"…flooding events will increase in frequency and intensity, and presents increased risk to the Scotland Route over the coming decades"* (Network Rail, 2014 p.20).

Patterns of change

No patterns of change have been identified.

Interpretation of indicator trends

No trends identified due to lack of historic payment data disaggregated to financial year.

Limitations

There are several key limitations to the assessment as summarised below:

1. This indicator adopts a proxy approach relying on data collated as part of the Schedule 8 payments regime. Whilst the approach is valid it is very specific to the rail industry and Network Rail's management of the rail network. To facilitate comparison with climate risks and impacts to other transport modes it would be useful to have absolute as well as proxy data (e.g. number of flood events, duration of line closure or speed restrictions).
2. Schedule 8 payments are designed to compensate operators for the financial impact of unplanned disruptions and to ensure that the impact of service disruption is placed on the organisation which is responsible for the disruption. These payments serve a separate purpose from passenger compensation arrangements for delay (Office of Rail Regulation, 2013). Future iterations of this indicator could include a metric on compensation payments if these can be directly attributed to the cause of disruption.
3. It was not possible to source Schedule 8 payments data disaggregated by financial year. Time series data of this nature is critical to enable this indicator to track flood events over time and to identify any trends in observed flooding related climate impacts to the rail network.
4. It was not possible to source spatial data on flood events affecting the rail network (i.e. the sites of flooding related disruption that have led to Schedule 8 payments being made). Spatial data would be useful to track any regionalised consequences of climate change in terms flood events affecting the rail network. Future iterations of the indicator may wish to obtain spatial data on Schedule 8 payments and undertake a regional assessment of BT12 (e.g. Local Plan Districts, Potentially Vulnerable Areas, catchments) to explore the degree to which climatic differences across Scotland might result in regionalised effects.
5. The Scotland Route WRCCAP (Network Rail, 2014) is the data source for the assessment of this indicator. From discussions with Network Rail (McLuskey, 2015), it is apparent that there will be a follow-up to the WRCCAP at some point but timescales have not yet been set. This is a risk for future iterations of this indicator given potential uncertainty accessing data. For future iterations it may be preferable to obtain the primary Schedule 8 payments data – this may also help to address points (2) and (3) above.

6. It should be noted that Schedule 8 rates and performance benchmarks were updated in Control Period 5 which runs from 1st April 2014 to 31st March 2019 (Office of Rail Regulation, 2013). This means that there will be a discontinuity in the data between the time period used in this indicator (2006/07) and future iterations of this indicator.

References

HR Wallingford, AMEC Environment and Infrastructure, The Met Office, Collingwood Environmental Planning, Alexander Ballard Ltd, Paul Watkiss Associates, & Metroeconomica (2012a). *UK Climate Change Risk Assessment* [online]. Available at: https://www.gov.uk/government/publications/uk-climate-change-risk-assessment-government-report [accessed 22/05/15]

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Further information

ClimateXChange (2016) Adaptation to Climate Change: Context and Overview for Transport Infrastructure Indicators. Available online at: http://www.climatexchange.org.uk/adapting-to-climate-change/indicators-and-trends/

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Appendix One: Indicator metadata and methodology

Table 1: Indicator metadata

	Metadata
Title of the indicator	BT12 Flood events affecting the railway network
Indicator contact: Organisation or individual/s responsible for the indicator	ClimateXChange
Indicator data source	Network Rail Scotland Route Weather Resilience and Climate Change Adaptation Plan (WRCCAP)
Data link: URL for retrieving the indicator primary indicator data.	http://www.networkrail.co.uk/publications/weather-and-climate-change-resilience/?cd=5

Table 2: Indicator data

	Indicator data
Temporal coverage: Start and end dates, identifying any significant data gaps.	The data used in this assessment of BT12 covers eight financial years: 2006/07 – 2013/14
Frequency of updates: Planned or potential updates	Unknown at present – see limitations
Spatial coverage: Maximum area for which data is available	Scotland Route-wide
Uncertainties: Uncertainty issues arising from e.g. data collection, aggregation of data, data gaps	
Spatial resolution: Scale/unit for which data is collected	
Categorical resolution: Potential for disaggregation of data into categories	N/A given current format of the data
Data accessibility: Restrictions on usage, relevant terms & conditions	WRCCAP is publically available online

Table 3 Contributing data sources

Contributing data sources Data sets used to create the indicator data, the organisation responsible for them and any URLs which provide access to the data.
Scotland Route weather attributed Schedule 8 costs as presented in the WRCCAP

Table 4 Indicator methodology

Indicator methodology The methodology used to create the indicator data
Data can be readily obtained from the Scotland Route Weather Resilience and Climate Change Adaptation Plans – the WRCCAP (Network Rail, 2014). There is no methodology as such for BT12 beyond downloading the WRCCAP and liaising with Network Rail to obtain any updates. This section provides an introduction to the general approach adopted in BT12 and lists the metrics obtained from the Scotland Route WRCCAP. *Introduction to the approach* Network Rail monitors the impact of weather on the rail network using rail performance data (services on time, services delayed etc.) as a proxy. Specifically, Schedule 8 costs – the compensation payments made to train and freight operators for rail network disruption – are seen to provide effective proxies for weather impacts due to the variety of causes of disruption monitored (ibid). The impacts covered within the Schedule 8 regime are as follows: 1) wind; 2) flooding; 3) snow; 4) adhesion; 5) earthslips; 6) heat; 7) sea level rise; 8) cold; 9) lightning; and 10) fog. A key purpose of the Schedule 8 regime is to compensate train operators for the financial impact of poor performance of the rail network, including as a result of weather related impacts (Network Rail, 2013). Thus these weather-attributed Schedule 8 costs may be used as a proxy for climate change impacts to the rail network over time. The WRCCAP is split into four main components: 1) strategy; 2) vulnerability assessment – vulnerability to key weather and climate related risks including consideration of resilience actions; 3) impact assessment – analysis of observed weather and climate related impacts to the rail network during preceding years; and 4) adaptation actions – action plan to address vulnerability to general and specific weather and climate related risks and impacts. The data used to assess BT12 is extracted from the impact assessment section of the WRCCAP which includes details of Schedule 8 costs for all weather related impacts considered. *Metrics assessed under BT12* ***Box 1. Metrics assessed under indicator BT12*** • **Metric No.1:** Total Schedule 8 costs of flooding impacts for WRCCAP period reported • **Metric No.2:** Annual average Schedule 8 costs of flooding impacts for WRCCAP period reported