MODELLING THE IMPACTS OF CLIMATE CHANGE ON CITIES: ECONOMIC COSTS OF RAIL BUCKLE EVENTS

ARCADIA FACTSHEET 9
Contact: jim.hall@eci.ox.ac.uk katie.jenkins@ouce.ox.ac.uk

As the effectiveness of a cities transport system is central for business, employees, and economic competitiveness damage to the system could be severe and far-reaching. In the UK high temperatures can directly damage railway lines due to buckling. This factsheet outlines a method for estimating the frequency of future buckle events under climate change. Economic costs of rail buckles are estimated and benefits of improved rail infrastructure assessed.

Context

- Railway networks are associated with an increased occurrence of rail buckling during high temperatures.
- A buckle can be defined as a track misalignment serious enough to cause derailment, which can be caused by forces produced by the metal expanding under high temperatures and by subsequent disturbance caused by a train.
- Speed restrictions are introduced when certain temperature thresholds are passed to reduce the risk of derailment.
- Theoretically, well maintained track should not be vulnerable to buckling up to ambient temperatures of ~39.3°C. However, severe buckles have been reported to occur when the maximum daily temperature is over 25°C.
- The majority of severe events occur over 27°C in London and the South-East, suggesting that track is of poorer condition.
- During the 2003 summer heatwave 137 buckle events were reported, at a cost of ~£2.5 million for repairs and delays. Extensive buckle related delays were also seen during the 2006 heatwave event.

Method

- The study provides an assessment of the number of days when one or more buckle events could occur in the study area and associated repair costs.
- Spatial temperature data from the urban spatial Weather Generator is used to facilitate an analysis of rail buckling under future climate change.
- Based on a study of historic buckle events and the corresponding temperature at the Heathrow weather station, it is assumed that buckle events could occur across London where daily maximum temperature (TMax) exceeds 27°C (fig. 1).
- The probability of one or more buckle events occurring on a day when the temperature threshold is passed is estimated based on published studies.
- The cost of repairs following a rail buckle are estimated as £10,000 per buckle.

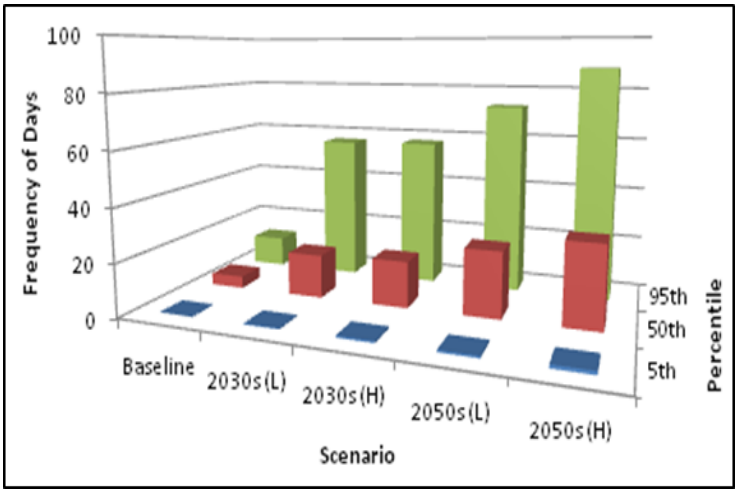

Fig. 1: The annual frequency of days which exceed 27°C at the grid cell corresponding to Heathrow for the baseline, 2030s and 2050s time periods and high (H) and low (L) emission scenarios. Results are provided at the 5th, 50th, and 95th percentile, reflecting the range of results provided by the urban spatial Weather Generator

Frequency and costs of rail buckle events

- Rail buckle events were projected to increase in frequency under all climate change scenarios compared to the present day.
- For the present day 11 to 13 buckle events are expected on average per year in the study area.
- For future time periods the study suggests that the annual number of events could increase to 56 to 70 events by the 2050s (low and high emission scenarios respectively, median results).
- Economic damages were projected to increase from £119,000 (baseline) to between £427,000 to £445,000 by the 2030s and £562,000 to £696,000 by the 2050s (low and high emission scenarios respectively, 50th percentile) (fig. 2).

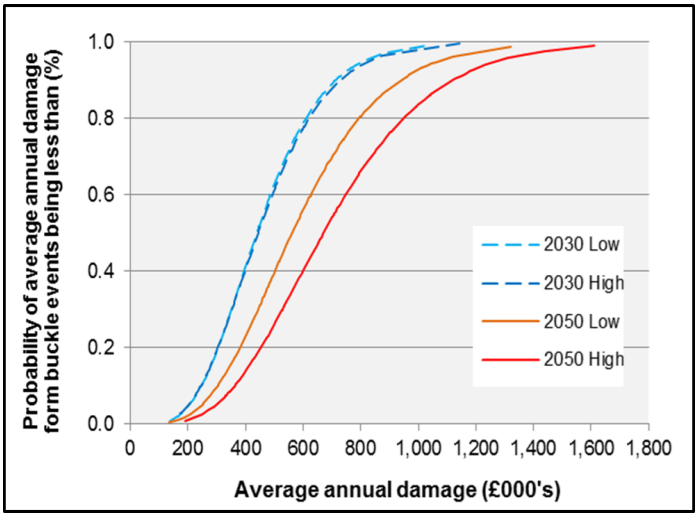

Fig. 2: Estimated average annual damage from rail buckle events for a range of climate scenarios.

Adaptation options to reduce rail buckle costs

- Given that the rail networks capacity is also set to increase there is a real need to invest and upgrade track to increase the resilience to high daily temperatures and heatwave events.
- It is stated that well maintained track should not be vulnerable to buckling up to ambient temperatures of approximately 39.3°C.
- Therefore, increased investment in the quality of track and repair and maintenance is one key mechanism to reduce risk.
- The potential cost benefits of upgraded track conditions are estimated by repeating the above methodology but increasing the TMax threshold to 31.3°C to represent moderate track conditions, and 39.3°C to represent good track conditions.
- The analysis highlights significant potential for improved track conditions to reduce buckle frequency and economic damages (fig. 3).
- Under the assumption of moderate track conditions a reduction in average annual damages of between 21 to 48% are seen in the 2030s, compared to estimates assuming poor track conditions.
- Damages are reduced by between 9 to 35% and 7 to 25% for the 2050s low and high emission scenario respectively.
- For the 2030s if it is assumed all track is of good quality no damages from buckle events are seen.
- For the 2050s good track quality results in large declines in average annual damages compared to the poor track scenario.
- For all scenarios if track conditions in the study area were of good quality then future average annual damages would be lower than the damages seen in the baseline period
- This highlights the potential economic benefits which could be gained.
- This will be particularly beneficial on key commuter routes to reduce impacts in terms of repair costs and commuter delays.

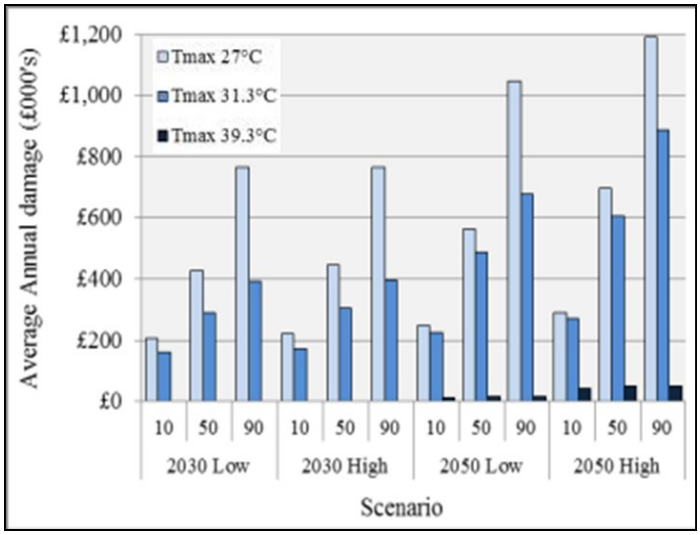

Fig. 3: Impact of track conditions on average annual damage from rail buckle events for poor track (TMax 27°C), moderate track (TMax 31.3°C), and good track (Tmax 39.9°C), for a range of climate scenarios.

For additional information see:

- ARCADIA website: www.arcc-cn.org.uk/project-summaries/arcadia/
- ARCADIA Factsheets 2 and 4