ANALYSING THE POTENTIAL FOR CLIMATIC EXTREMES TO DISRUPT URBAN TRANSPORT SYSTEMS: TRANSPORT MODEL

ARCADIA FACTSHEET 4

Contact: alistair.ford@newcastle.ac.uk

Extreme weather events can have an impact on public transport systems, directly through damage to roads or track infrastructure or indirectly due to speed restrictions imposed for safety reasons. In order to understand these impacts better, a spatial model of network disruption has been developed in ARCADIA. This factsheet examines the effects of heat on rail infrastructure and the cost of these effects in terms of disruptions to commuter journeys in London.

Context

- Extreme temperatures can cause damage to railway infrastructure through expansion of the rails and associated buckling.
- The extent of impacts will be dependent on the spatial pattern of the temperature, the maximum temperature reached, the spatial configuration of the transport network, and the condition of the railway lines themselves.
- Not only is direct damage costly to repair but it can also cause extensive disruption to commuter journeys due to imposed speed restrictions outlined by rail maintenance authorities for health and safety purposes.
- Disruption to services can also result in costly fines and compensation payments for rail operators.
- To understand the full implications of weather events on the transport network increased journey time resulting from reduced speeds on the network must be determined in conjunction with the number of passenger journeys impacted.
- Passenger delay minutes can then be quantified and monetised to provide a more comprehensive picture of economic costs.

The Transport Model

- In ARCADIA, a new transport model was developed to simulate the number of passengers using each part of the transport network for their daily journey to work.
- The transport model is GIS-based. It utilises publicly available data to construct and represent transport networks in London.
- The networks represent private car journeys on roads and trips by public transport on rail, light rail or bus.
- Observed or modelled flows of people across the city can be mapped onto the transport network based on the shortest routes between areas of residence and employment.

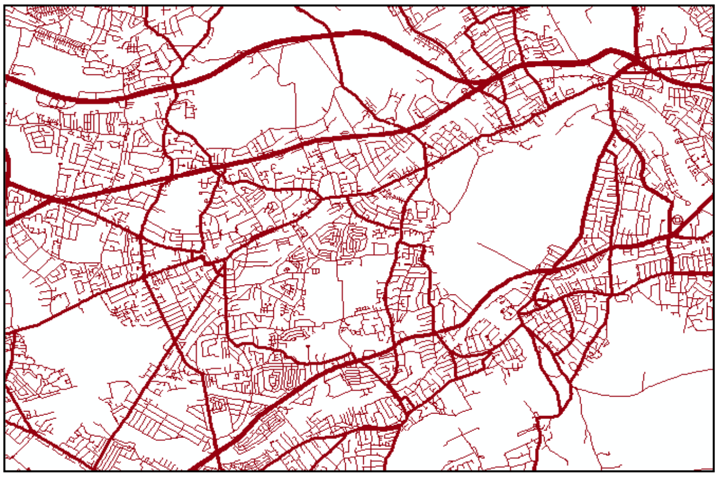

Fig. 1: A section of the road network within the ARCADIA transport model. The thickness of lines denotes the capacity of each road in vehicles per hour

- Network capacity is also included (fig.1) to capture any congestion on the networks.
- Congestion will be important when weather related disruption causes people to look for alternative routes for their journey to work.
- Any resultant congestion can further reduce journey times adding to delays in addition to those directly caused by weather events.

Linking heat events and speed restrictions

- In order to calculate the cost of commuter disruption following extreme heat events the spatial pattern of temperature and the railway infrastructure must be examined together.
- Speed restrictions are imposed when track temperatures reach a given threshold, as determined by railway maintenance authorities, and based on track conditions (table 1).
- The temperature thresholds are applied to output from the Urban Spatial Weather Generator (described in ARCADIA Factsheet 3) (fig. 2).
- A range of different time-periods and emission scenarios can be analysed to assess the probability of each threshold being exceeded on any given day, and the associated speed restrictions which would be imposed on the transport network.

Threshold	Speed restriction
<27°C	None
Poor Track ≥ 27°C < 28°C	30mph
Poor Track ≥ 28°C	20mph
Moderate Track ≥ 33°C <35°C	60mph
Moderate Track ≥ 35°C	20mph
Good Track ≥ 36°C	90mph
Good Track ≥ 42.6°C	60mph

Table 1: Thresholds of maximum external air temperature at which effects start to be felt on rail networks in the UK. For poor track condition impacts can occur at relatively low temperatures which are projected to be surpassed with higher frequency under future climate conditions.

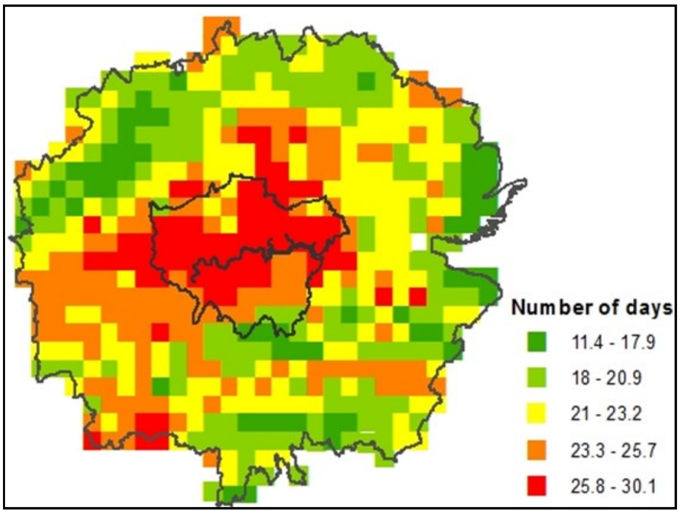

Fig. 2: A spatial map showing the annual number of days when maximum temperature exceeds 27°C in Greater London and the surrounding region (for the 2050s under a high emission scenario)

Modelling transport disruption and commuter delays

- Based on the thresholds outlined above spatial maps of daily heat events and their equivalent impact on railway speeds can be linked to the transport model.
- By overlaying this data onto the railway network the disruption to commuter journeys, and propagation of these impacts over time, can be modelled (fig. 3).
- The total impact in terms of delay minutes for each event day can be calculated for each scenario and different levels of track condition.
- Passenger delay minutes can be converted to economic costs and different scenarios compared.
- The spatial transport model allows the wider impact of heat-related speed restrictions on journey times to be examined for London and the wider region.
- Key infrastructure vulnerabilities can be identified, highlighting the transport links whose failure would cause the largest commuter disruption and costs.

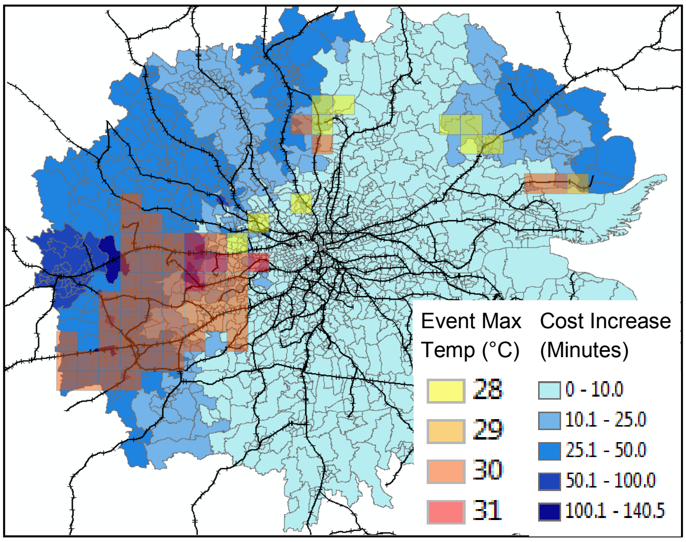

Fig. 3: An example disruption output for the public transport network for one extreme heat event day. The increased journey costs (in terms of time) resulting from heat speed restrictions can be seen.

For additional information see:

- ARCADIA website: www.arcc-cn.org.uk/project-summaries/arcadia/
- Newcastle University CESER Website: www.ncl.ac.uk/ceser/researchprogramme/informatics/transportanalysisforclimateimpactassessment/