Quantifying the impact of heat and climate change on London Underground's infrastructure

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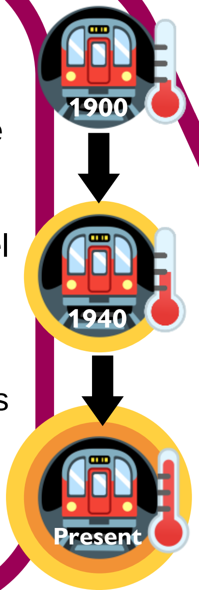
1 Heat on the tube: a background

The London Underground is the world's oldest metro network; owned and operated by Transport for London (TfL). Temperature is the second biggest climate risk after precipitation on the network[1]. The "deep tube" tunnel environment is a particular challenge, as tunnel walls absorbed heat over 100+ years due to legacy design and operation[2]. Research suggests that as temperatures deviate from climatological norms, railway asset failure rates increase[3-5]. Heat-related challenges such as thermal discomfort have been studied on the London Underground network[6], but less research exists related to its infrastructure.



2 Methodology

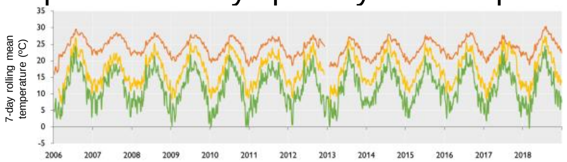
There were three main objectives of this study:

1. Distinguish changes and differences in the thermal environment across the London Underground network.
2. Investigate and interrogate the relationships between asset faults (switches/points) and thermal environment.
3. Estimate future asset failures under selected future UK climate scenarios (RCPs 6.0 & 8.5, 90th percentile[7]).

Weather/climate data were collected for 2006-2018[8-9]. TfL provided tunnel temperature and asset fault data. Daily min, mean, max and diurnal temperature were analysed.

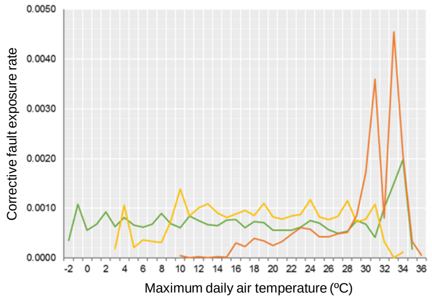
3 The thermal environment

Surface, sub-surface and deep tube tunnel temperatures vary spatially and temporally.



4 Fault exposure rates

Switch/point fault asset data were normalised and joined to daily temperature data variables to produce fault exposure rates[4] by operating line, section of the network, and type of fault. A tunnel temperature estimation model was developed to fill data gaps in sub-surface and tunnel temperature data[10]. Signals of failure harvesting[3,11] before peak summer temperatures were also detected.



5 Future climate change

Using fault exposure rates and climate projection data, total annual switch/point faults were estimated for the 2050s and 2080s. Under similar future operational conditions, climate change is estimated to **increase faults by up to 10%** by the 2080s. Increases are mainly on the surface and in tunnels.

6 Discussion and conclusion

Three key outcomes of this study were:

1. TfL should continue **consolidating databases and data platforms** to improve transparency, analytical capacity and streamline pan-TfL operations.
2. TfL should improve and extend **internal and external stakeholder relations** to help plan for climate change.
3. TfL should begin its **adaptation pathway planning** process on the basis that points 1 and 2 address capacity growth opportunities.

TfL recently published its first adaptation plan[12], which is welcome progress in developing an iterative climate change planning process.

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