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Assessing the need for infrastructure adaptation by simulating impacts of extreme weather events on urban transport infrastructure

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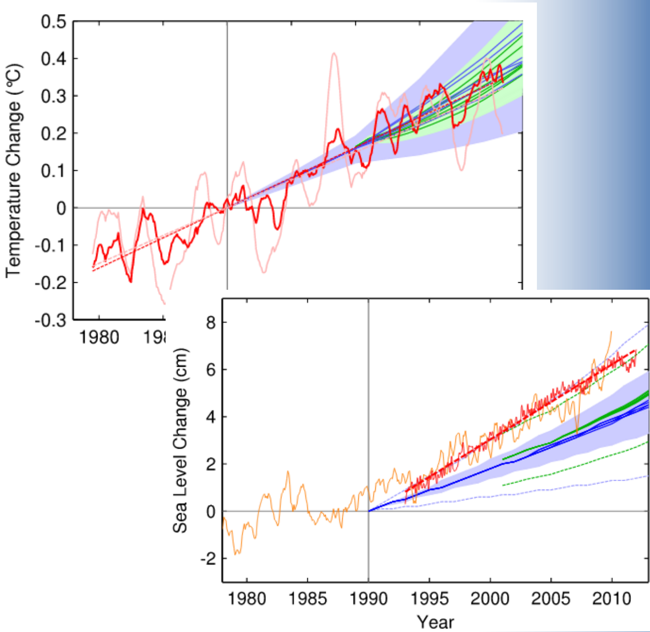
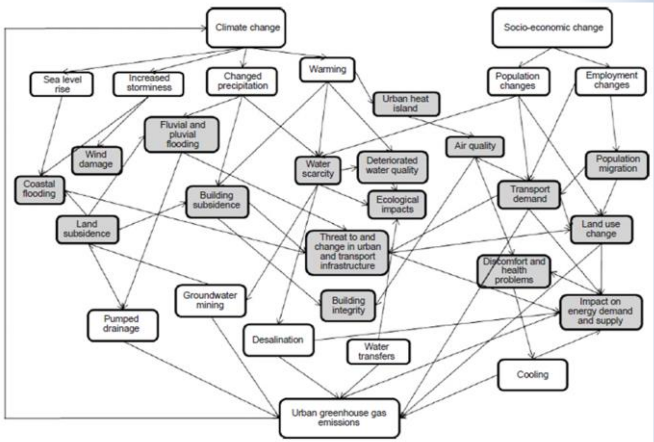
Introduction

- Climate change is already underway
  - Current emissions leading to 2° rise
  - Mitigation will not halt this
- Urban infrastructure under pressure
  - Increased climate extremes
  - Socio-demographic pressures

    (IPCC 5th Assessment WG2)
- Decision-makers must consider adaptation
  - Spatially-explicit
  - Potential trade-offs, co-benefits
  - Multi-sector
  - Not sacrificing mitigation



(Rahmstorf et al, 2012)



(Walsh et al, 2011)

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Calculating Adaptation Costs

- Baseline Costs:

Damage Cost of Climate Event without Adaptation

- Adaptation Costs:

Damage Cost after Adaptation **+** Cost of Implementing Adaptation **-** Co-benefits from Implementing Adaptation

- Baseline costs will change due to non-climate change

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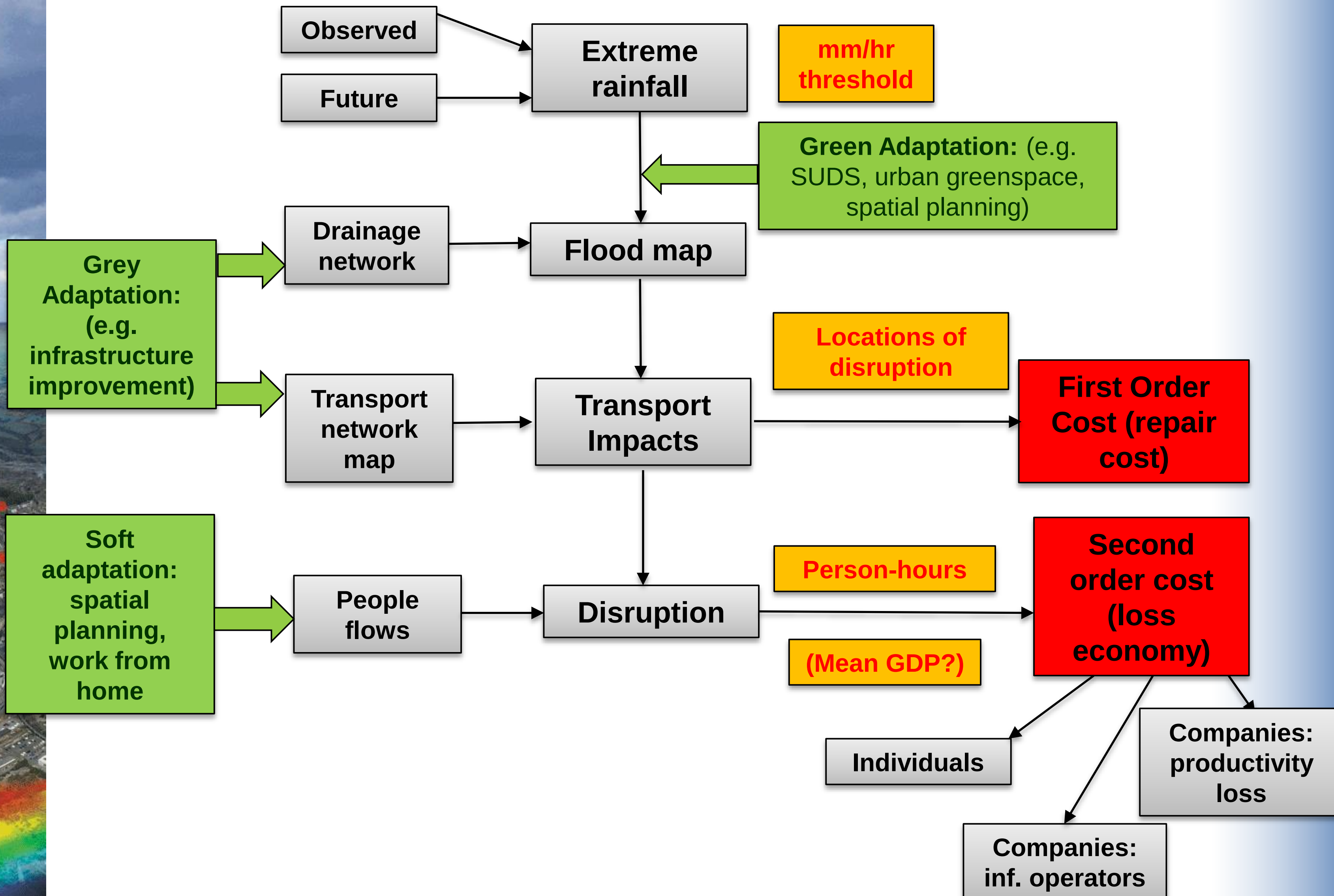
Calculating Adaptation Costs: flooding



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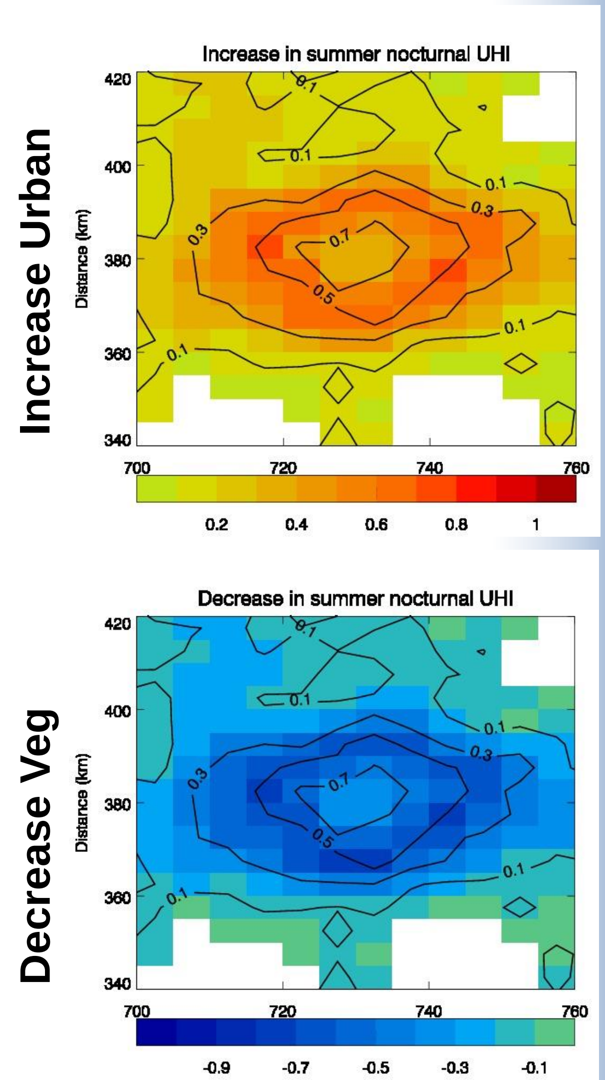
Hazard Modelling

- Built on UKCP09
- Spatially-consistent outputs
  - Rainfall
  - Temperature
- Regional Climate Model + Urban Change Factors
  - Anthropogenic effects
  - 42% of winter night-time heat
- Daily time series on 5km grid



McCarthy et al, 2012

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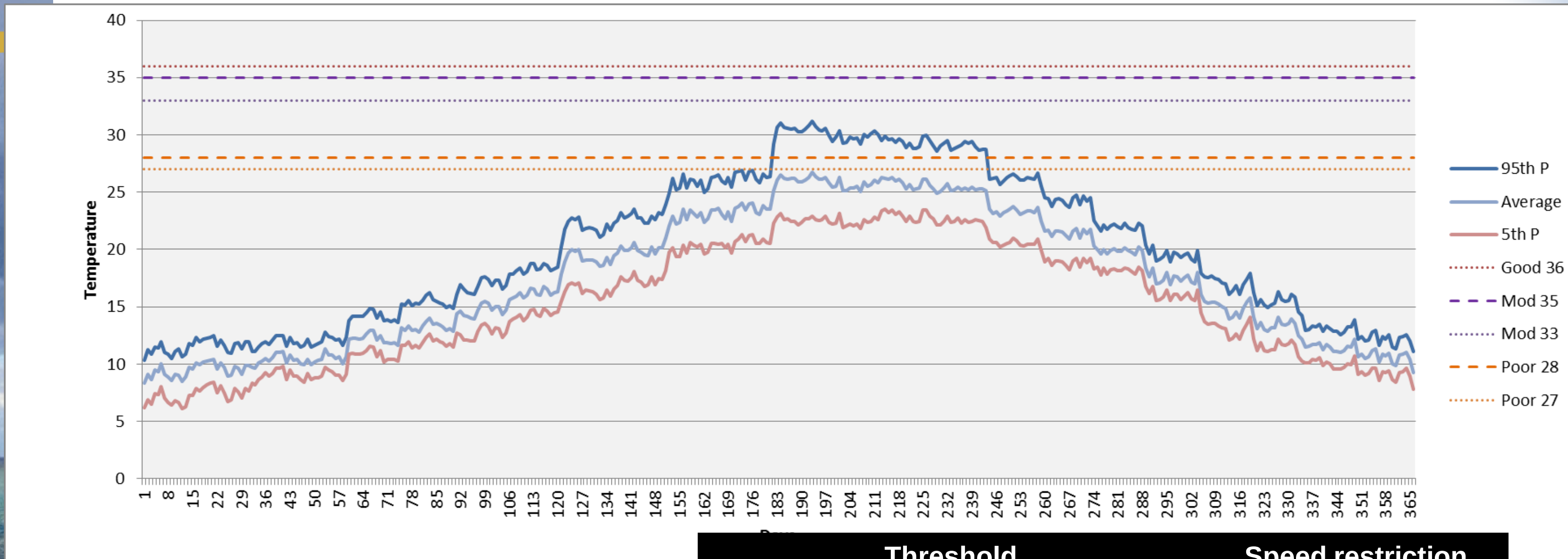
Heat Impacts on Railways

(After Dobney et al., 2009)



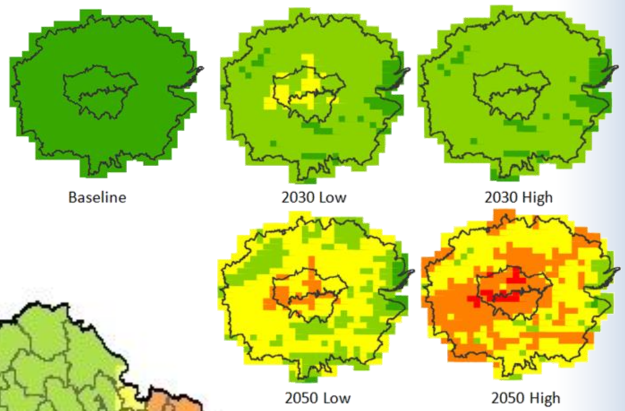
Time-series data for a single grid cell for the average, 5th, and 95th percentile values for daily Tmax

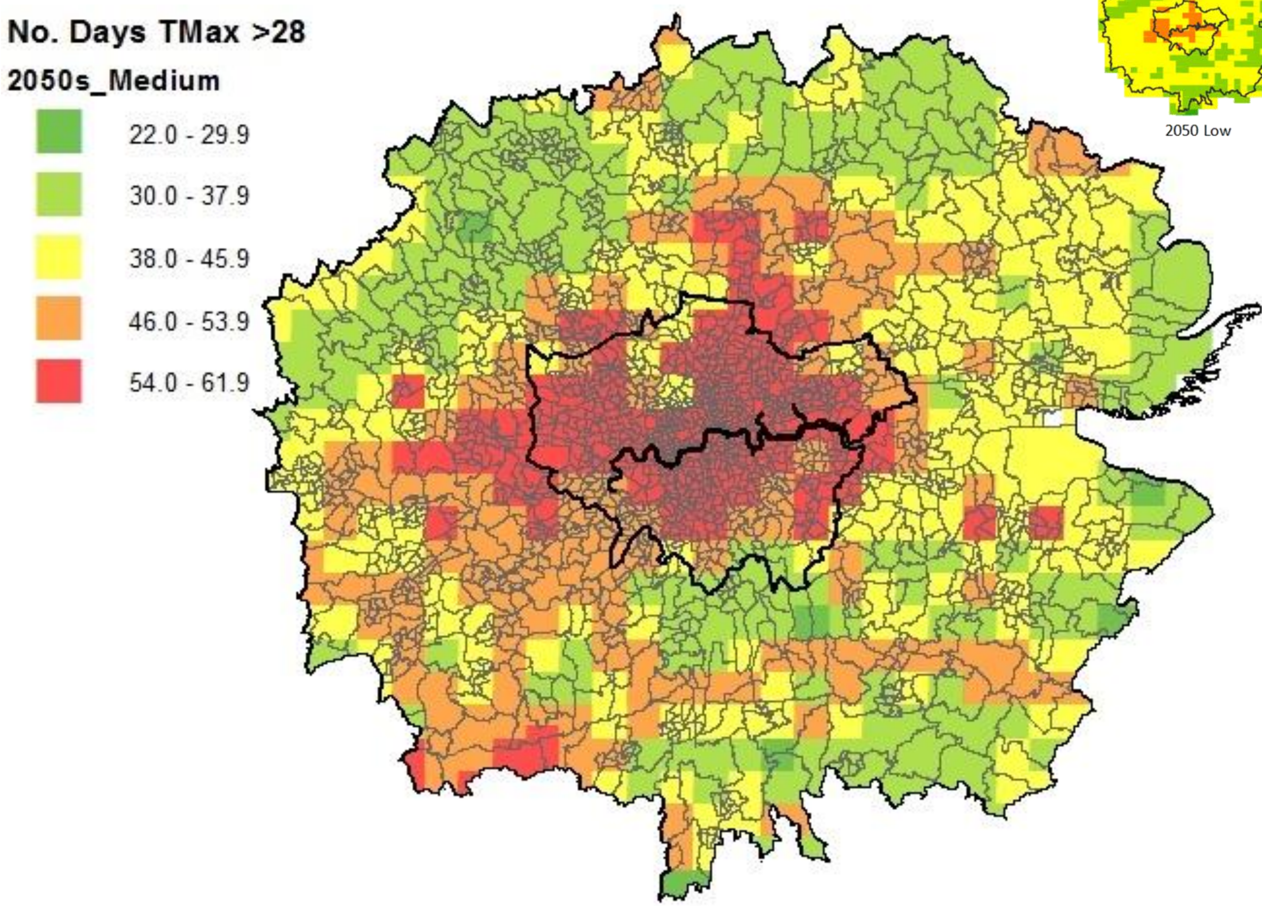
(Orange lines = poor track thresholds of 27° C and 28° C; purple lines = moderate track thresholds of 33° C and 35° C; and red line = Good track threshold of 36° C)

Threshold	Speed restriction
<27°C	None
Poor Rail Track ≥ 27°C < 28°C	30mph
Poor Rail Track ≥ 28°C	20mph
Moderate Rail Track ≥ 33°C <35°C	60mph
Moderate Rail Track ≥ 35°C	20mph
Good Rail Track ≥ 36°C	90mph
Good Rail Track ≥ 42.6°C	60mph
Tube Lines ≥ 33°C <36°C	30%
Tube Lines ≥ 36°C	50%

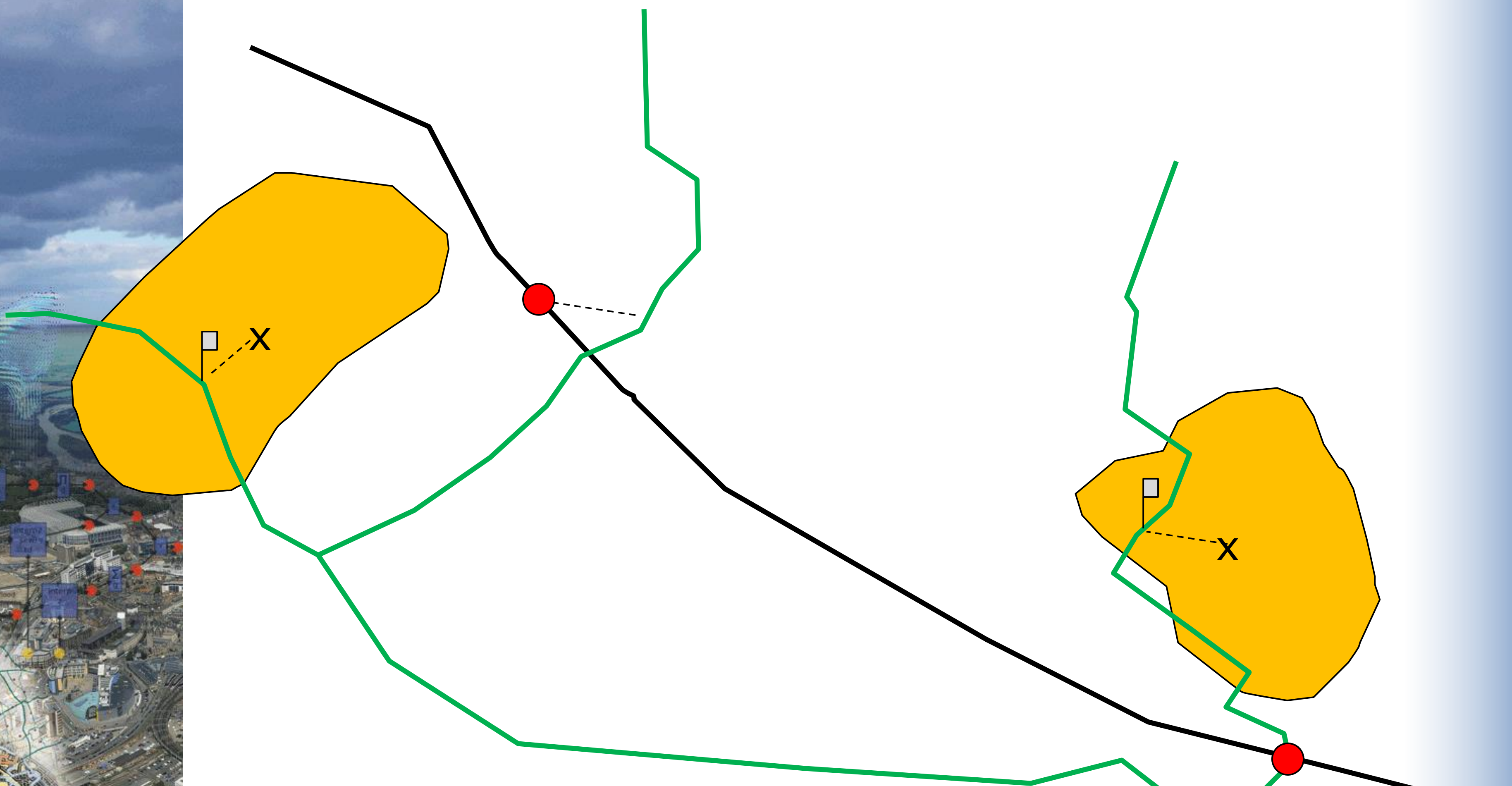
Spatial patterns

- Ensemble of 100 x 30 yr daily runs





Disruption to Transport Networks

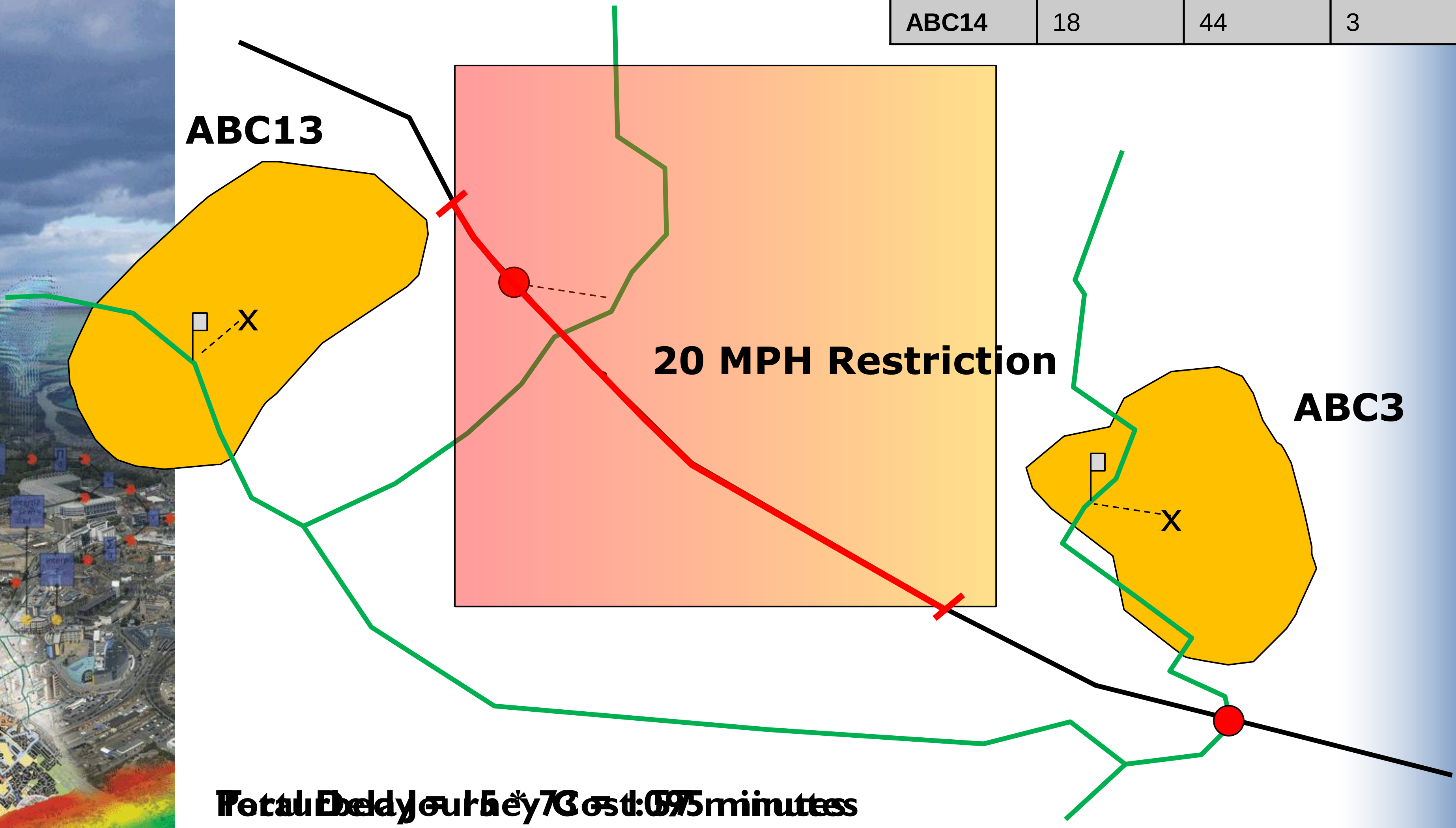


Baseline Journey Cost: 42 minutes

4 min walk + 6 min bus + interchange +12 minute train + interchange + 4 min bus + 3 min walk + tickets

Disruption to Transp

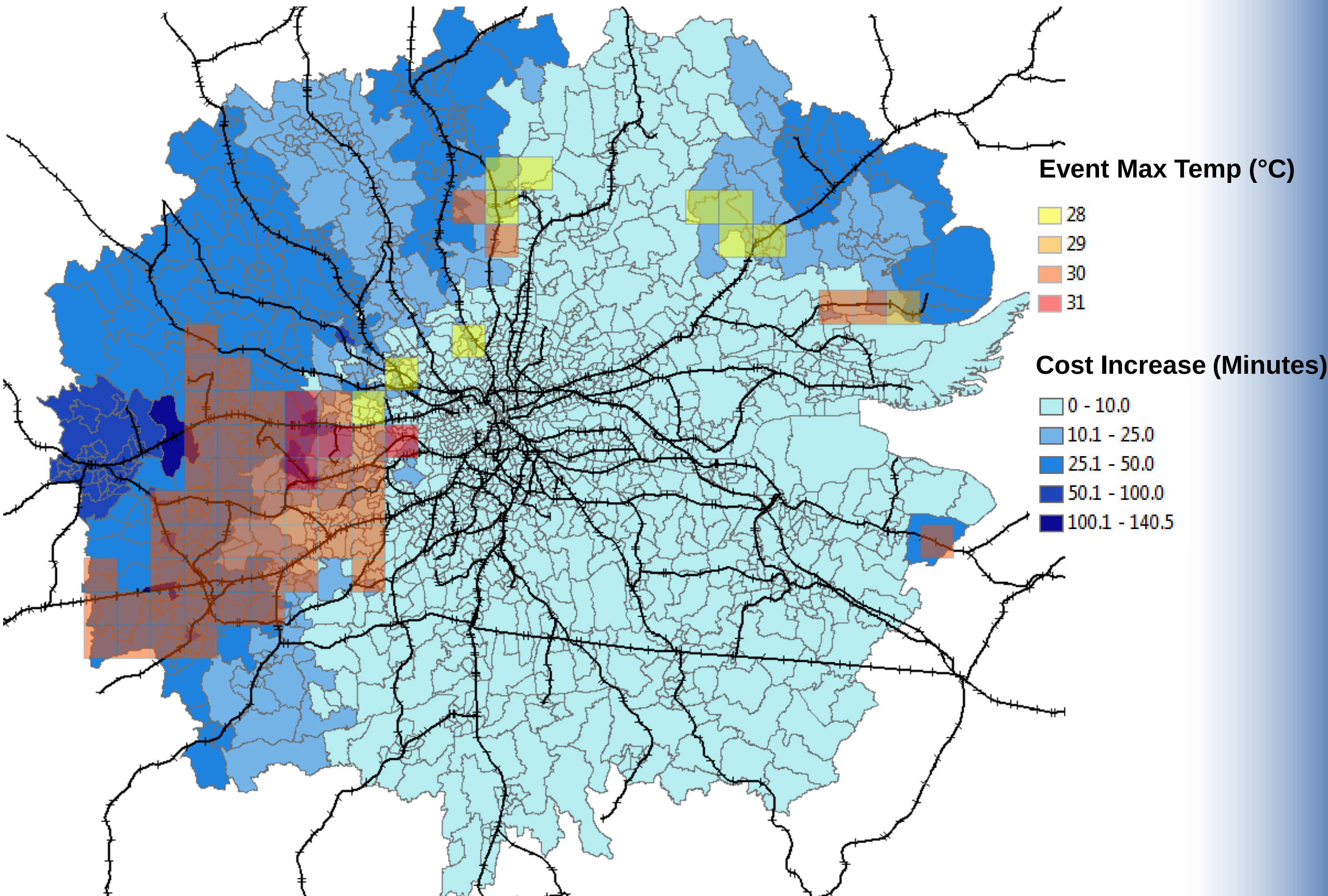
Orig/Dest	ABC1	ABC2	ABC3
ABC12	0	25	171
ABC13	32	9	73
ABC14	18	44	3



Total Delay = 5 * 7 = 35 minutes

Perturbed Journey Cost: 1[illegible] minutes

Disruption Example



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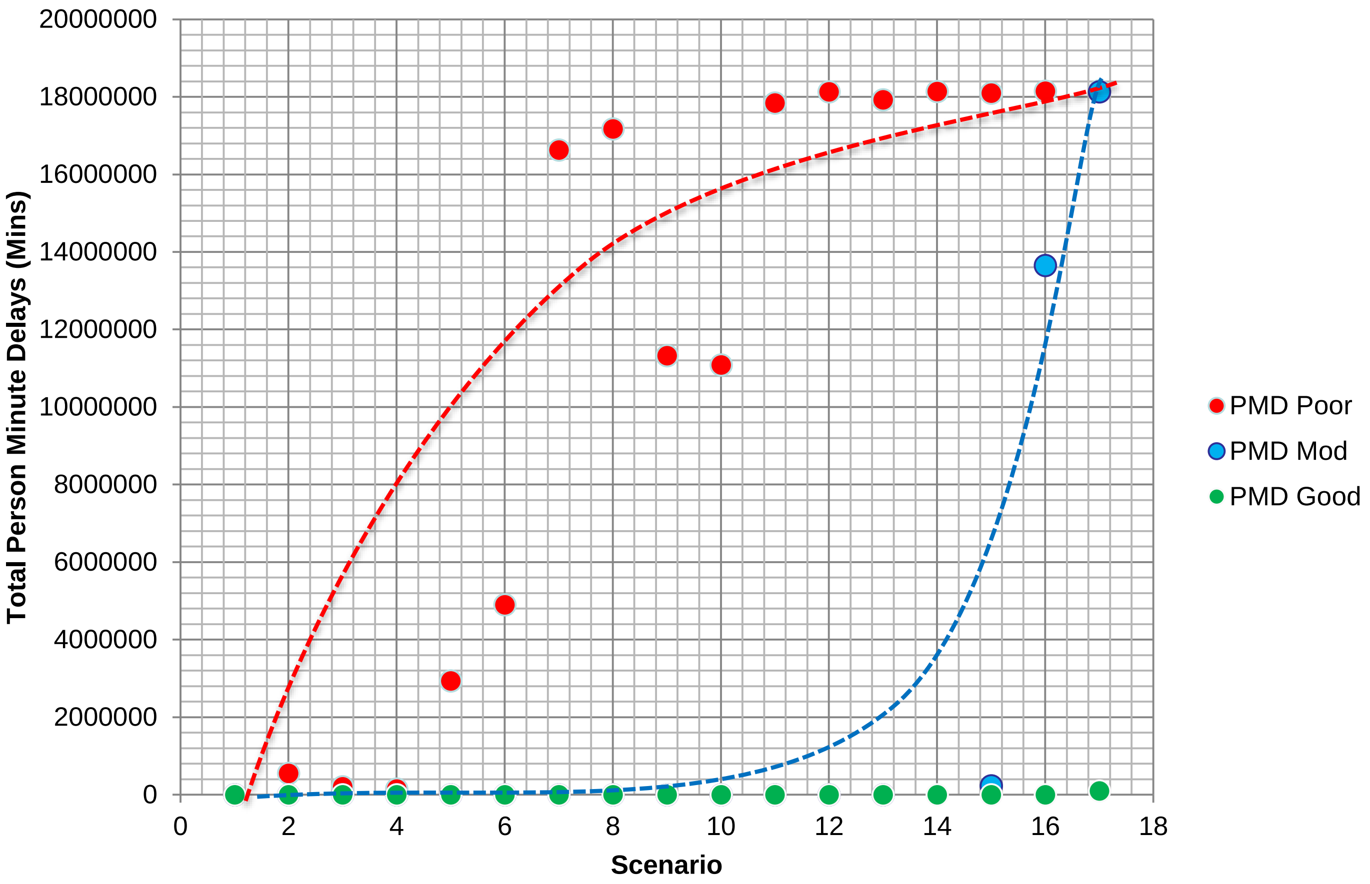
Direct Impacts: Passenger Delays

- Delays to commuters from speed restrictions



Flooding Impacts on Roads

- Vehicles easily affected by floodwater
- Cars are unstable in as little as 0.5 metres of still water
  - Depth decreases as water velocity increases
- Little guidance on driving during floods in the UK
  - No advice in ‘The Highway Code’
  - No advice from Environment Agency
  - Motorists often unaware of the risks
- Water depth of 0.25m is unsafe

  (Green Flag, 2014)

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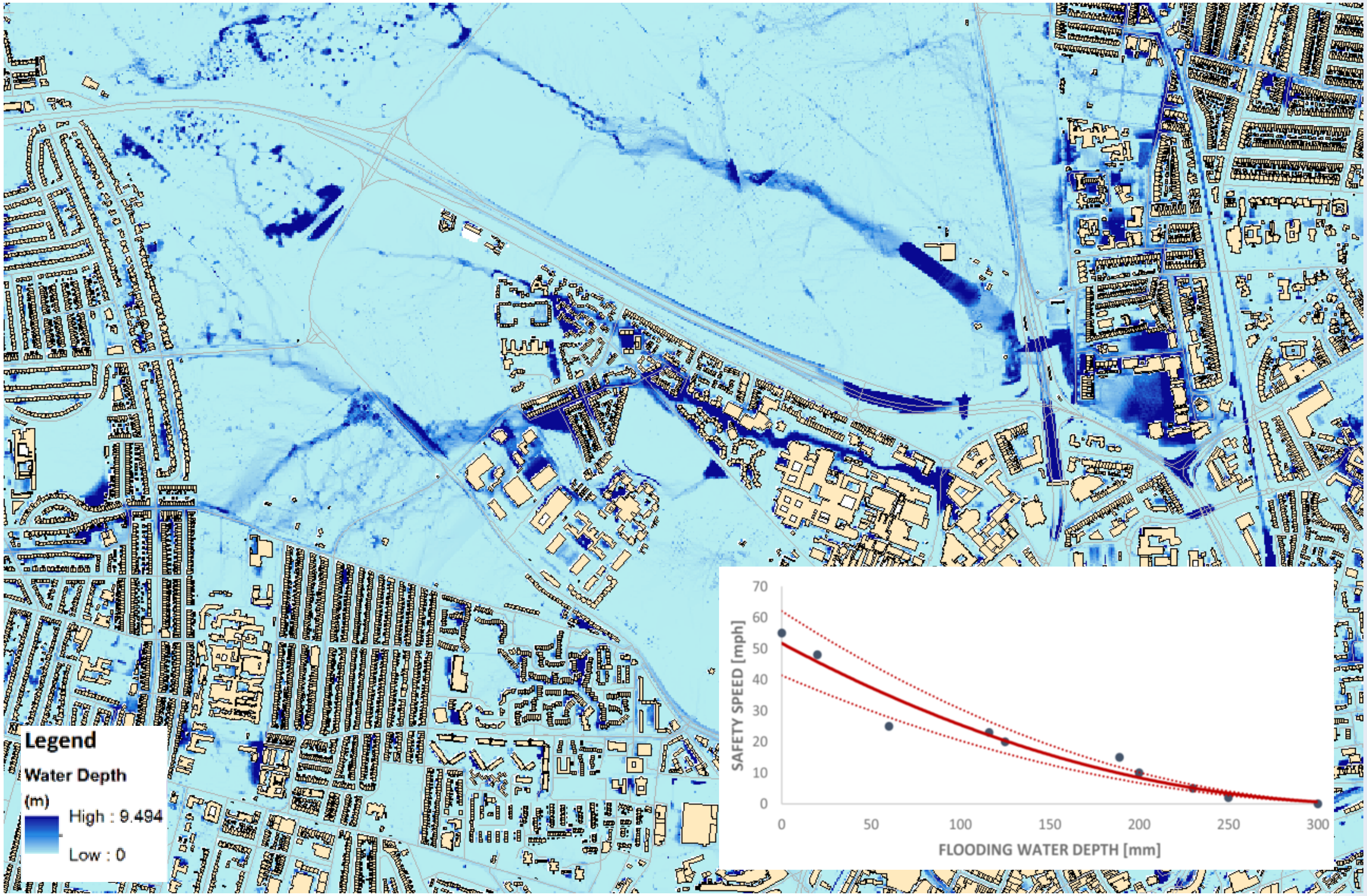
Hazard: Surface Water Flooding

- CityCAT model, developed by Newcastle University (Glenis et al, 2013)



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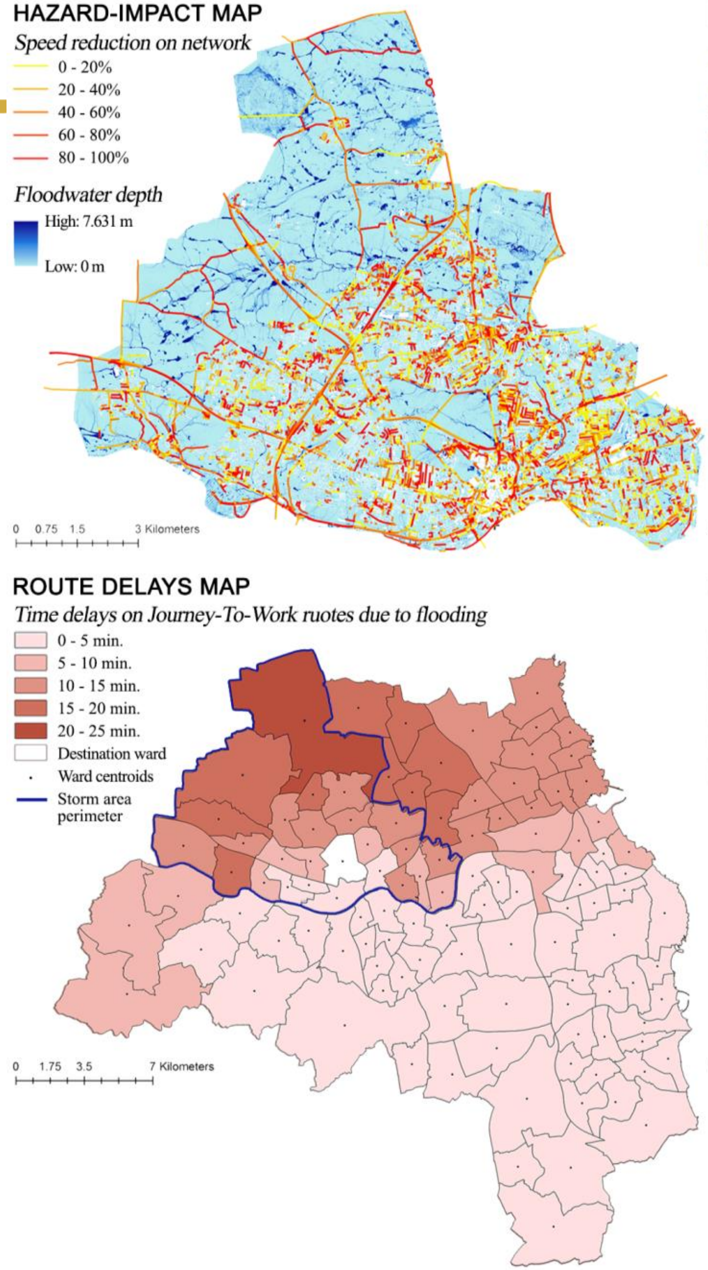
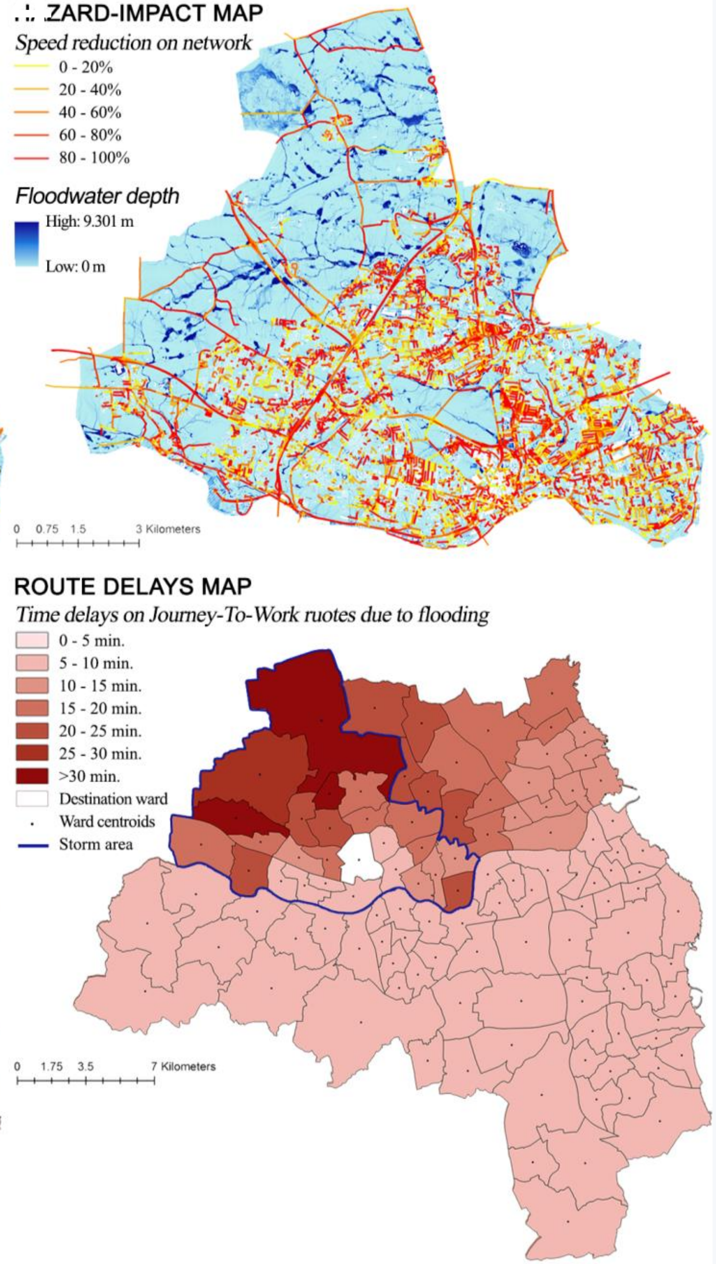
Scenario A: return period= 10 ys, duration = 60'



Scenario B: return period= 200 ys, duration = 60'



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Ongoing work

- Analysis of impacts using simple trip-assignment model
  - Congestion effects
- Testing of adaptation options
  - Blue/green roofs
  - SUDS
  - Improved drainage
  - Link-scale interventions
  - Modal shift
  - Planning strategies
- Cost-benefit analysis of adaptation
- Case studies in London, Antwerp, and Bilbao

COOPERATION
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http://www.ncl.ac.uk/ceser/

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