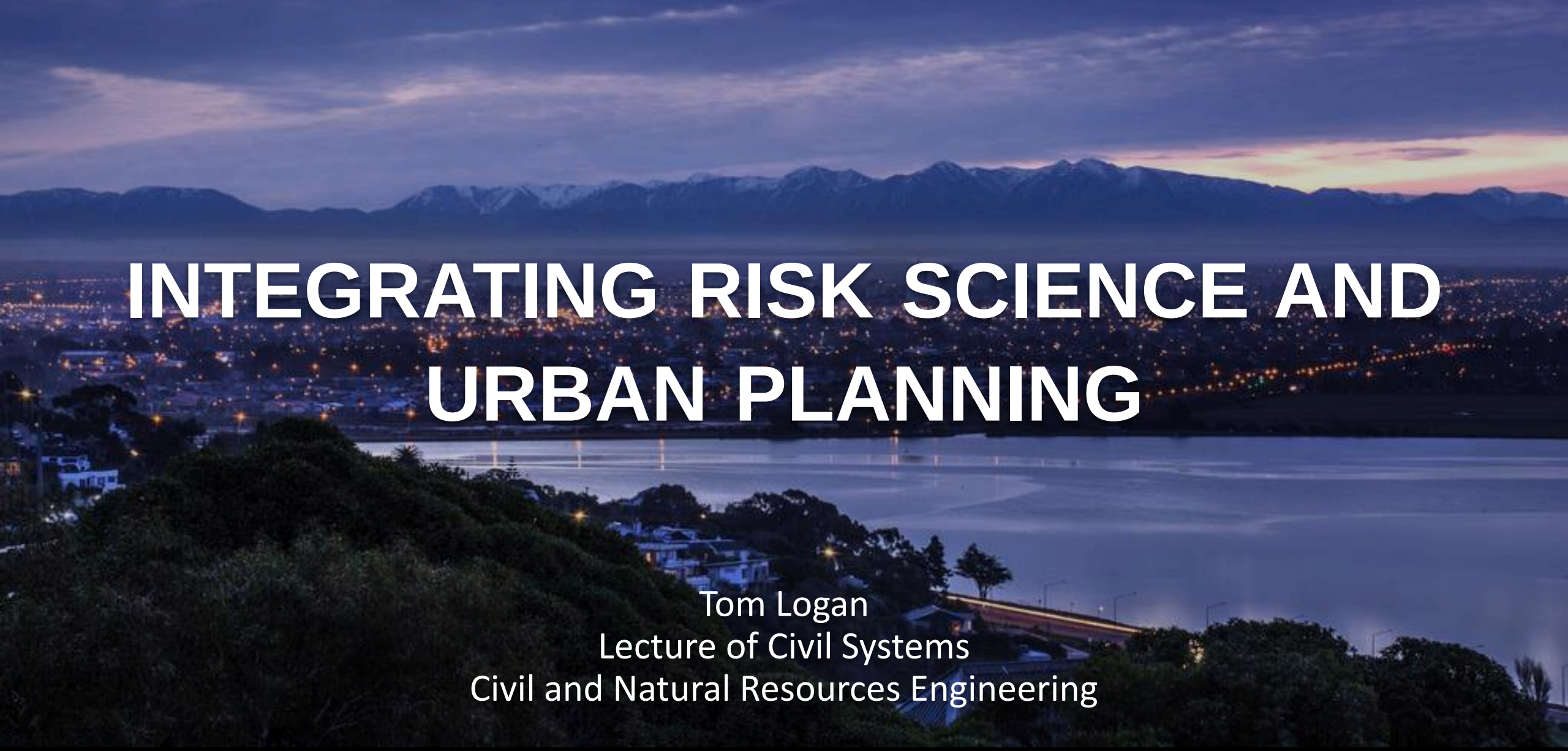

INTEGRATING RISK SCIENCE AND URBAN PLANNING

Tom Logan
Lecture of Civil Systems
Civil and Natural Resources Engineering

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My background

- BE (Hons), Natural Resources Engineering, University of Canterbury, New Zealand
- BSc, Mathematics, University of Canterbury, New Zealand

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- BE (Hons), Natural Resources Engineering, University of Canterbury, New Zealand
- BSc, Mathematics, University of Canterbury, New Zealand
- MS, Geography and Environmental Engineering, Johns Hopkins University, Baltimore, MD, USA
- PhD, Industrial and Operations Engineering, University of Michigan, Ann Arbor, MI, USA

My background

- Returned to UC as a lecturer in civil systems engineering

Why a systems approach

Maladaptation

Maladaptation occurs when actions unintentionally increase the vulnerability of a community

Systems approach: integration

- Address issues simultaneously
- Can identify maladaptation potential
- Solutions that create synergies

Risk science

- Evolution of risk over time
- Capturing consequences temporally (resilience)
- Repeated hazards and human feedbacks

Prioritising intervention

- How do we capture the co-benefits and trade-offs?
- How do we evaluate alternative strategies?
- How do we address deep uncertainty?

“Research is needed on the effect of, and the dynamics between, adaptation alternatives for .. cities. Complex and dynamic feedback systems can result in seemingly intuitive infrastructure solutions resulting in maladaptation. ...” (Prieur-Richard et al., 2018)

Overview

Agent-based modeling

Machine learning and spatial data

Urban resilience framework

Integrating risk analysis and data-driven planning for urban resilience

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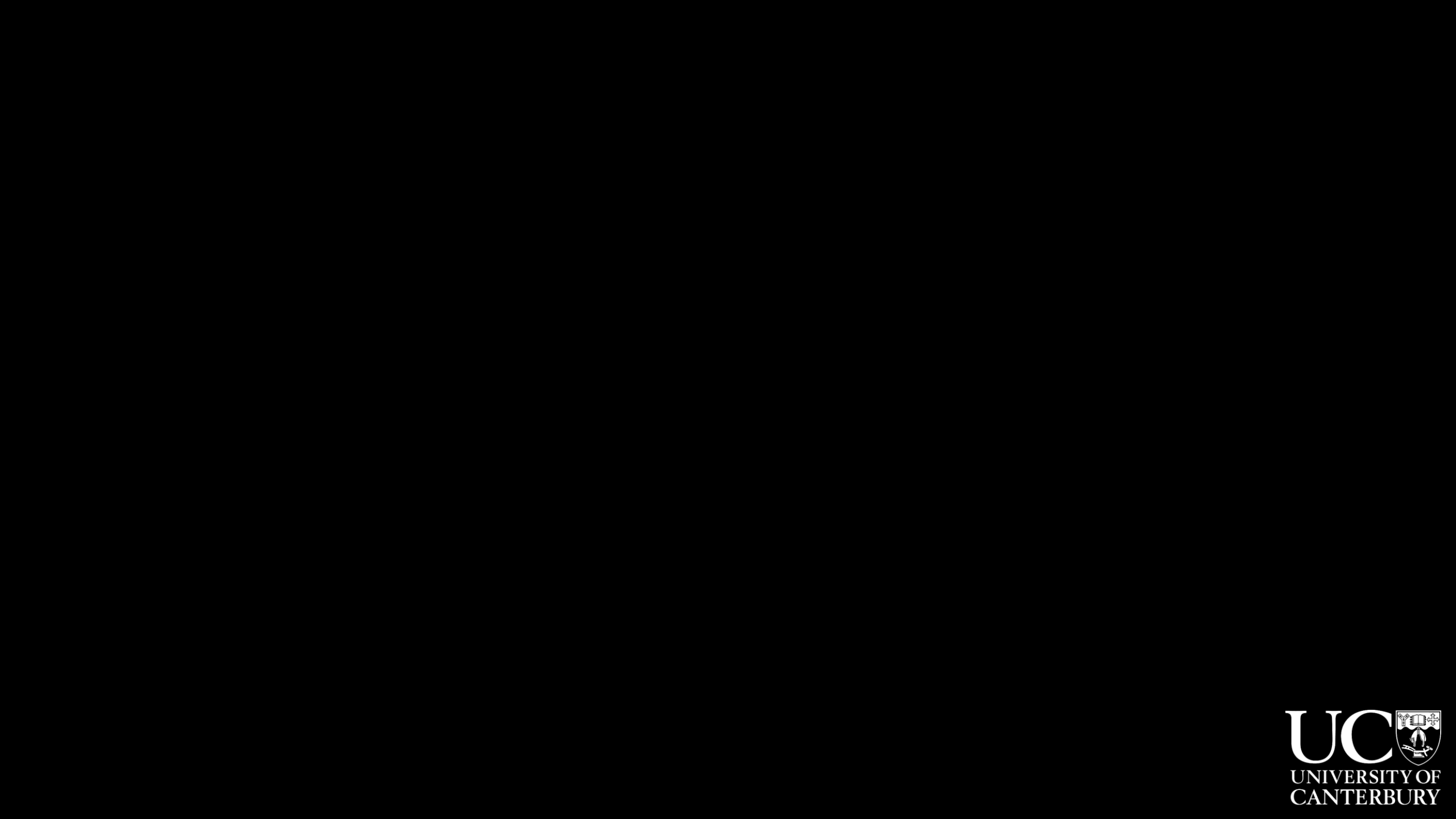
Agent-based modeling and stochastic simulation

- Incorporating feedbacks
  - Behaviour
  - Time

Logan, T. M., Guikema, S. D., & Bricker, J. D. (2018). Hard-adaptive measures can increase vulnerability to storm surge and tsunami hazards over time. *Nature Sustainability*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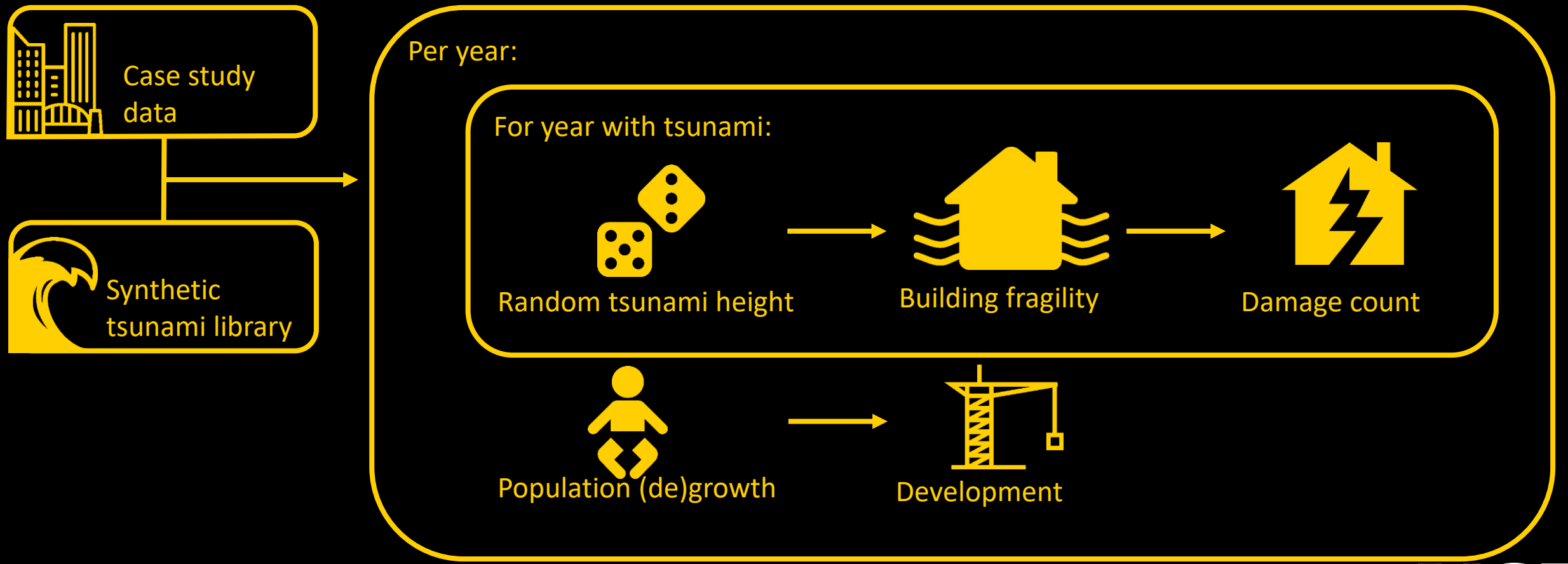
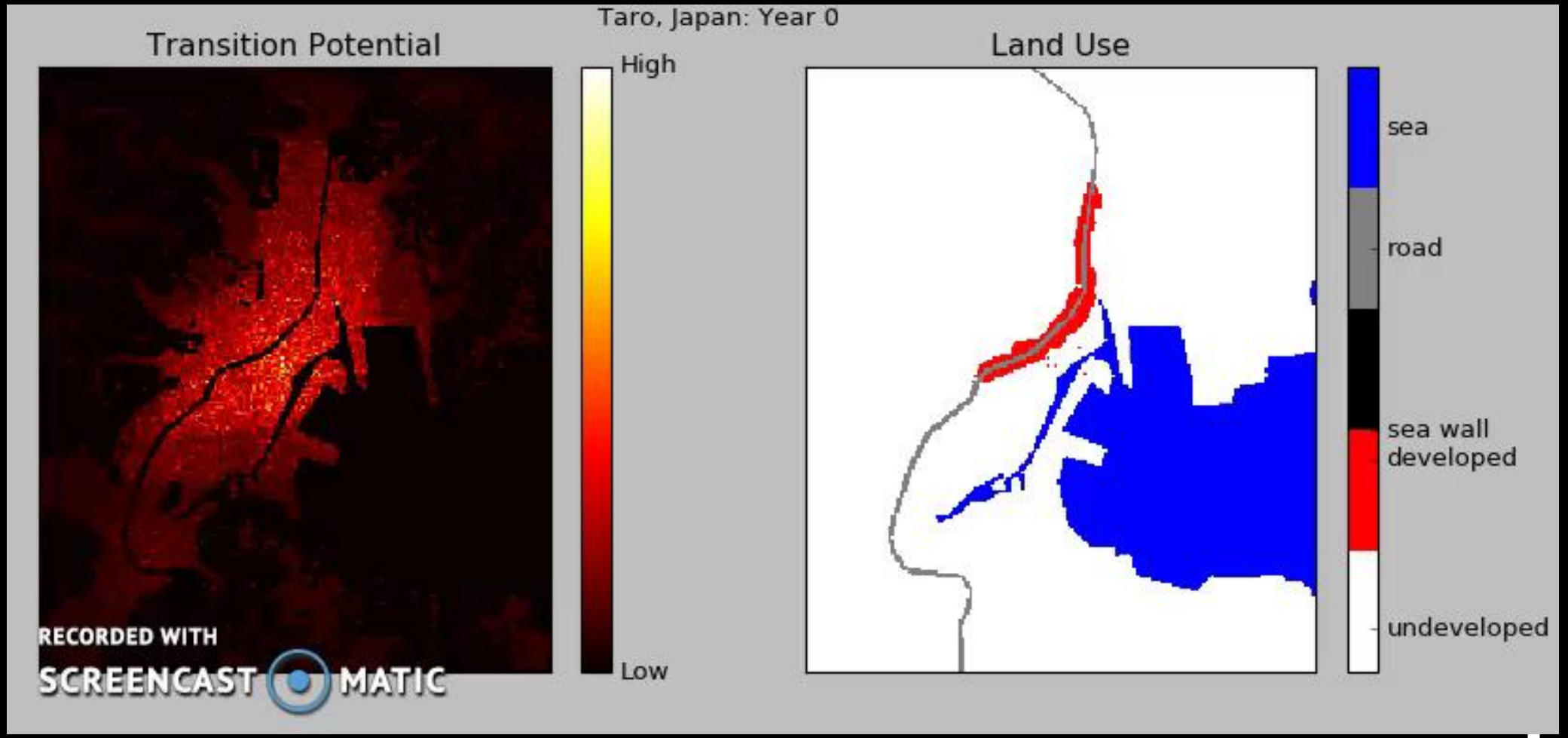
Model



Nature Sustainability, 2018

Our model for land-use, tsunami, & human memory



Logan 2018, *Nature Sustainability*

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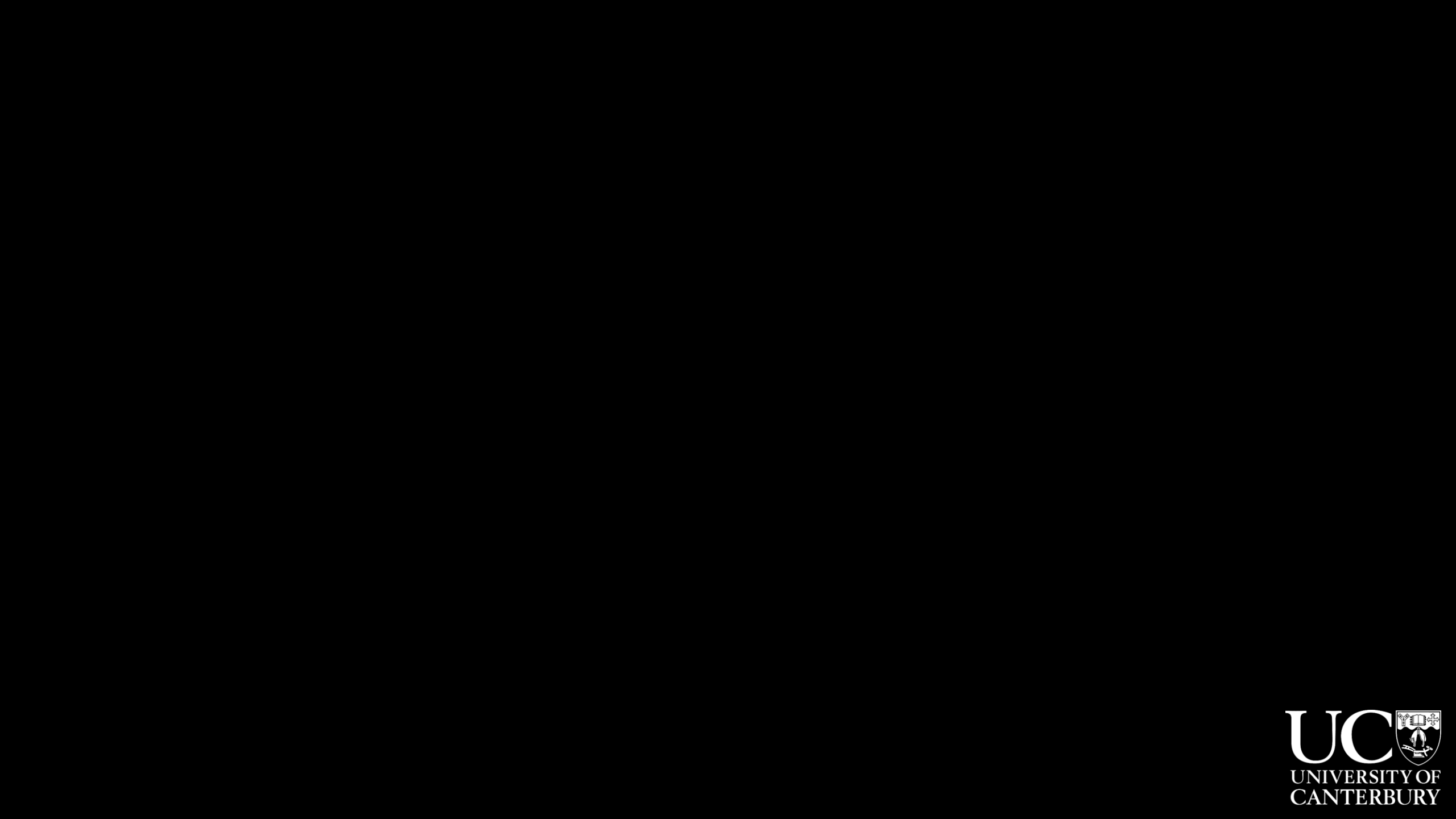
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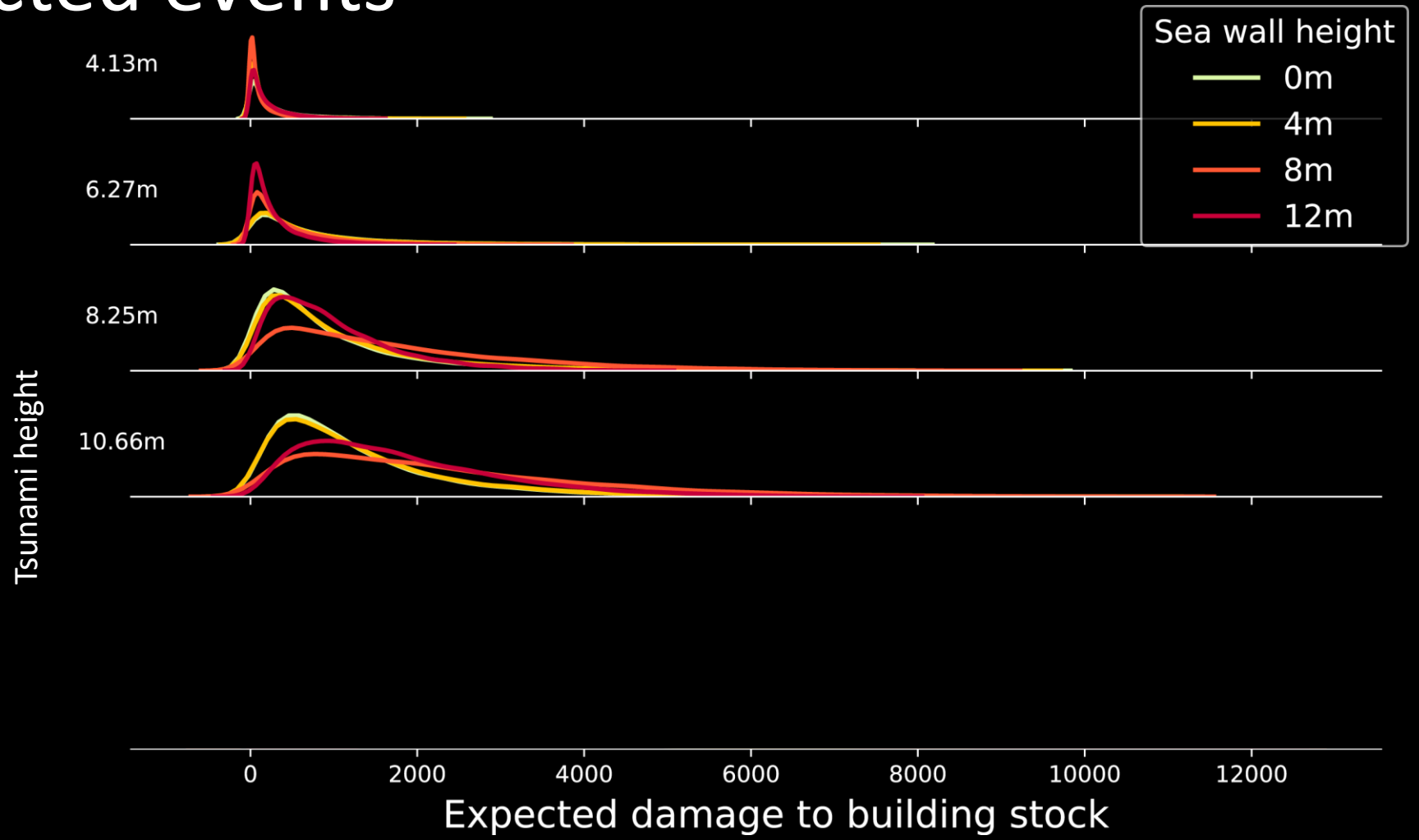
Seawalls don’t make much difference for expected events

Simulated city may have experienced these tsunami heights



Logan 2018, *Nature Sustainability*

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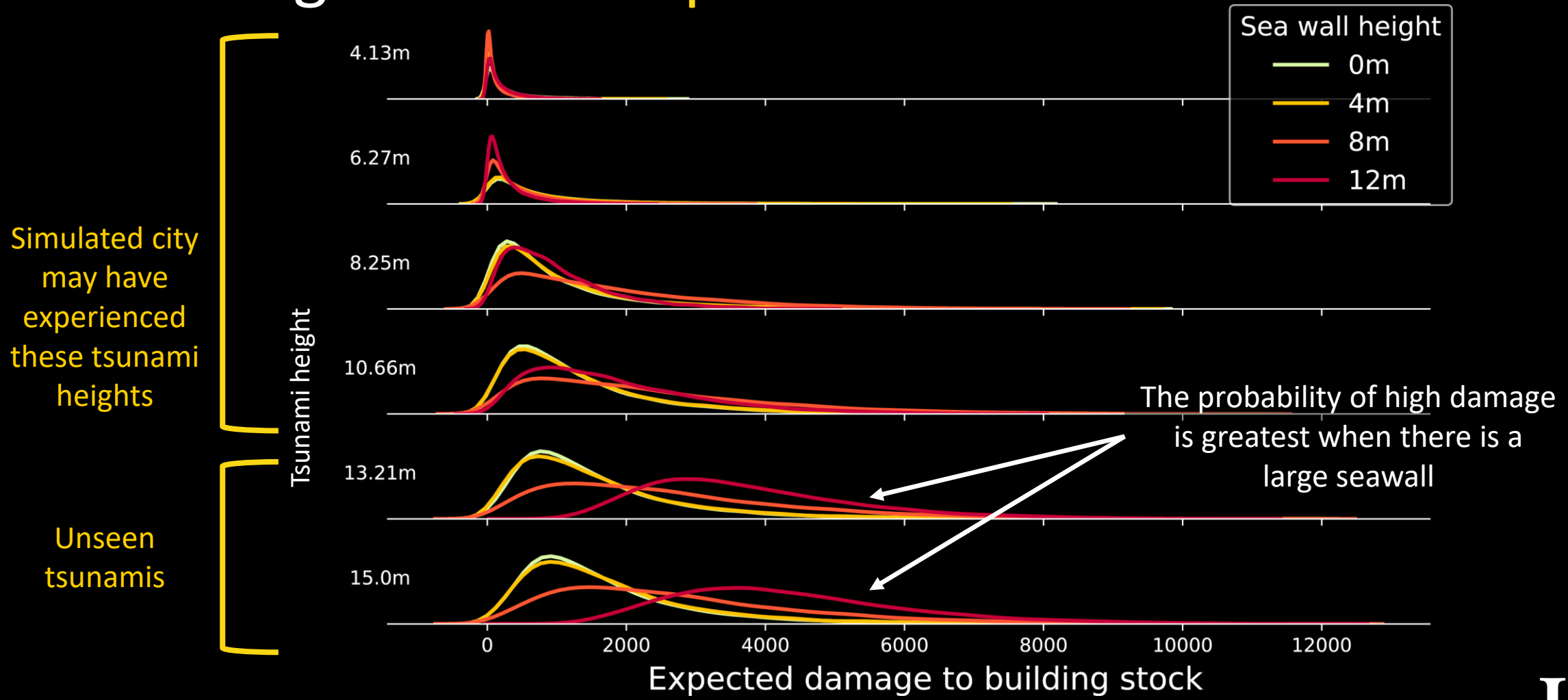
Communities with large seawalls have more damage from unexpected events



Logan 2018, *Nature Sustainability*

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Communities with large seawalls have more damage from unexpected events

Large walls

- Protect against smaller events
- Prevent community from learning
- It makes people think they're safe

Logan 2018, *Nature Sustainability*

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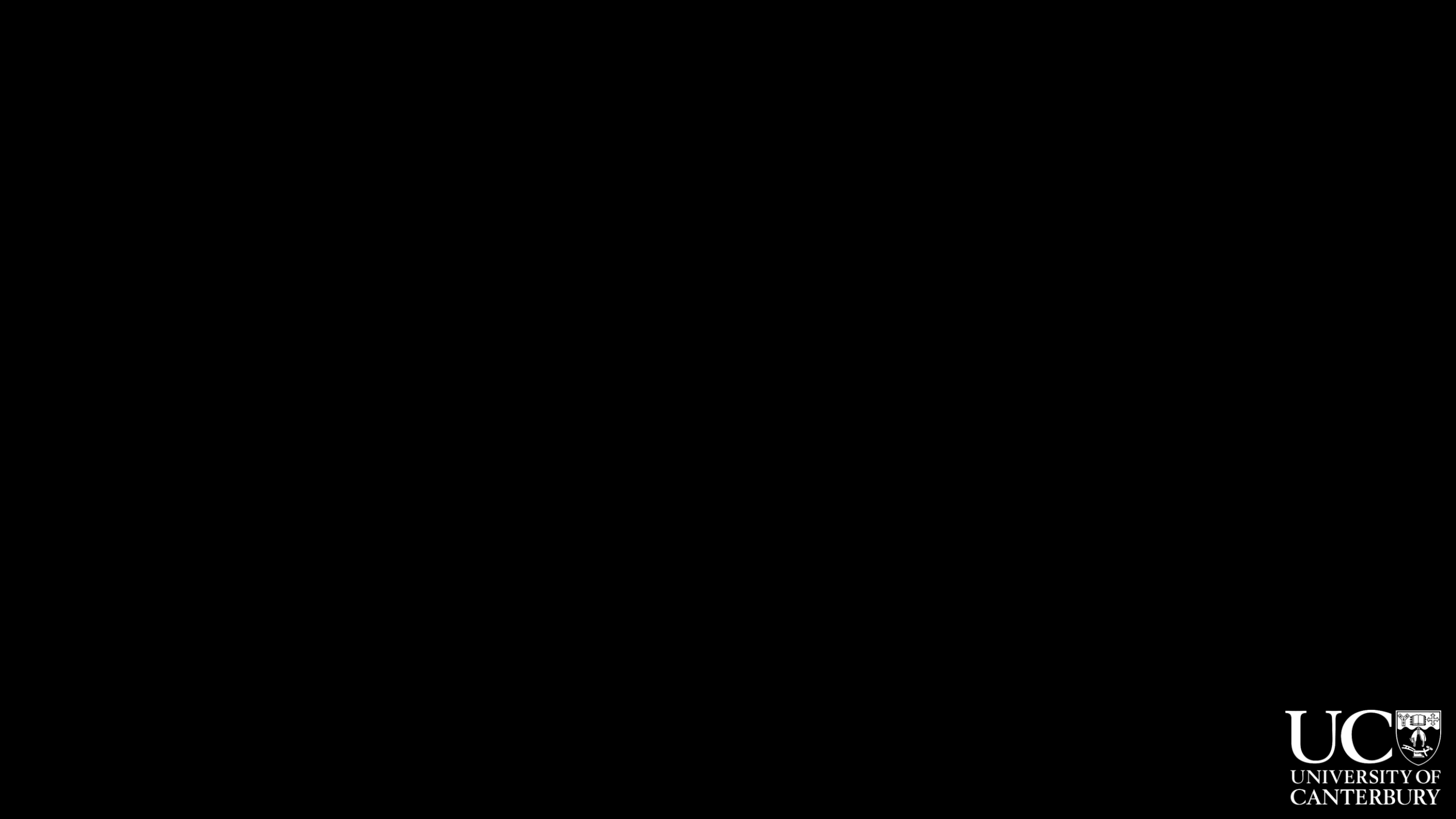
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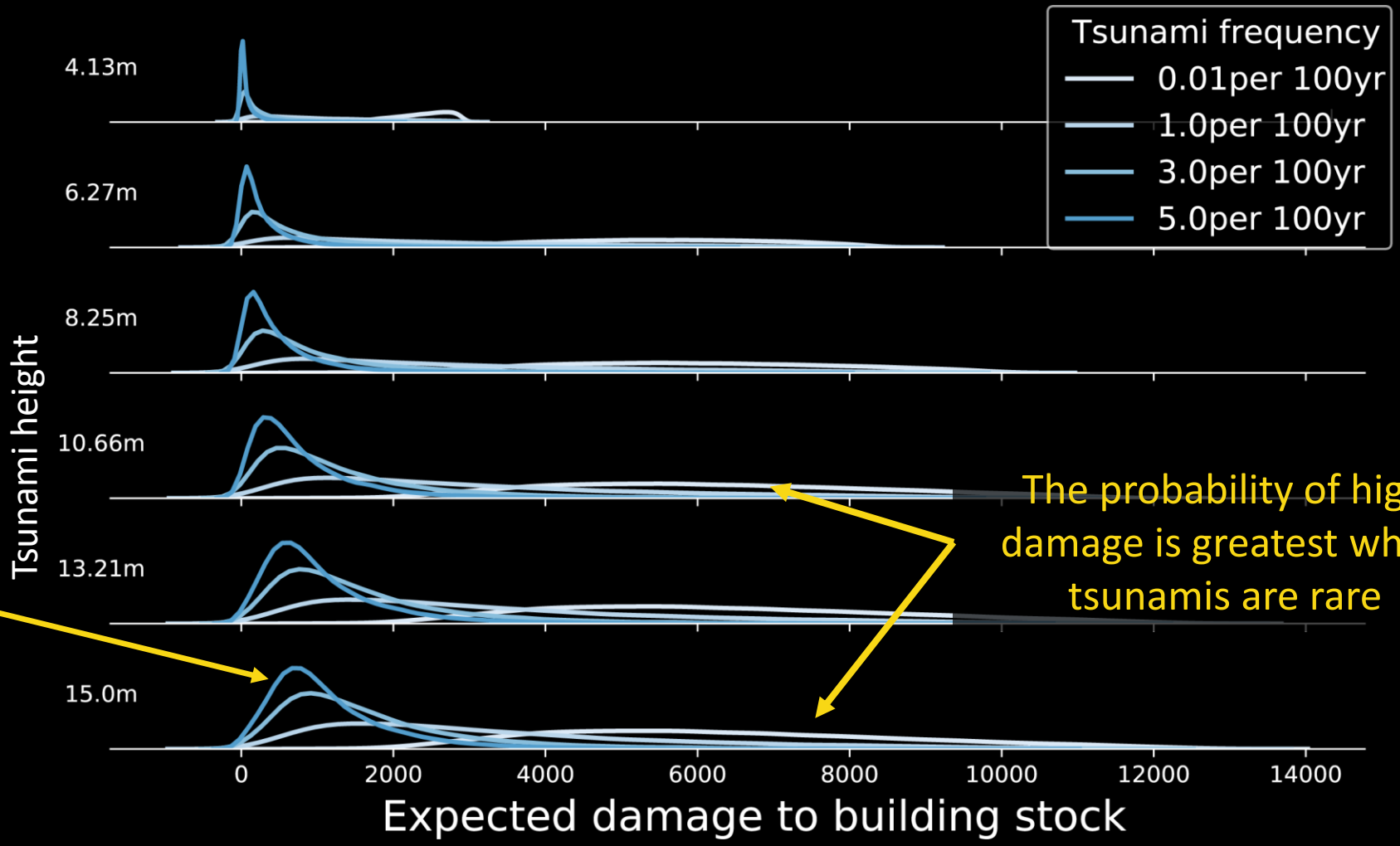
More frequent events reduce vulnerability



High probability of only little damage when hazard is common

The probability of high damage is greatest when tsunamis are rare

Logan 2018, *Nature Sustainability*

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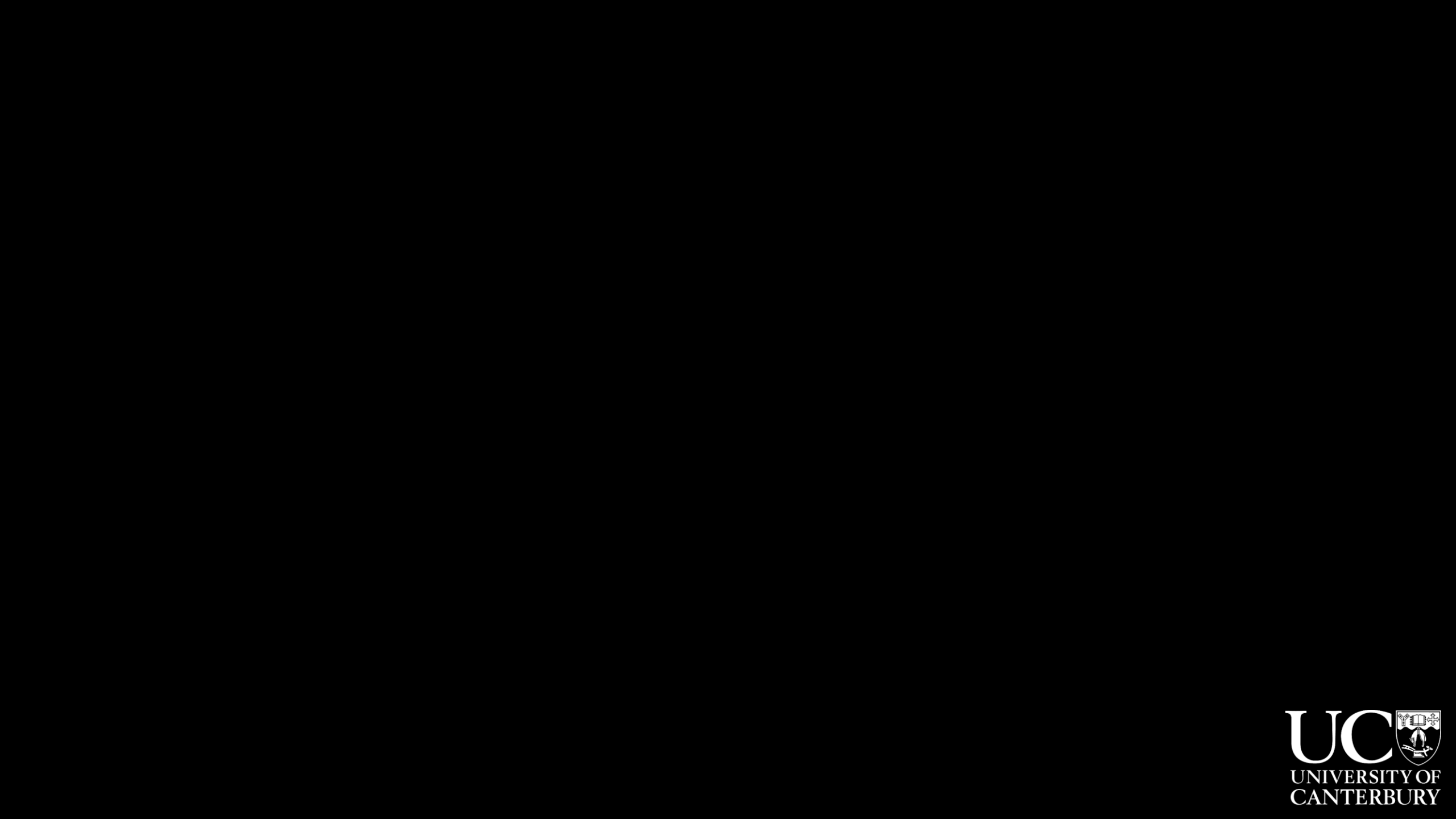
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events that raise the salience of risk will make people and governments more likely to pay attention to that risk, act on that risk or demand action from others — regardless of whether such actions actually reduce risk

(Anderson et al. 2018)

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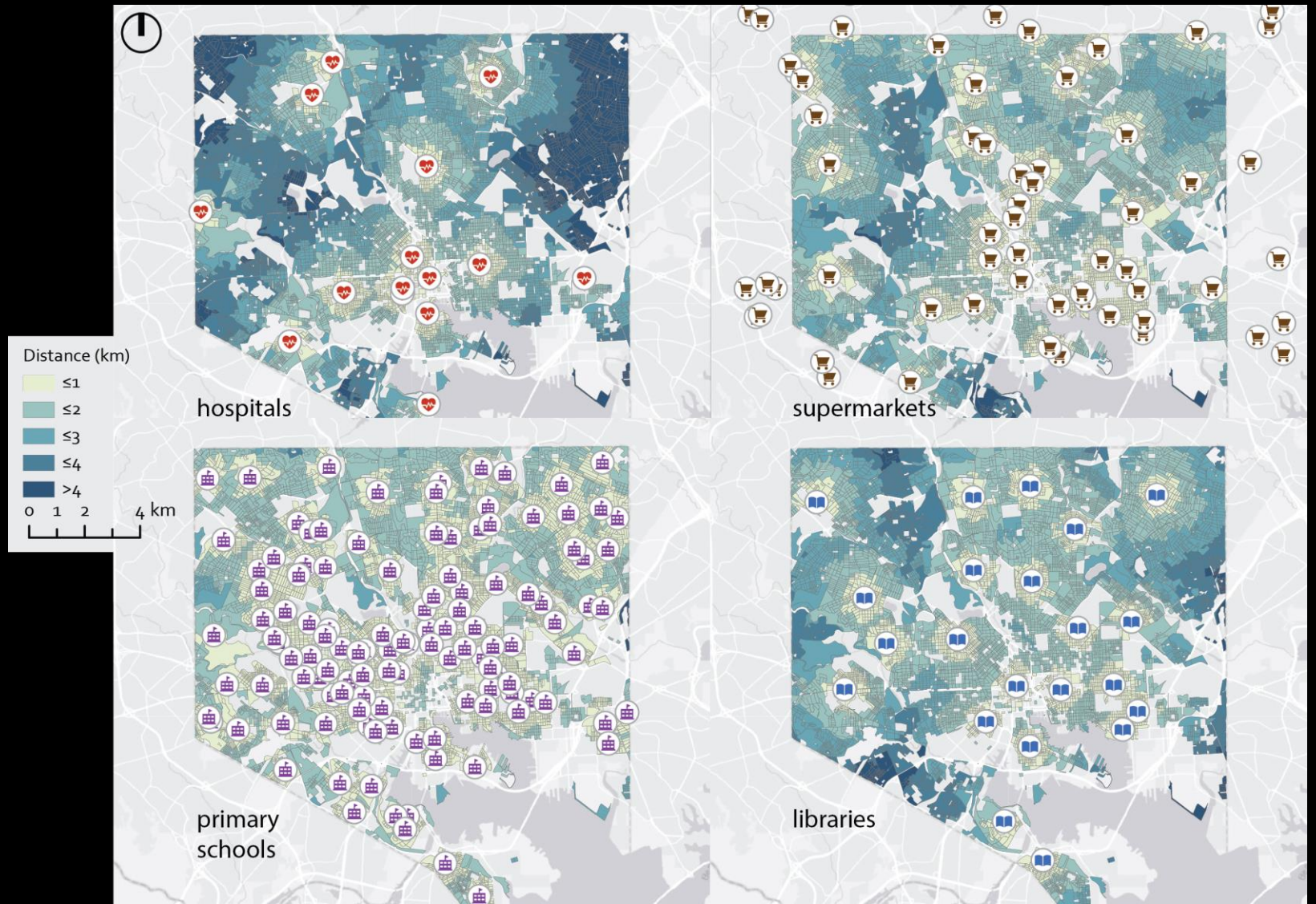
Community resilience

- We need an approach that captures the impact of hazards and infrastructure disruptions on people
  - Logan, T. M., Williams, T. G., Nisbet, A. J., Liberman, K. D., Zuo, C. T., & Guikema, S. D. (2019). Evaluating urban accessibility: leveraging open-source data and analytics to overcome existing limitations. *Environment and Planning B: Urban Analytics and City Science*
  - Logan, T. M., & Guikema, S. D. (under review). Reframing Resilience: Equitable Access to Essential Services. *Risk Analysis*

We calculate the walking distance from every house to every service within a city



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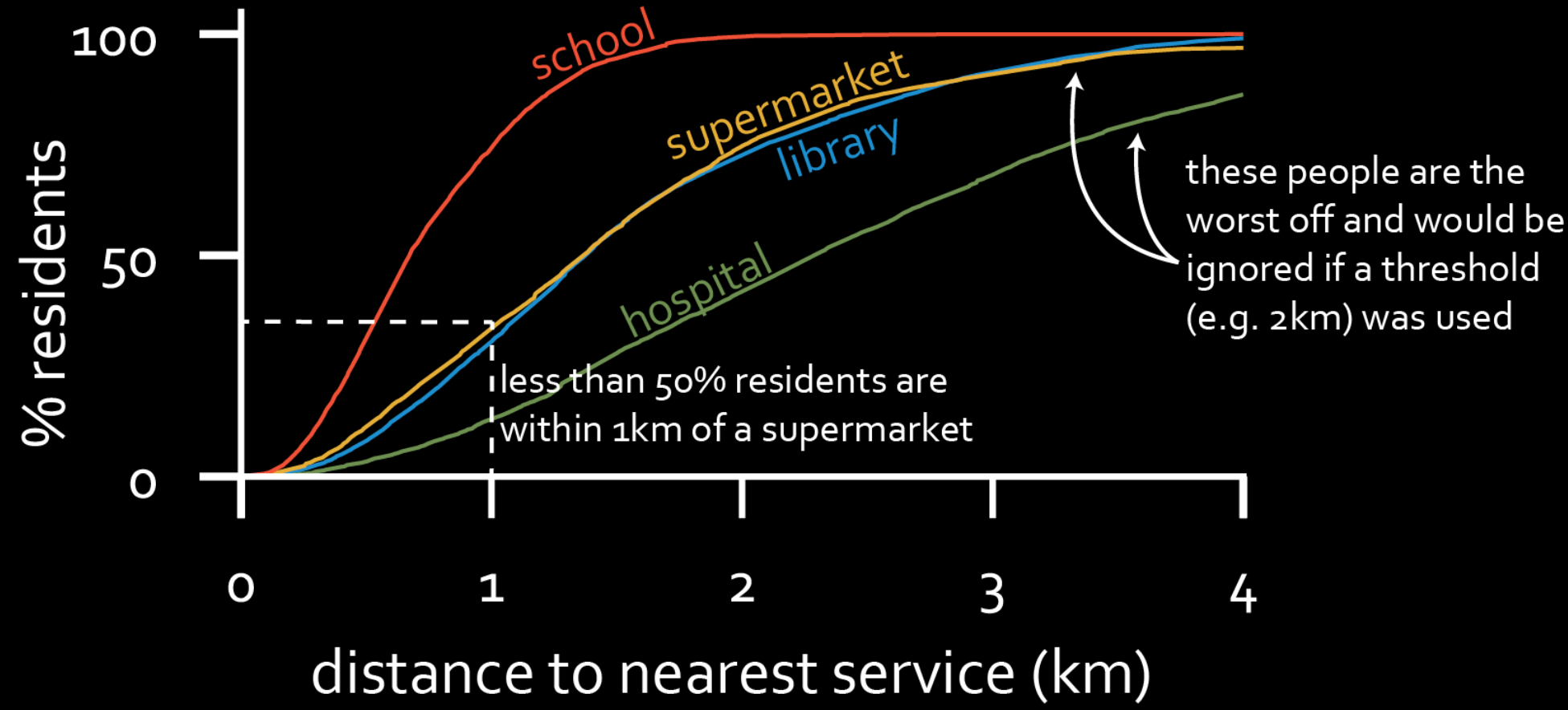
Using census data we calculate the city-wide distribution for access to services



Logan 2017, *Environment and Planning B: Urban Analytics and City Science*

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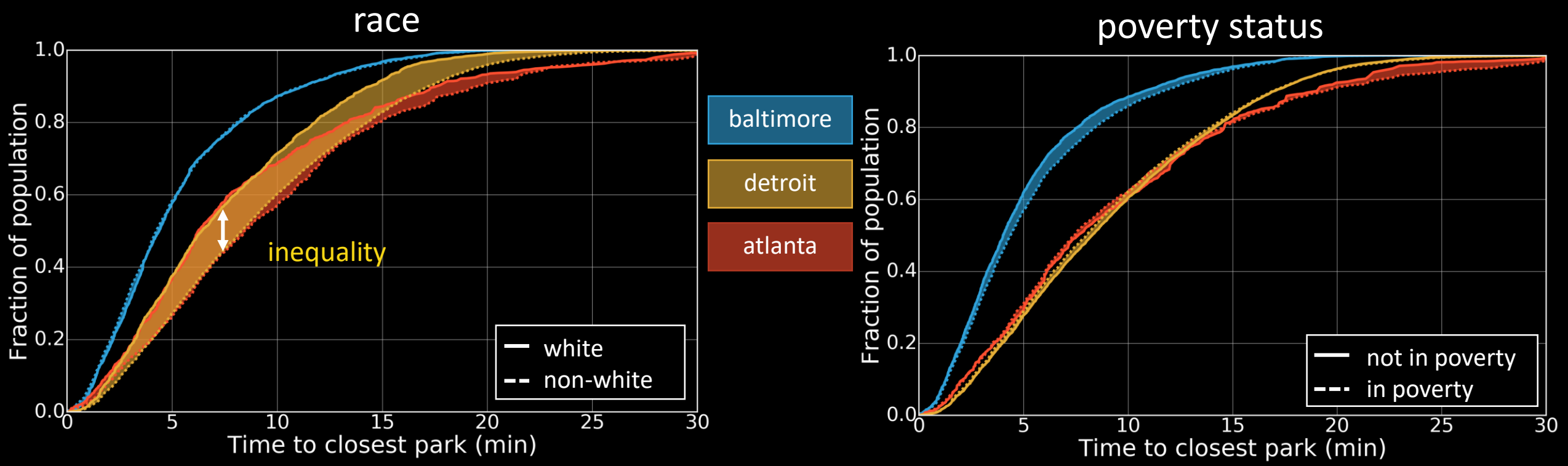
Using census data we can compare the access to services for different demographic groups



Williams et al. (under review), *Landscape and Urban Planning*

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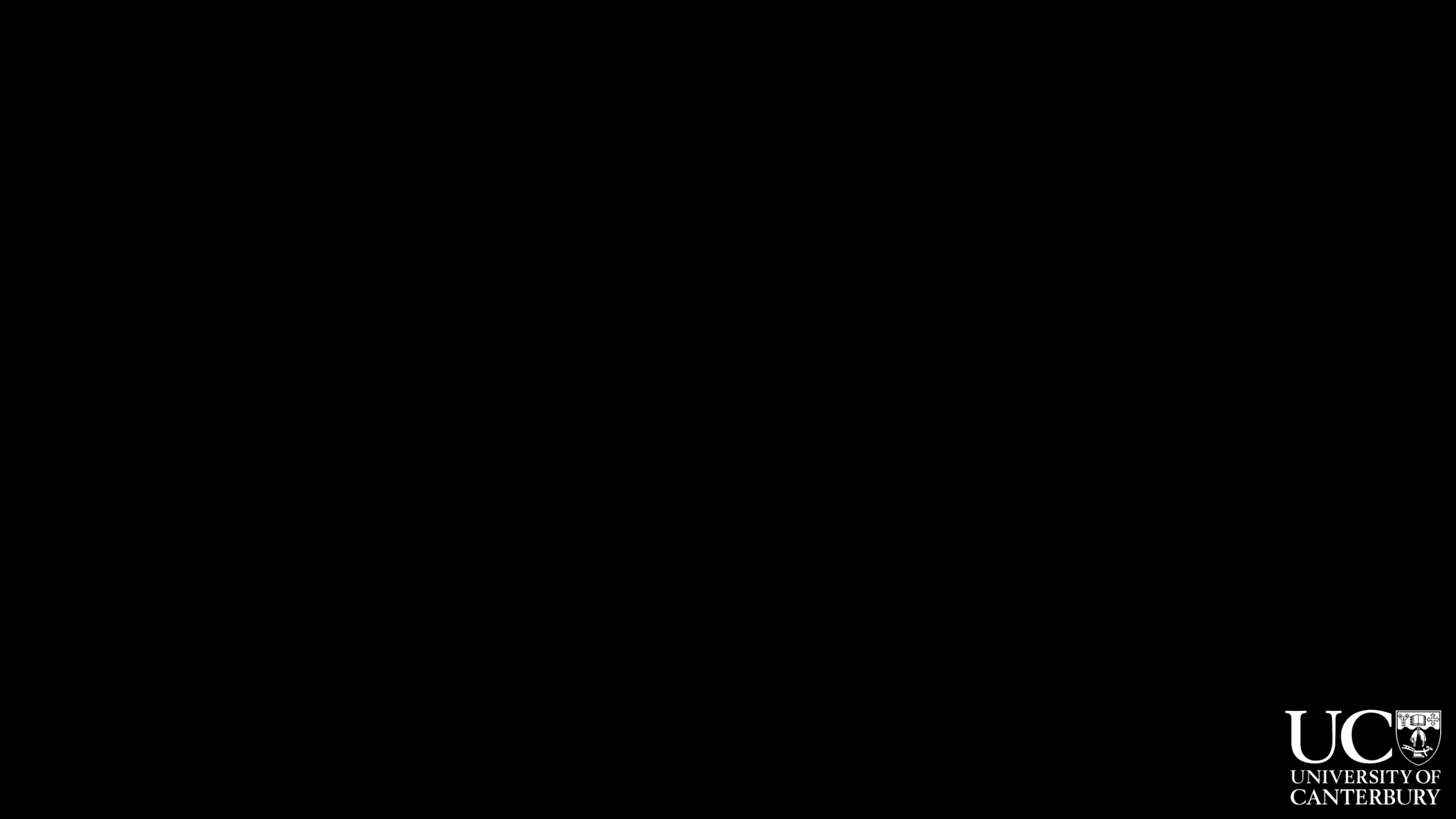
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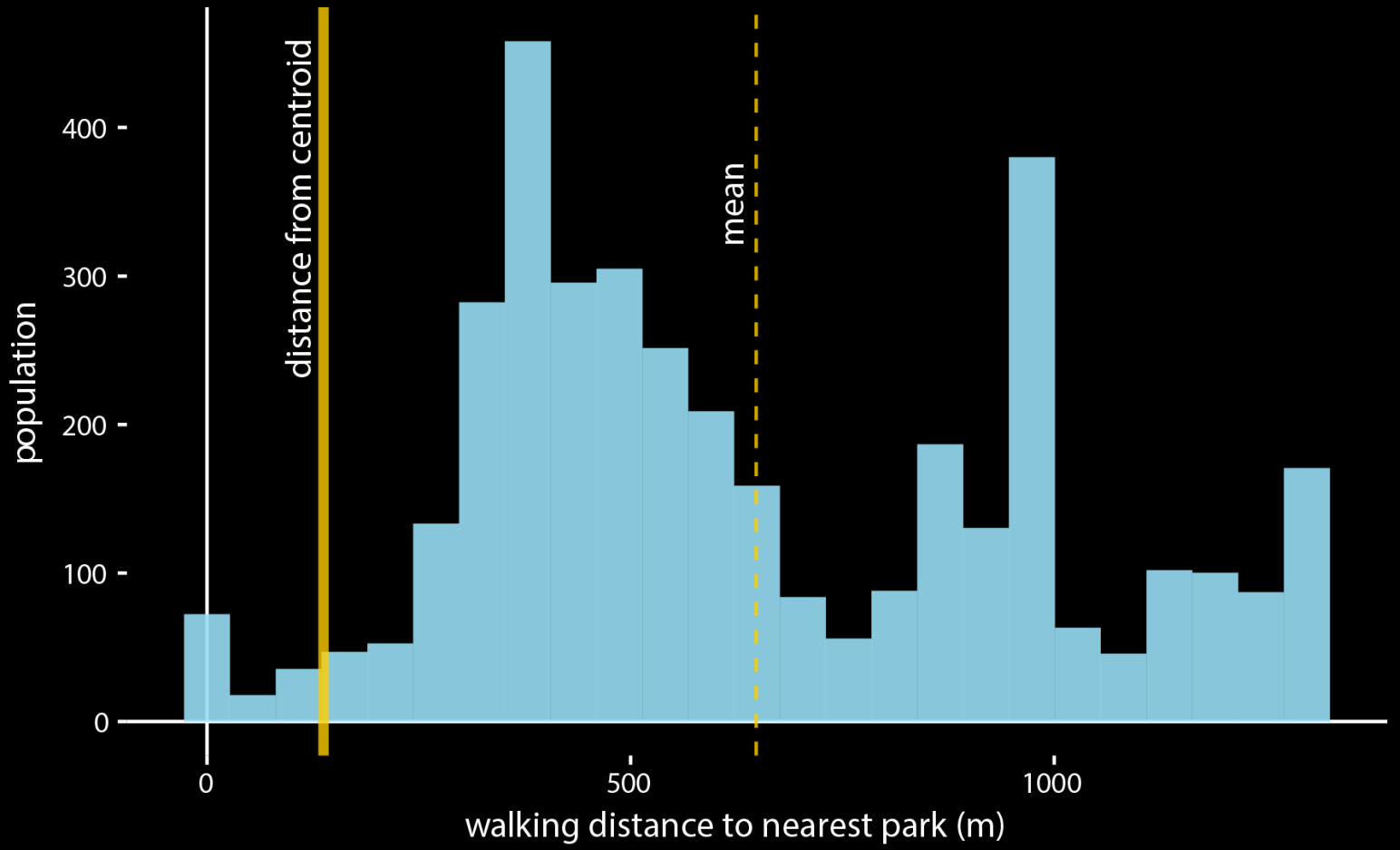
We must use high spatial resolution otherwise access-poor people are overlooked



Logan 2017, *Environment and Planning B: Urban Analytics and City Science*

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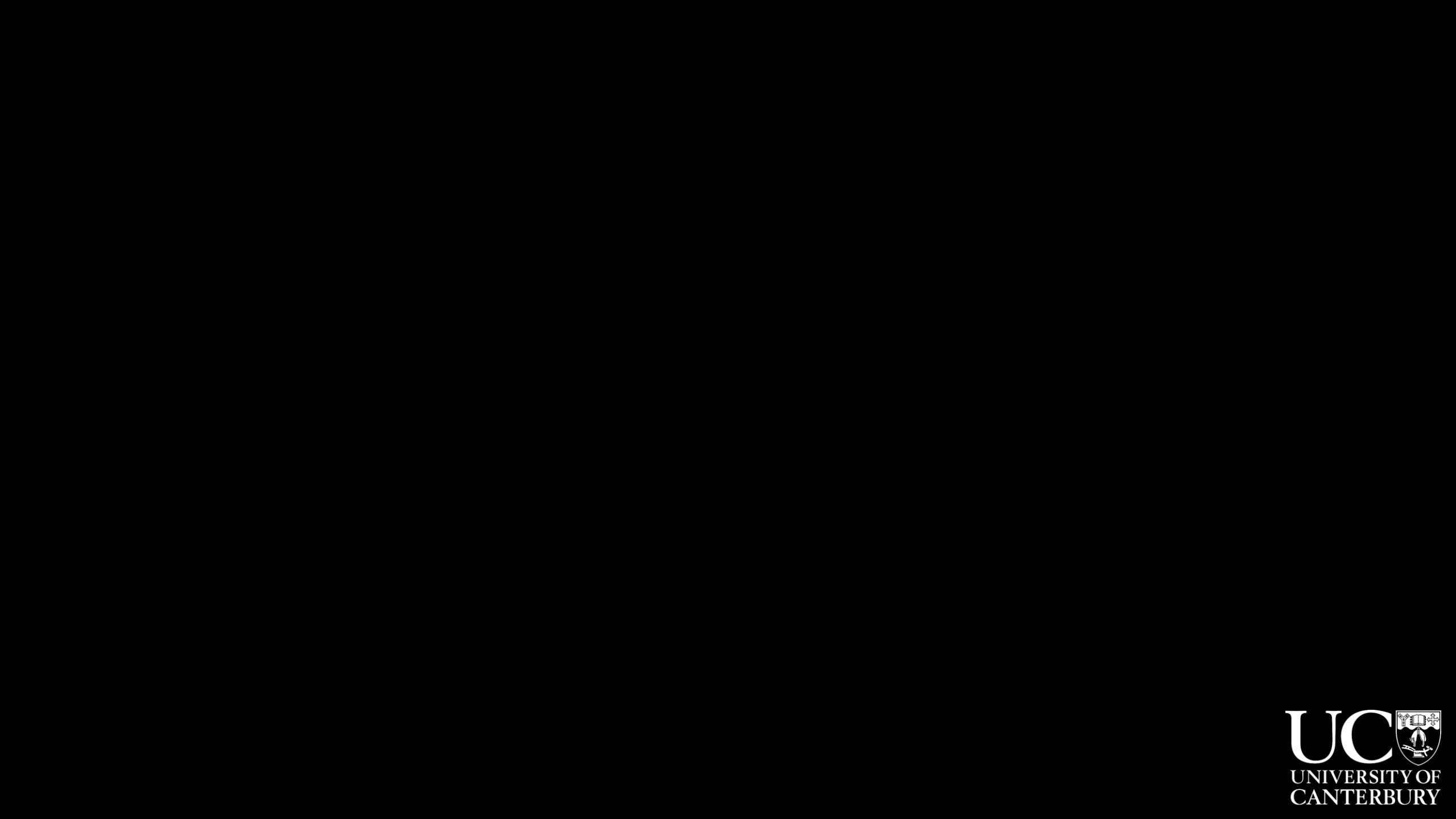
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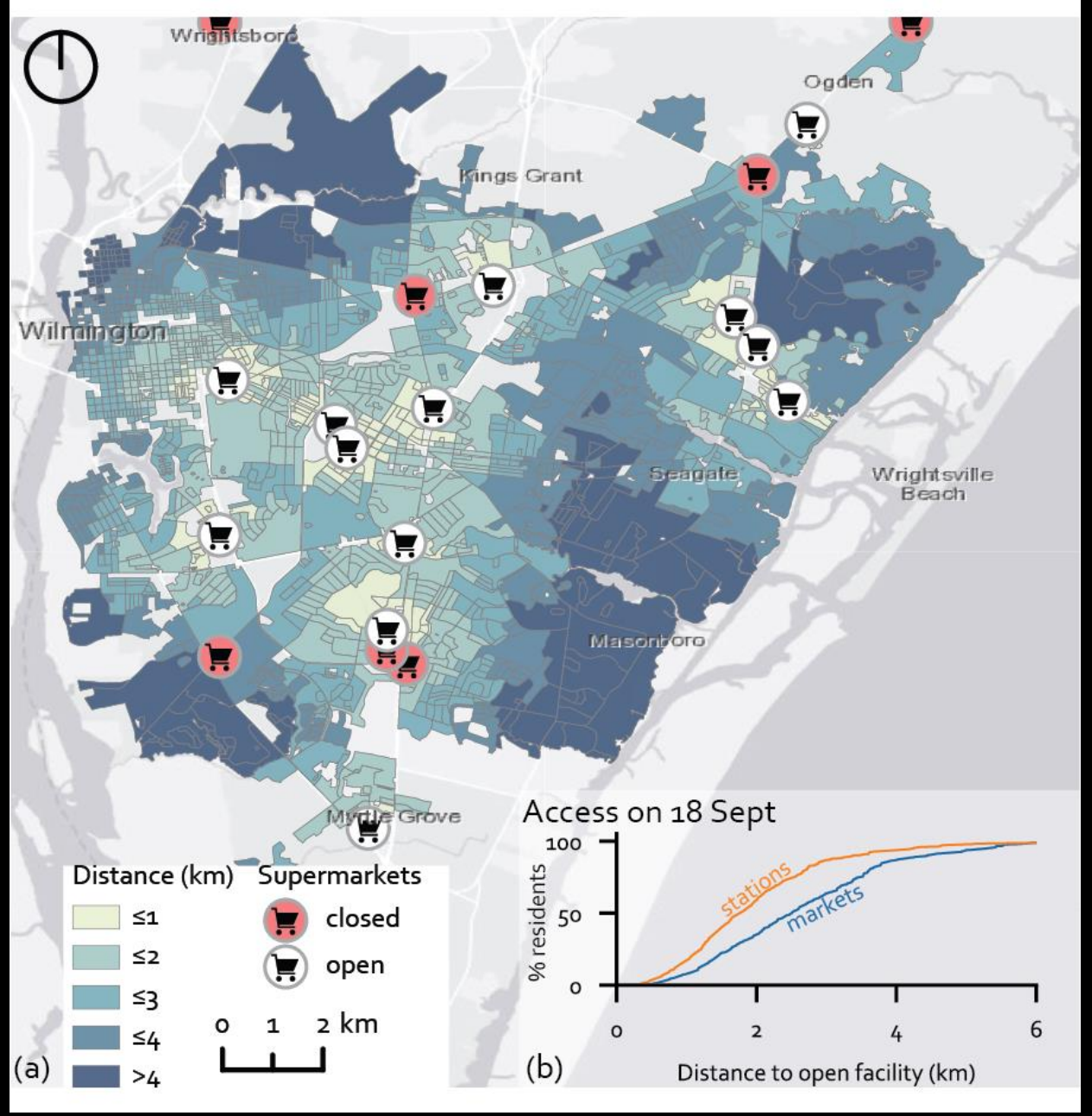

Logan (under review), *Risk Analysis*

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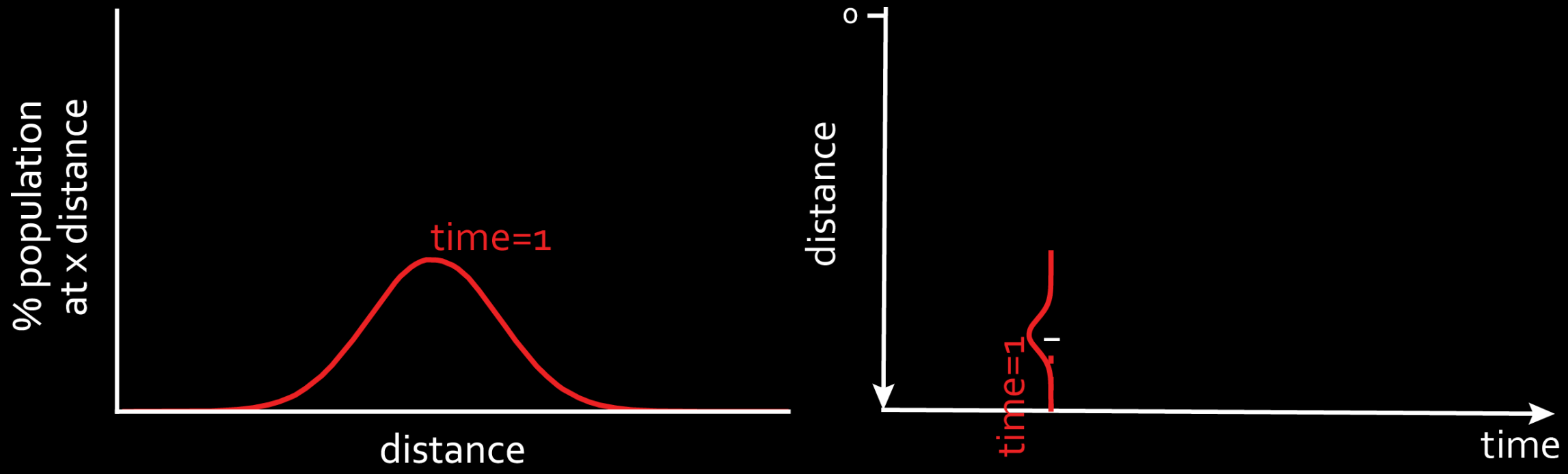
We map the distance distribution to a resilience curve by including time



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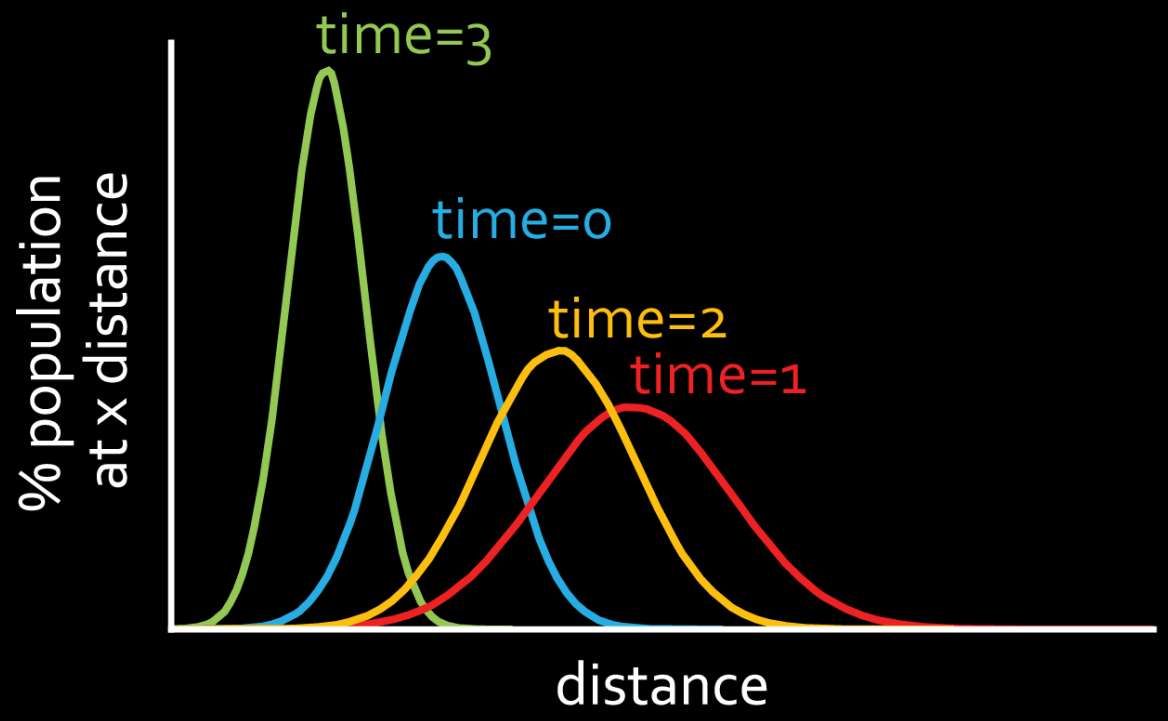

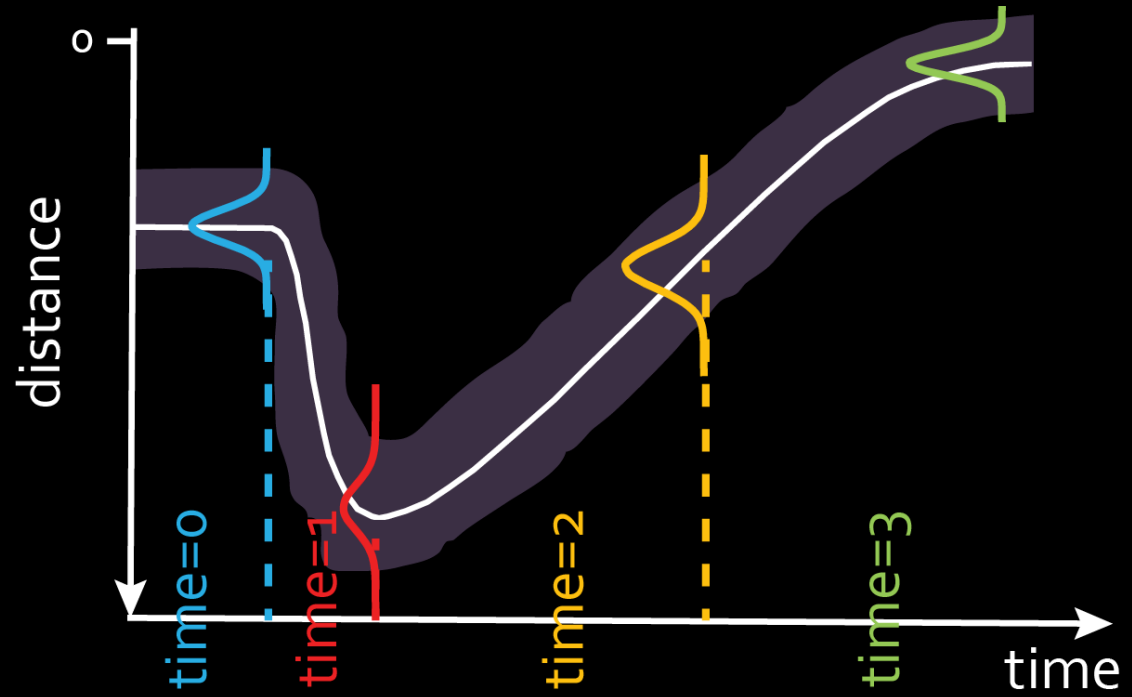

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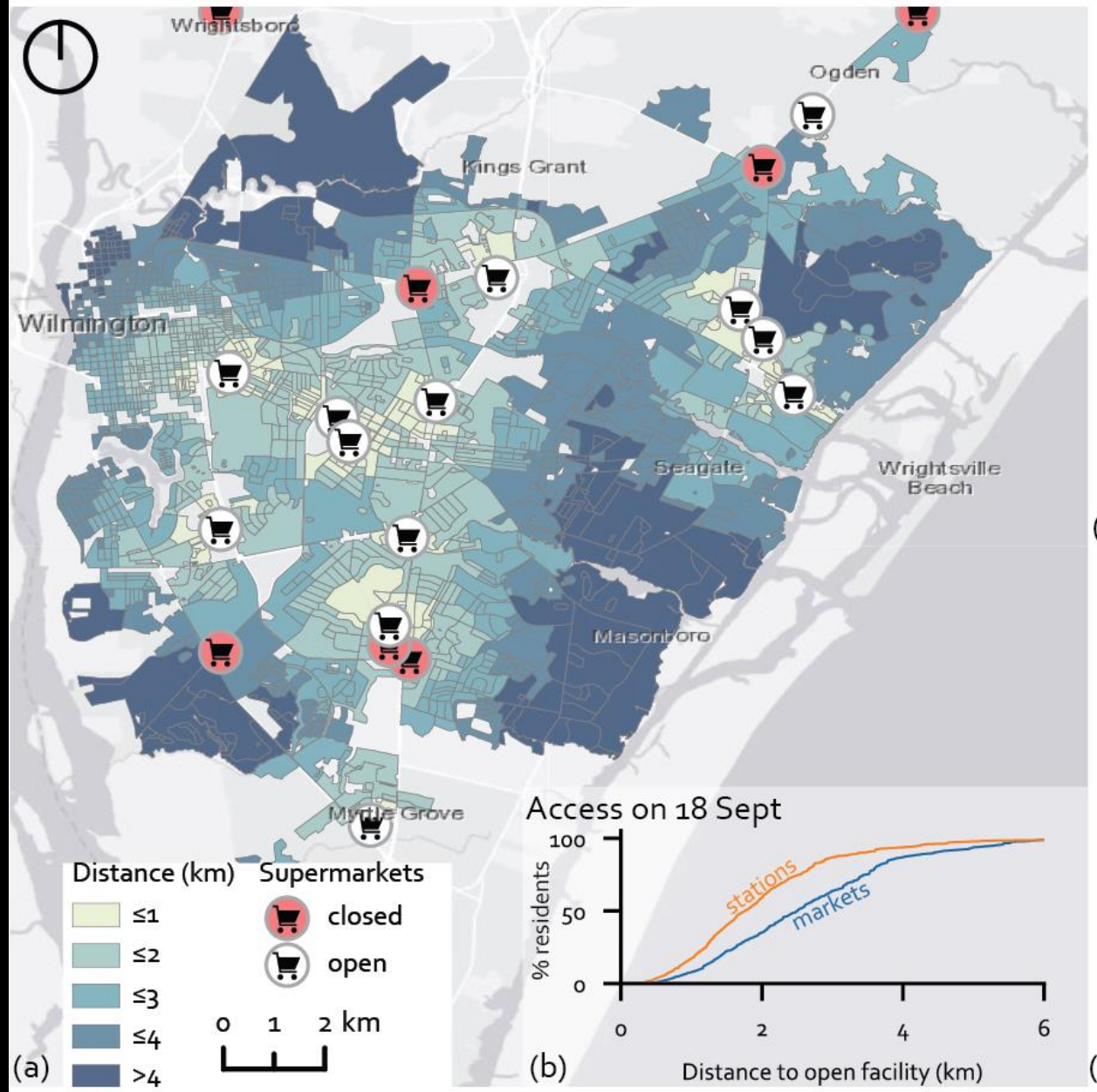

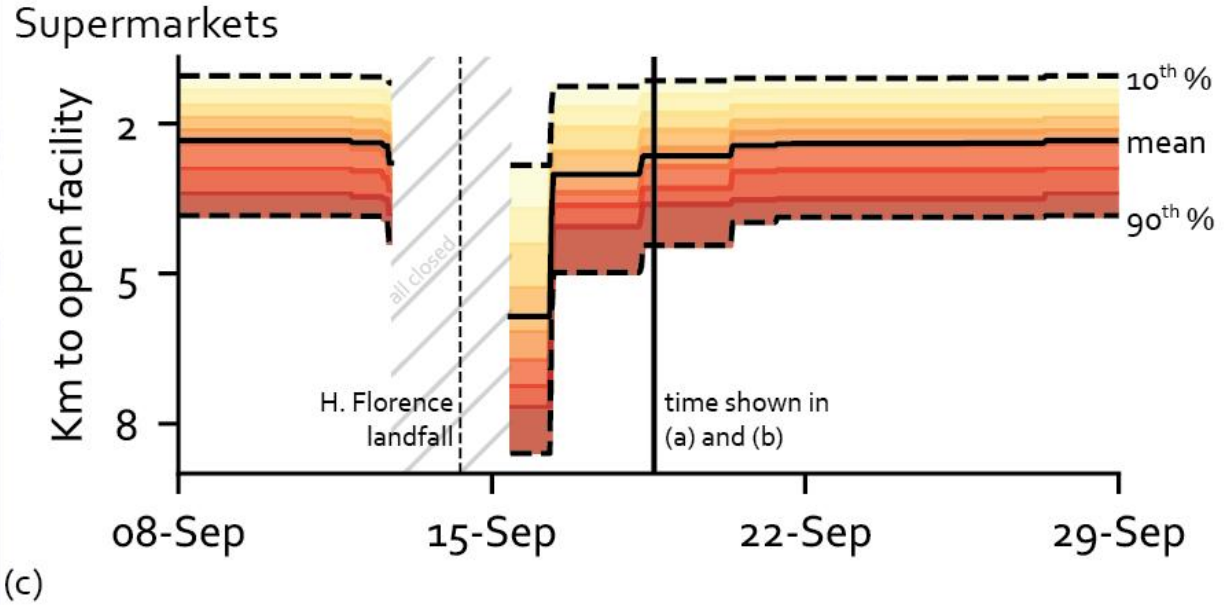

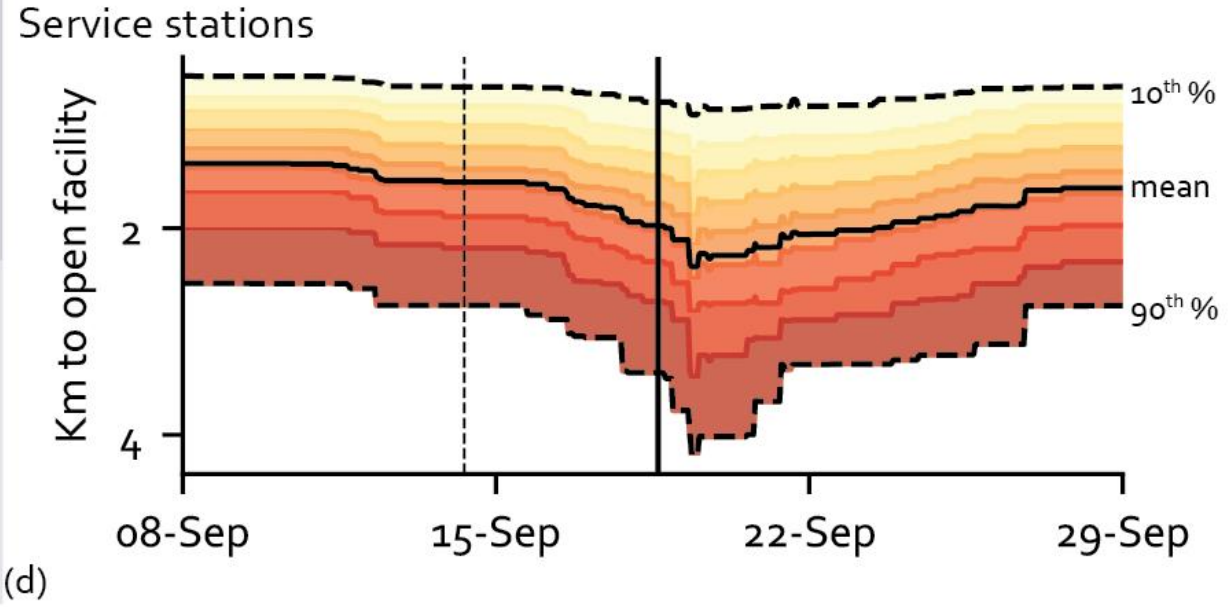

Logan (under review), *Risk Analysis*

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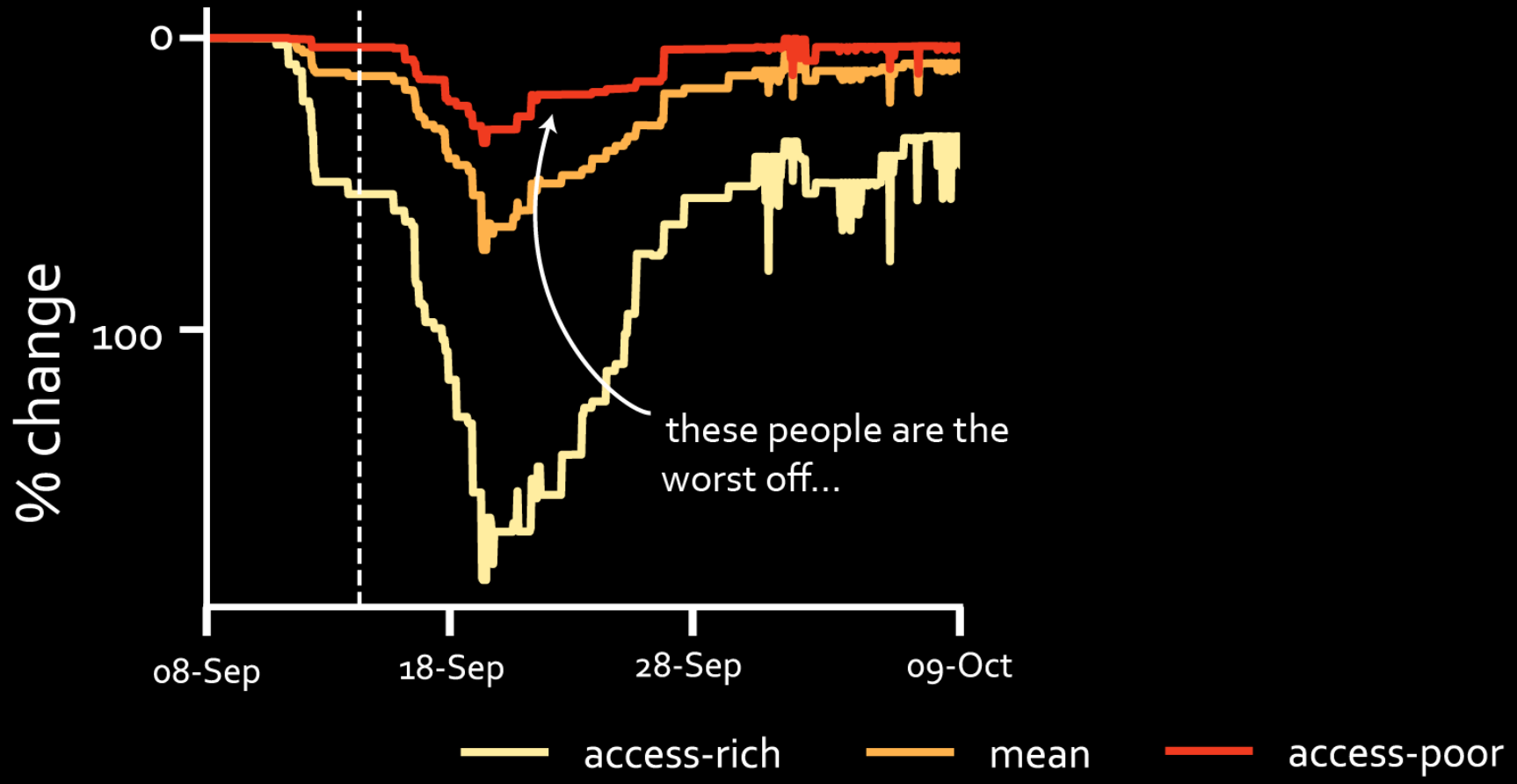
How the resilience measure is calculated can perpetuate inequality



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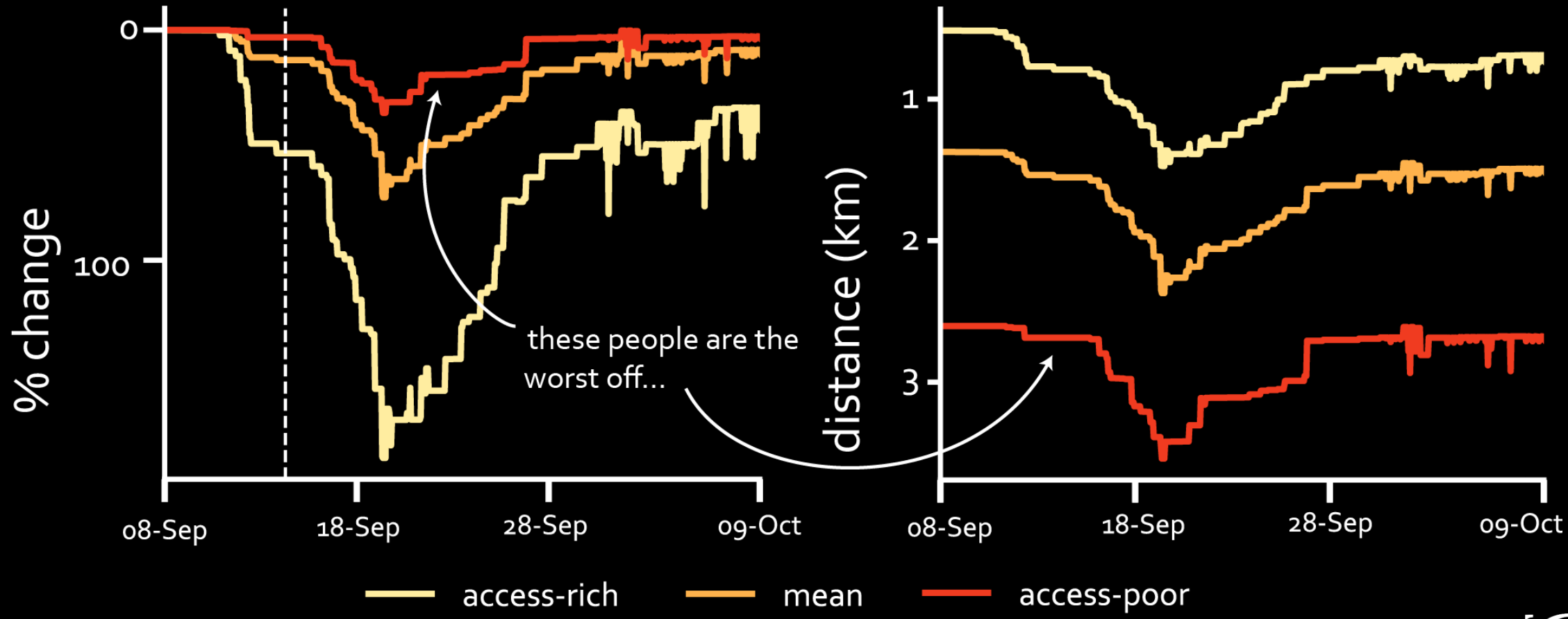

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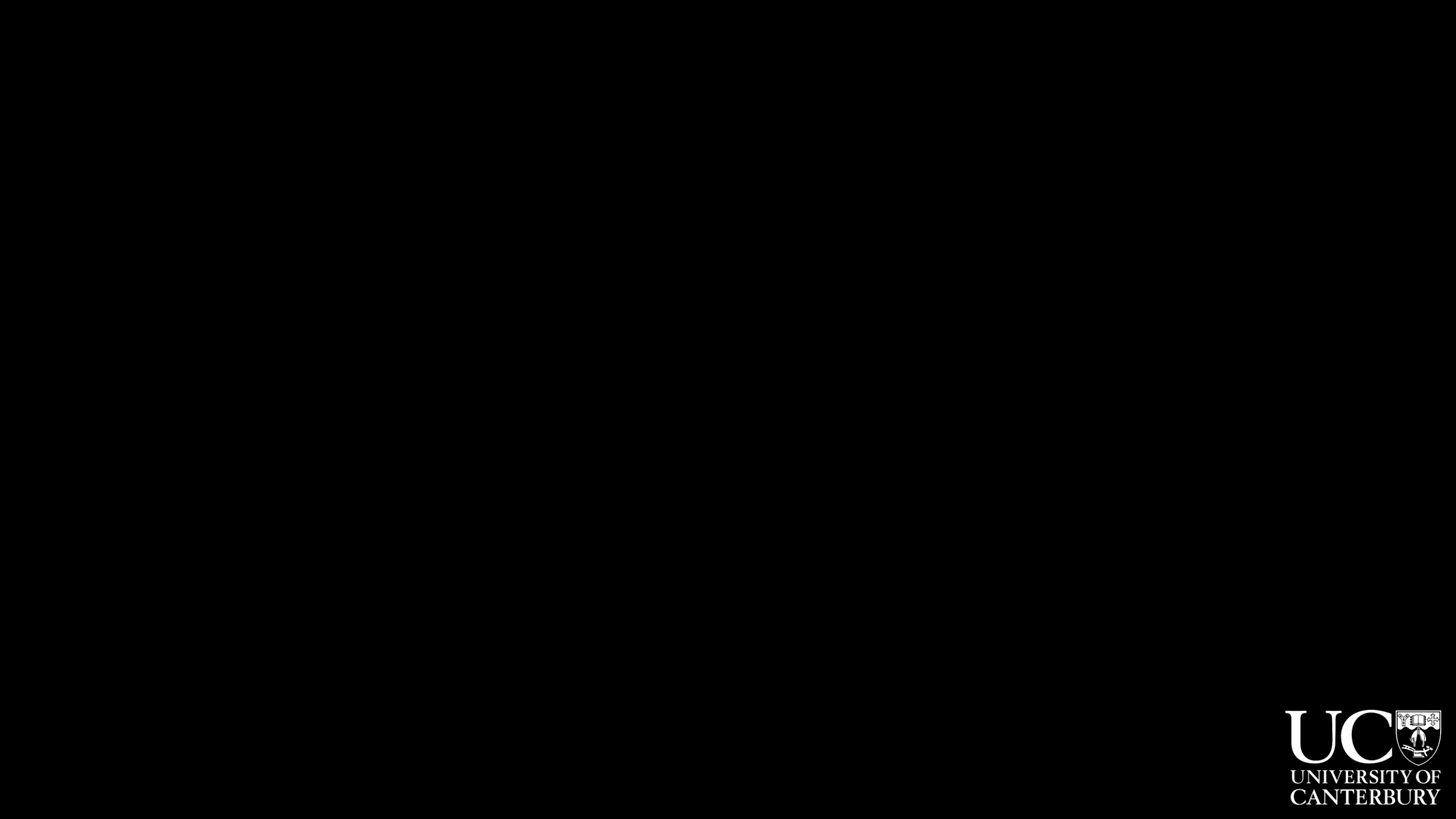
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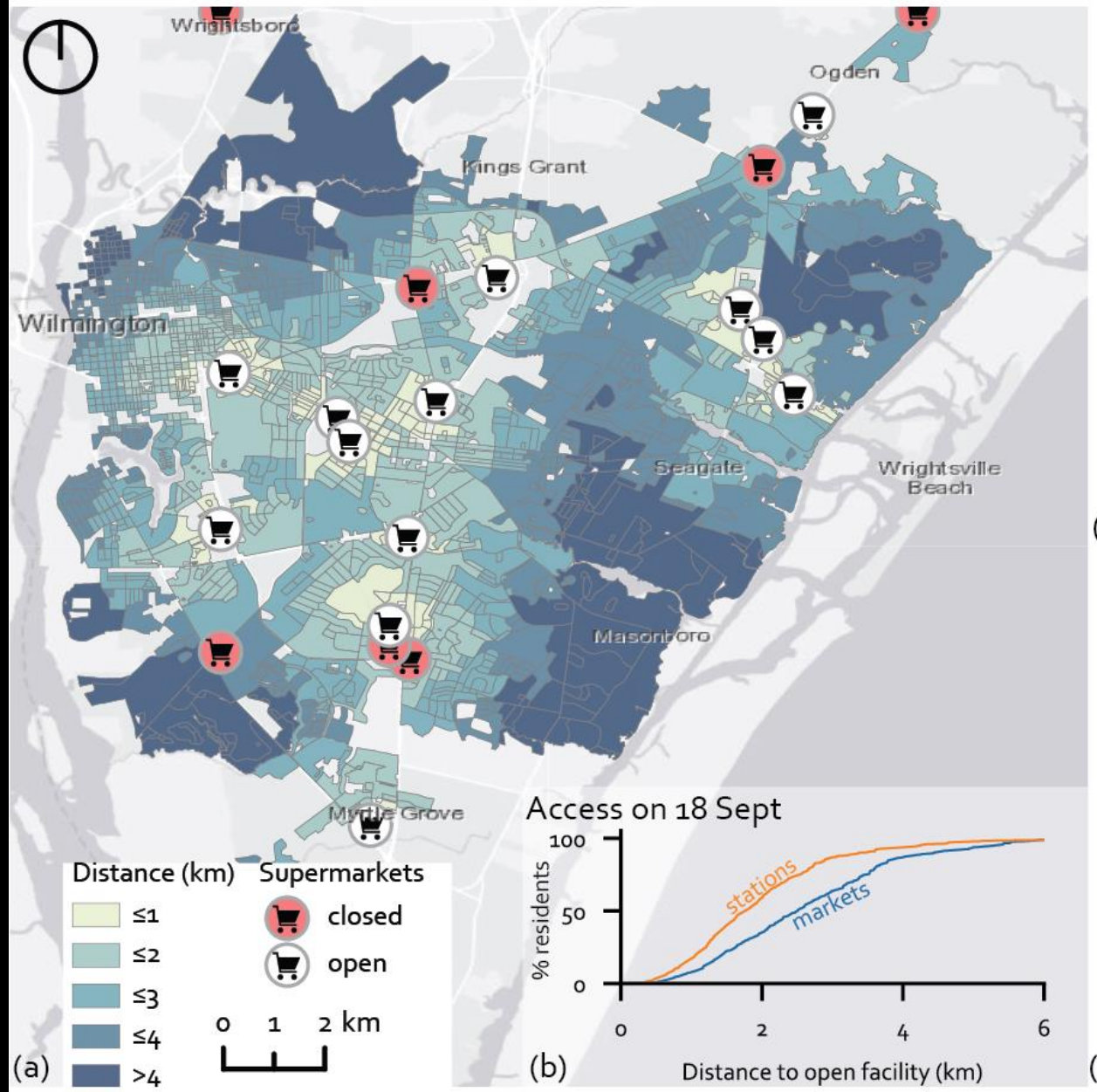

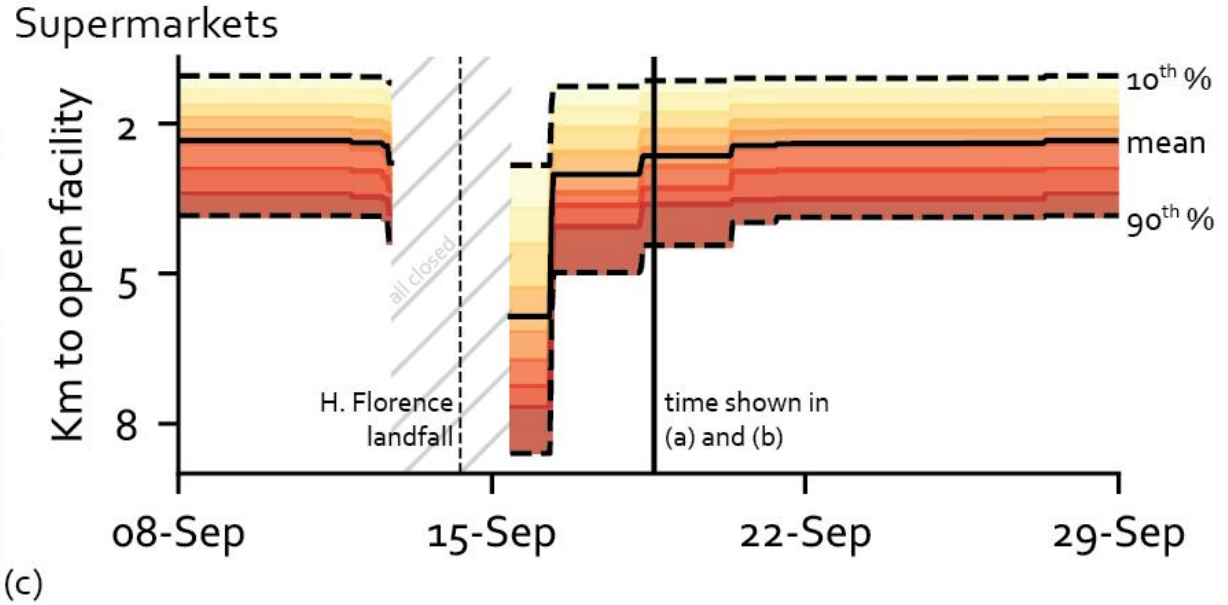

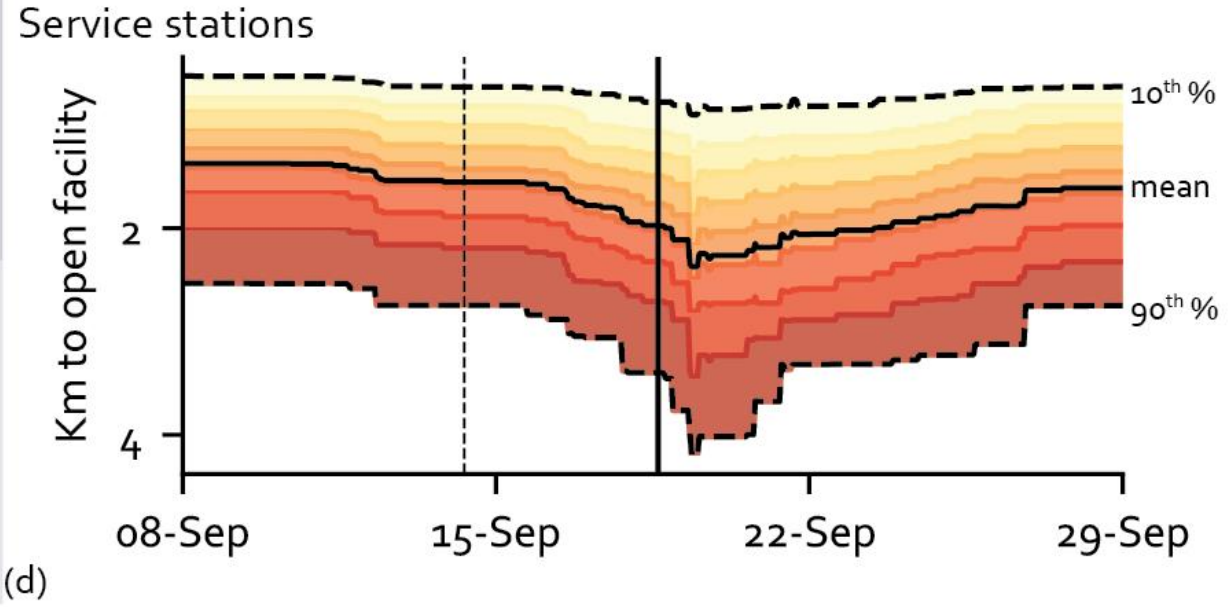

Logan (under review), *Risk Analysis*

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Risk science

- Contemporary risk analysis tools can be used for resilience analysis
  - Yet there are moves to silo the two
- Working on papers that
  - Clarify how risk deals with time
  - Describe how resilience analysis fits within a risk framework
  - Identify how resilience metrics dictate the equity of interventions

Machine learning and spatial data science

- Investigating the land characteristics that drive high urban land temperatures using a variety of AI models
  - Logan, T. M., Zaitchik, B., & Guikema, S. D. (under review). Night and Day: What is the influence and relative importance of urban characteristics on land surface temperature? *Remote Sensing of Environment*.

- Evaluating the effect of density on public health in US cities