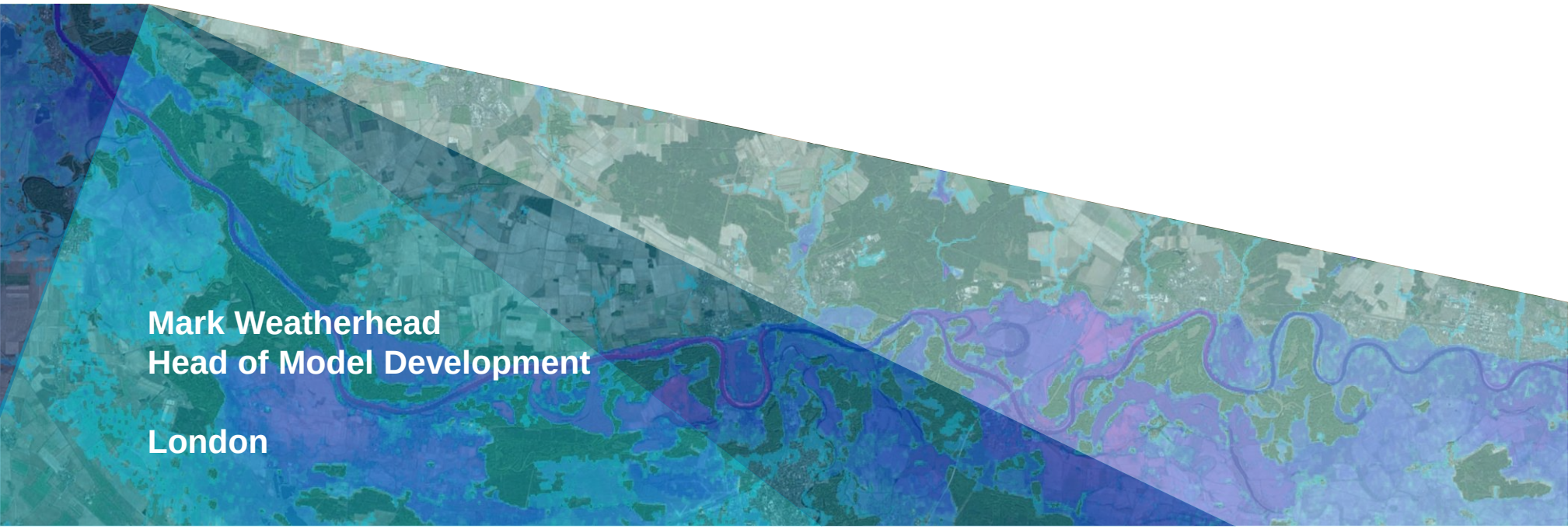
GUY CARPENTER

FLOOD MODEL CHALLENGES AND LIMITIATIONS

NOVEMBER 2016



Mark Weatherhead
Head of Model Development

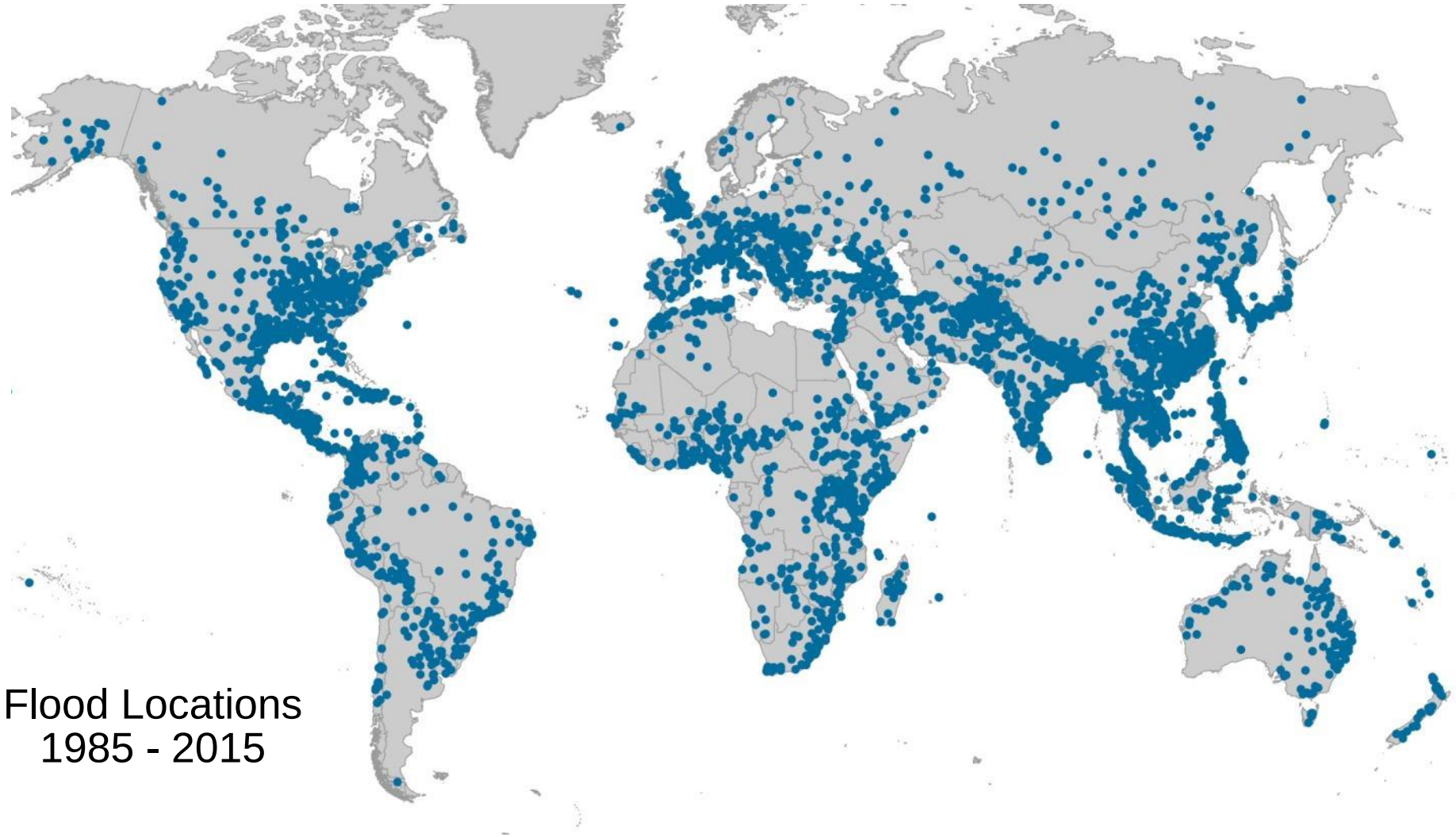
London

MARSH & McLENNAN COMPANIES

Overview

- Recent trends in flood hazard mapping
- Mitigation of flood risk via defences
- The problem with flood damage curves

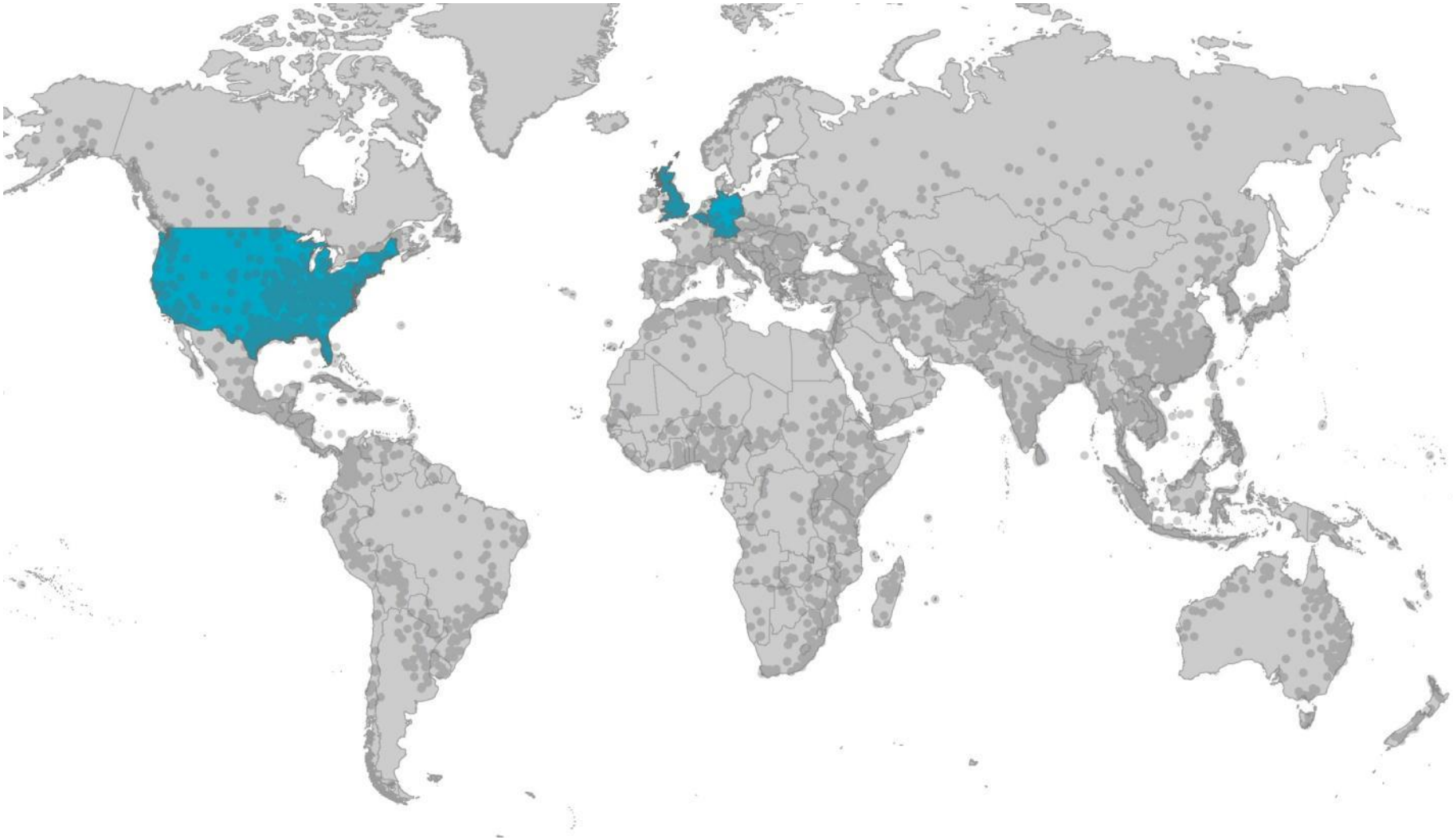
Why are we concerned about flood?



Flood Locations
1985 - 2015

Flood Model Development

To date the “Big Three” vendors have not addressed flood in a broad way



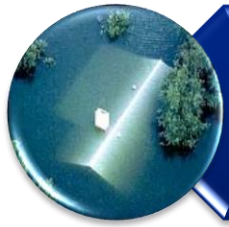
Catastrophe model structure

Hazard

- Hazard maps
- Stochastic event set
- Defence information

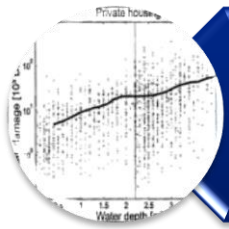
Exposure

- Location
- Building and occupancy types
- Disaggregation



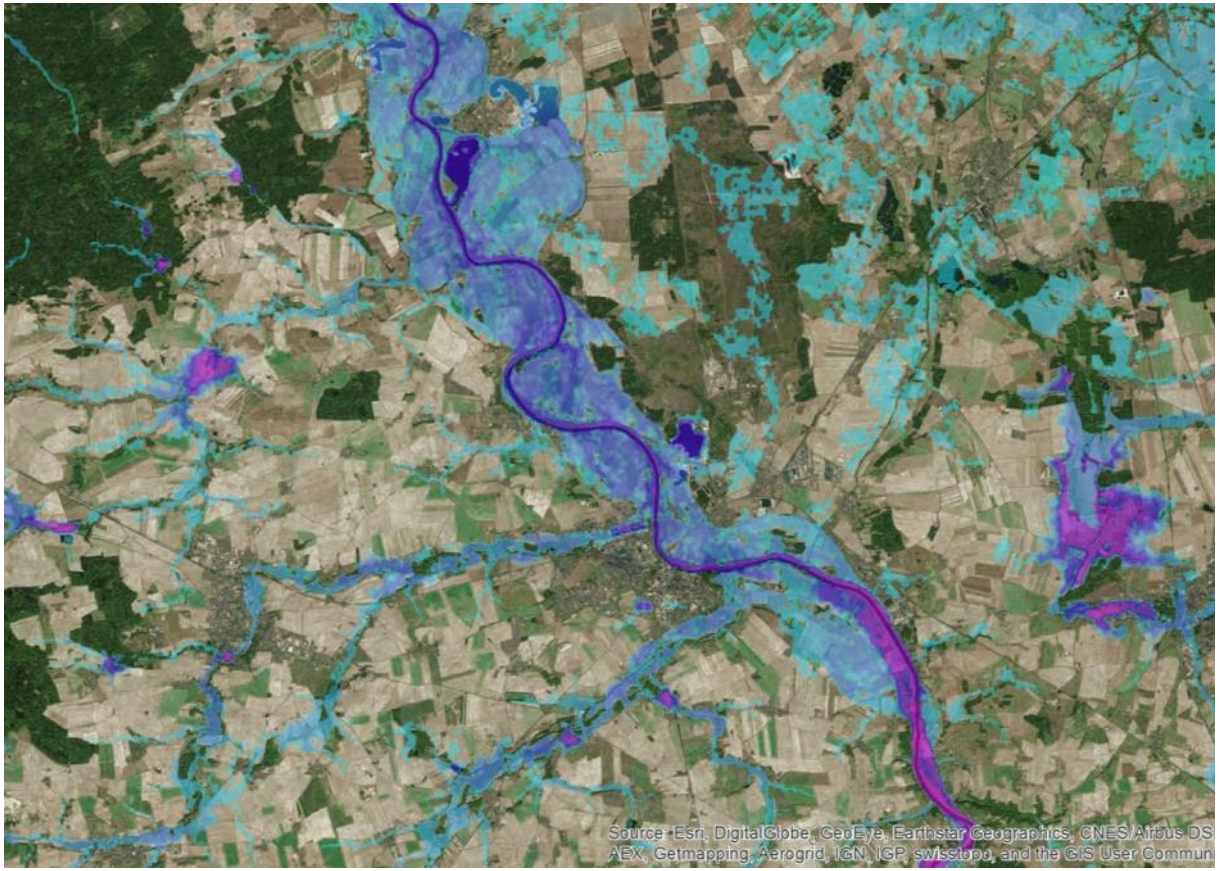
Damage/Vulnerability

- Damages by risk type and hazard intensity



Financial

- Financial conditions
- Deductibles and limits

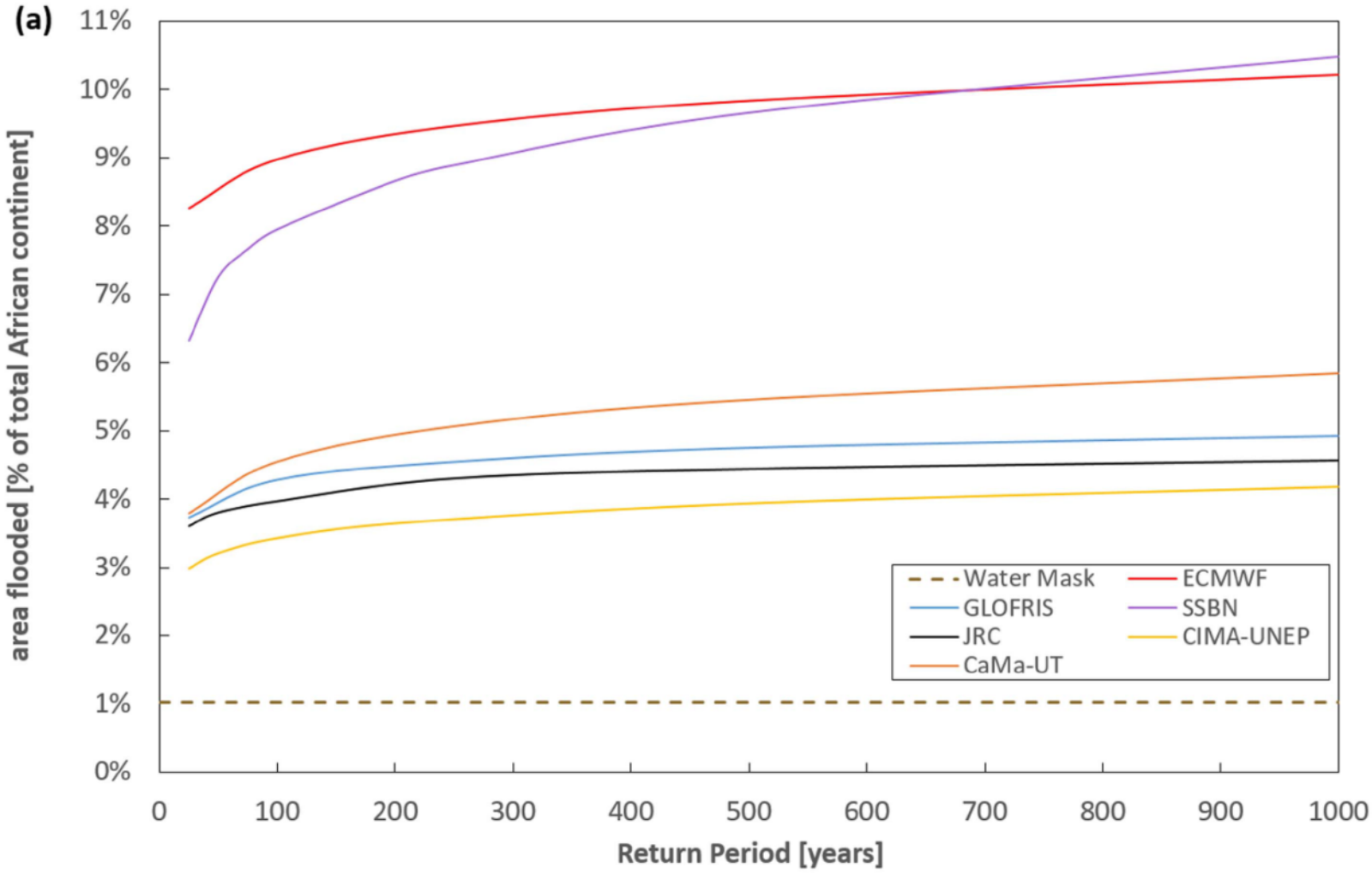


Flood Hazard Mapping

Flood Hazard Mapping

- Global hazard maps now available, typically 10 to 100 m resolution
- Higher resolution hazard maps are commonly available now for most developed countries
  - Focus on public safety
  - Riverine initially, now expanding to Pluvial and other flood types
- Loss models not so available on a global basis
  - Most of the development to date has been by brokers and reinsurers
- Can be big differences between maps
  - Methodology
  - DTM
  - Gauge-based vs Rainfall-runoff.
  - Limited calibration/validation data in many places

Flood inundation model comparison at 1:100 years (SRTM based)



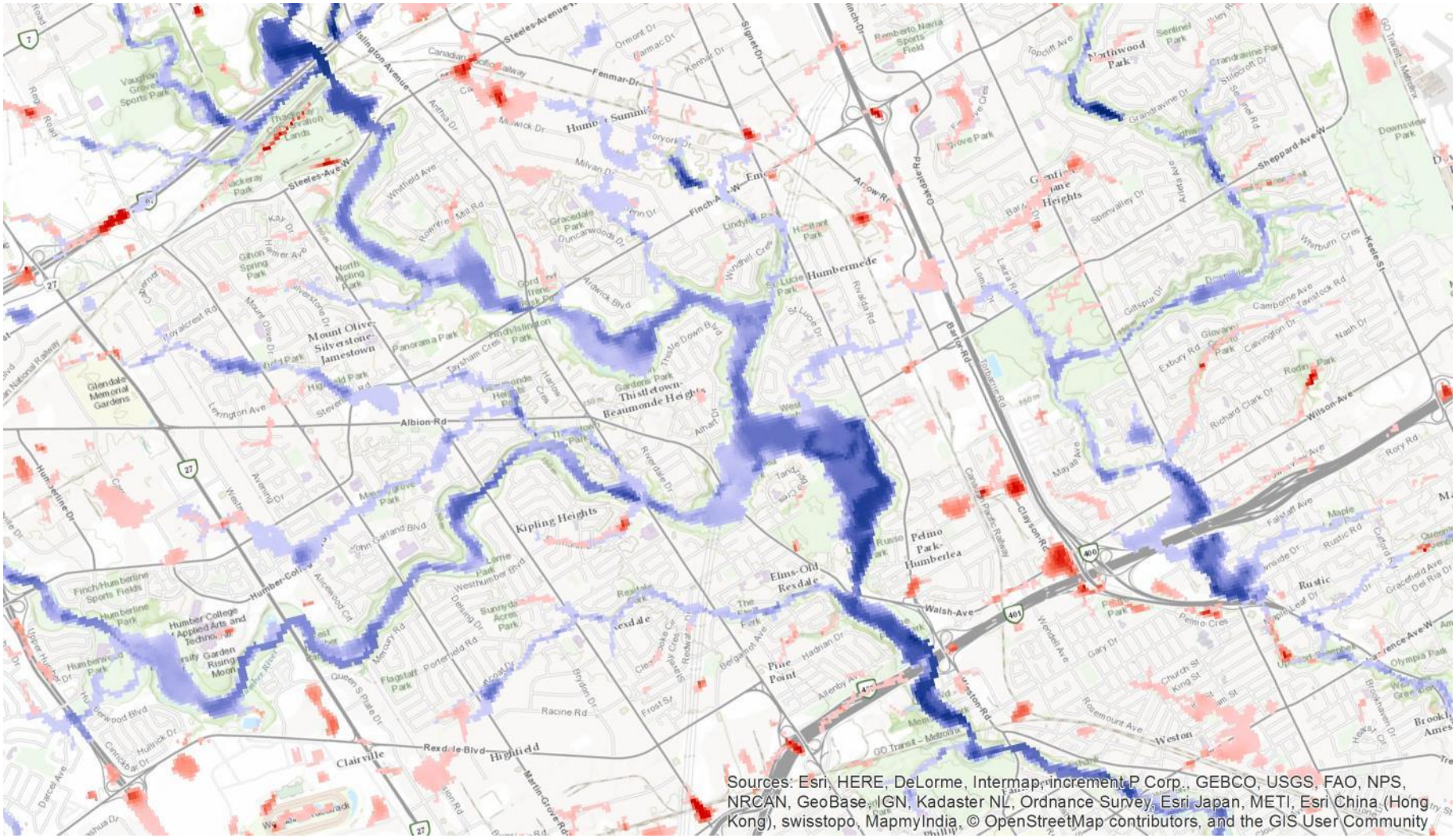
Source: M.A. Trigg et al. (2016) The credibility challenge for global fluvial flood risk analysis. Environ.Res.Lett. 11

The UK is one of the most comprehensively modelled countries

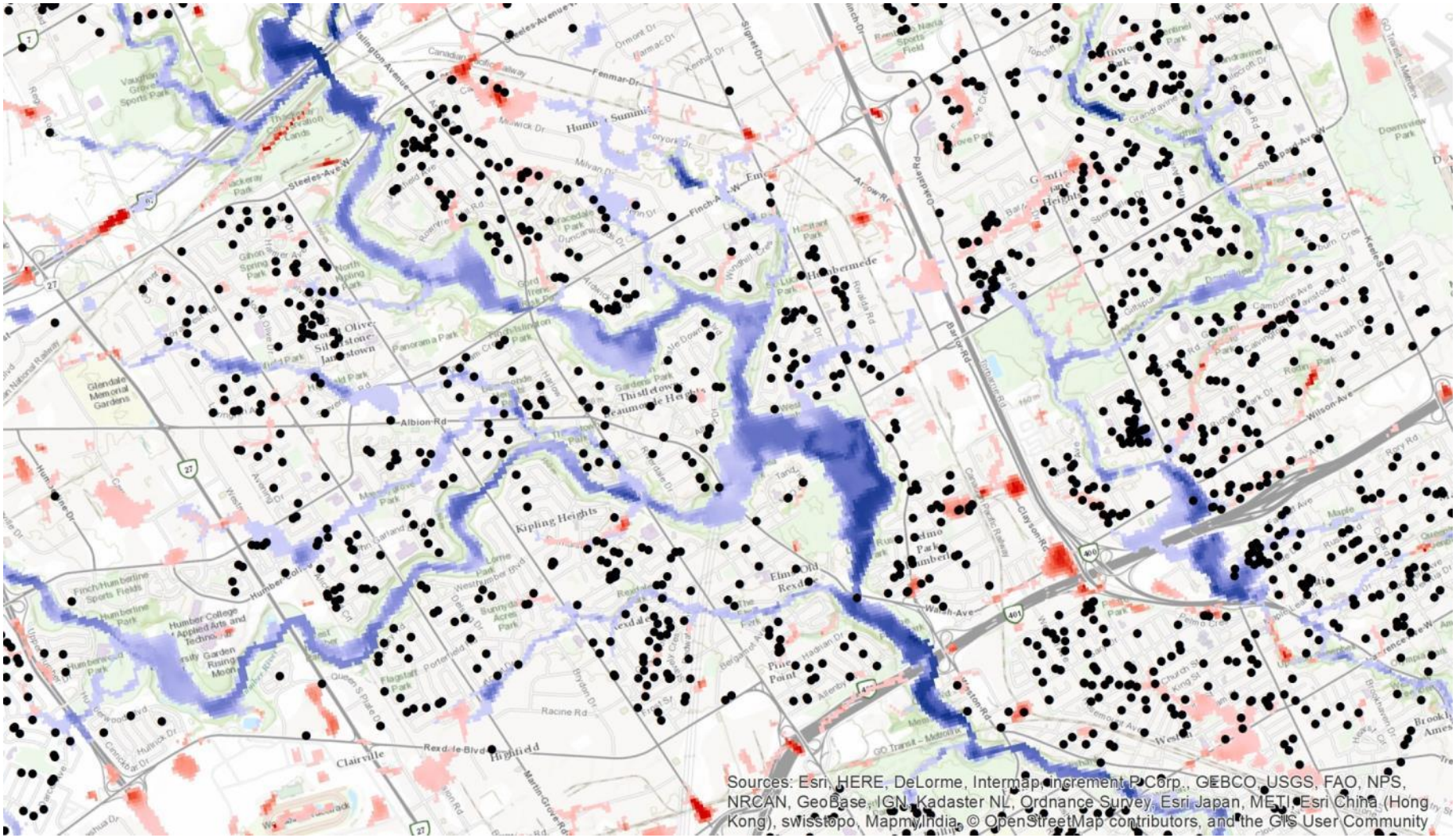
- Hazard Maps
  - JBA
  - HR Wallingford
  - Ambiental
  - KatRisk
  - CH2M
  - Etc..

- Probabilistic models
  - RMS
  - AIR
  - JBA

Pluvial Flood
Important cause of flood losses

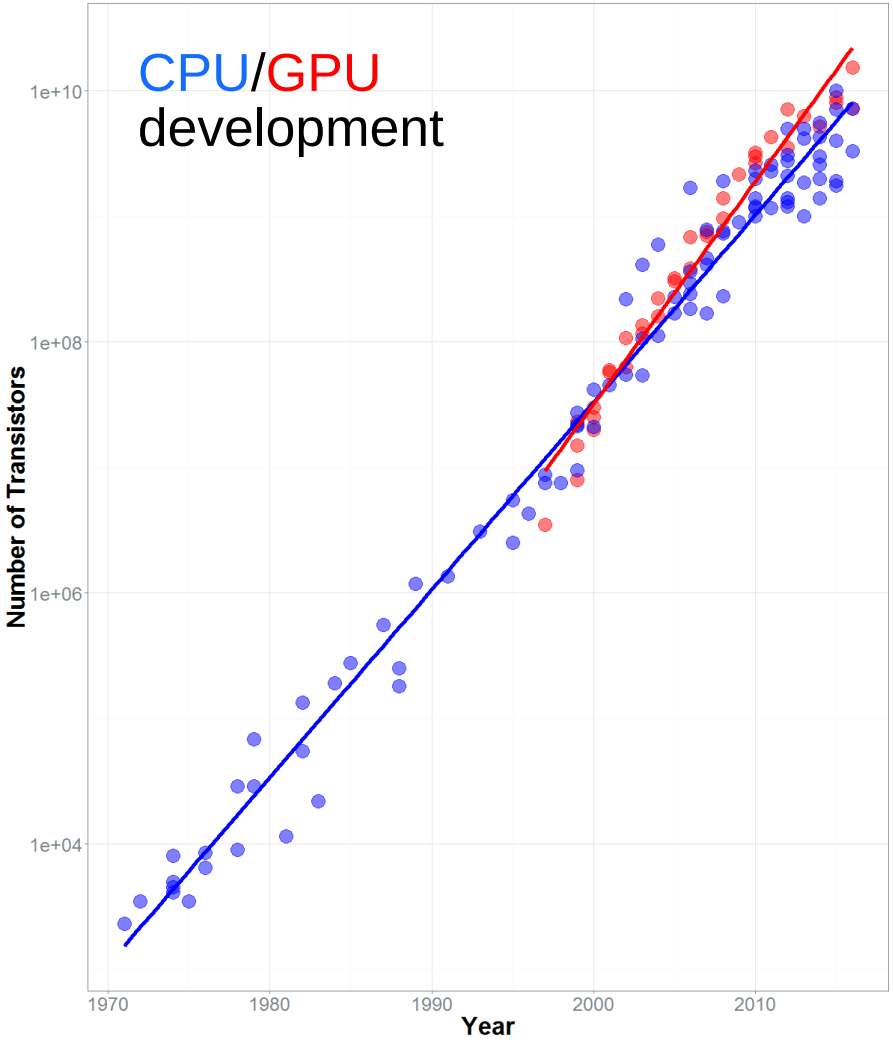


Pluvial Flood
But.. pluvial claims and pluvial maps often don't match

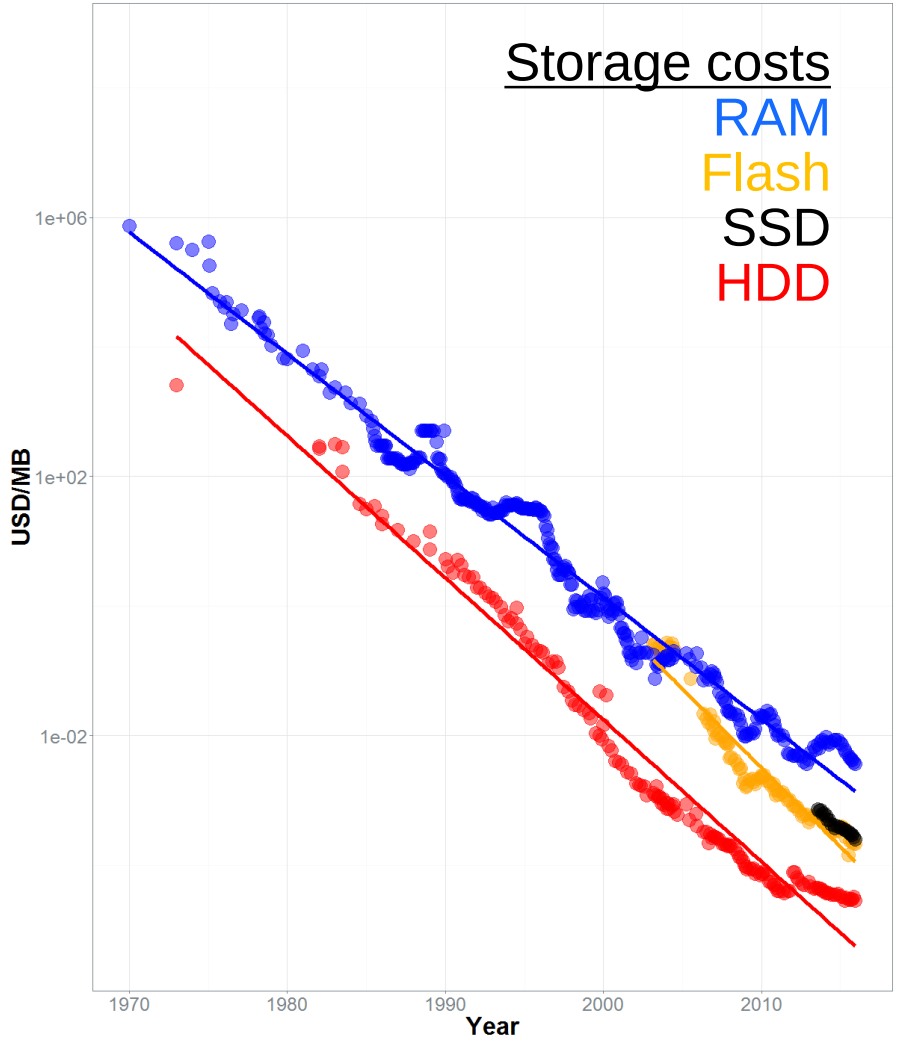


Changes in Computing

We can deal with increasingly large scales and higher resolutions



Source: Wikipedia



Source: www.jcmit.com

Digital Elevation Models (DEMs)

LIDAR and Satellite based data becoming more widespread and cheaper

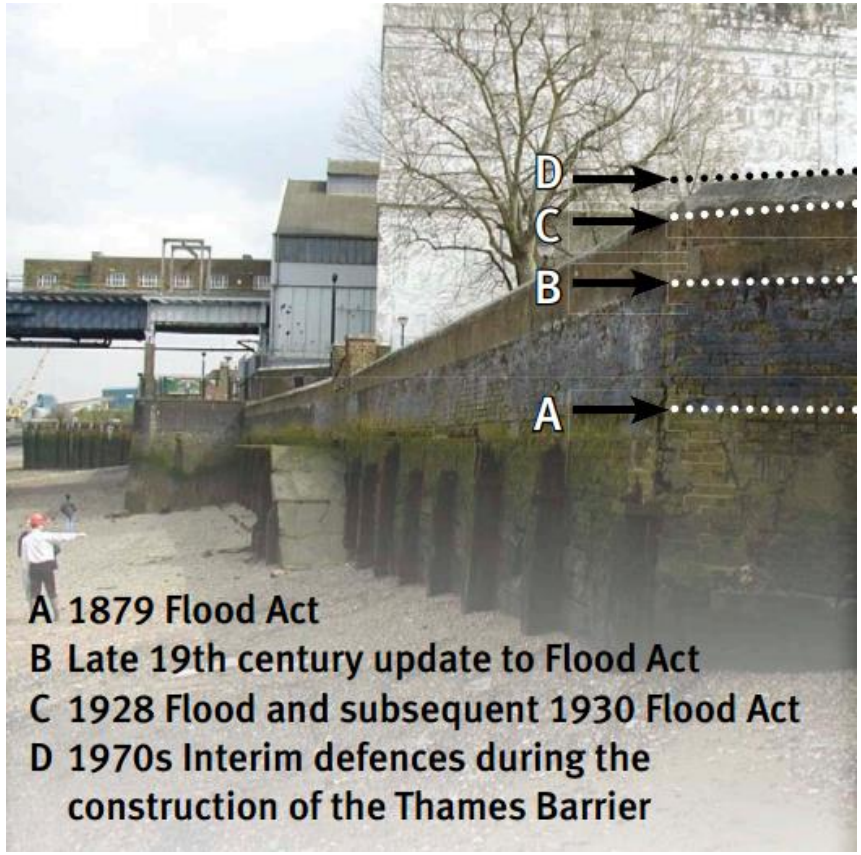
- GTOPO30 ~ 1km
- SRTM ~ 90m
- ASTER ~ 30m
- WorldDEM ~ 12m

- UK (EA) – 2m → 0.5m
- USA – 30 → 3m
- AUS – 5m (coastal/populated areas)
- NZ – 8m

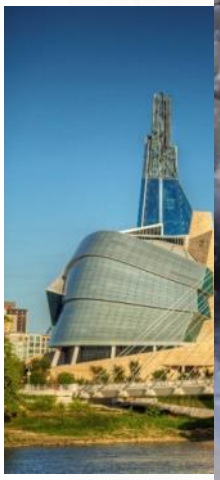
Flood Defences

Defences

- Defences are critical to assessing flood impacts
- Very difficult to assess during flood extent modelling
- Can be done on a local scale, but downstream effects are not usually assessed as the number of potential outcomes increases exponentially
- Data is often poor or incomplete
- Usually planned and executed at local scales with limited consideration of impacts further up/down-stream. This is particularly problematic when rivers cross national boundaries.
- **How do we model human action?**



Example : Red River @ Winnipeg



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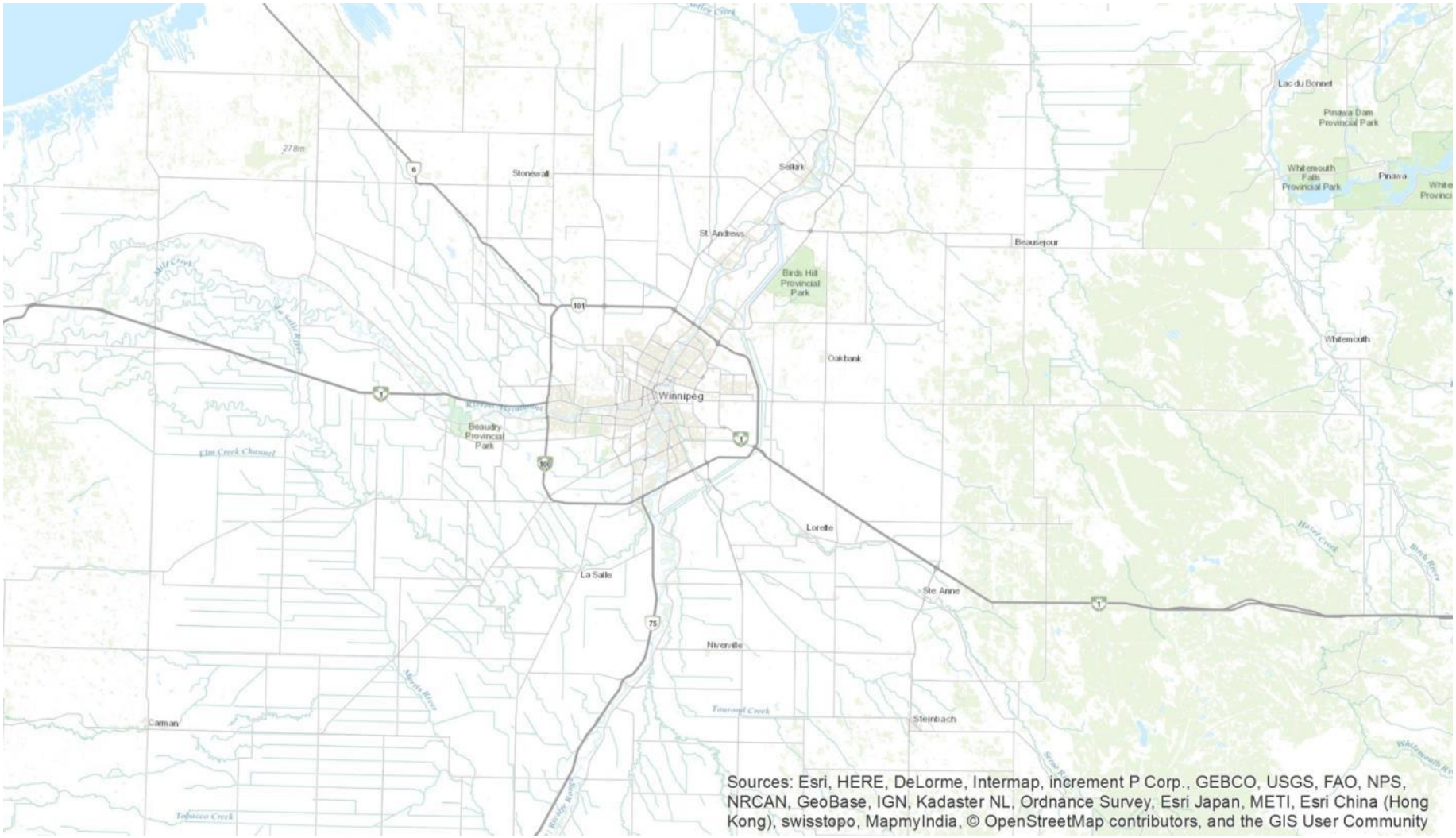

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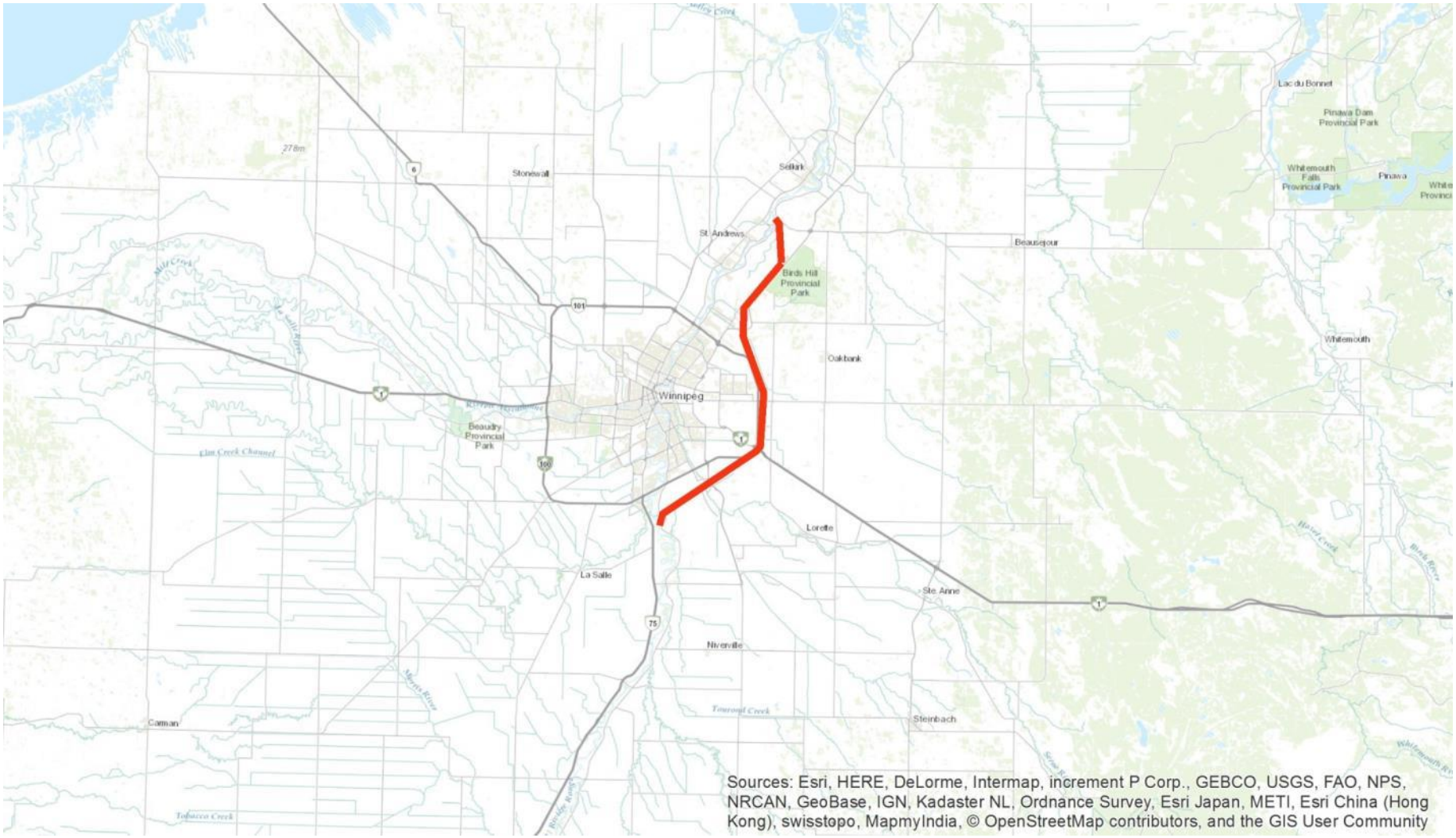
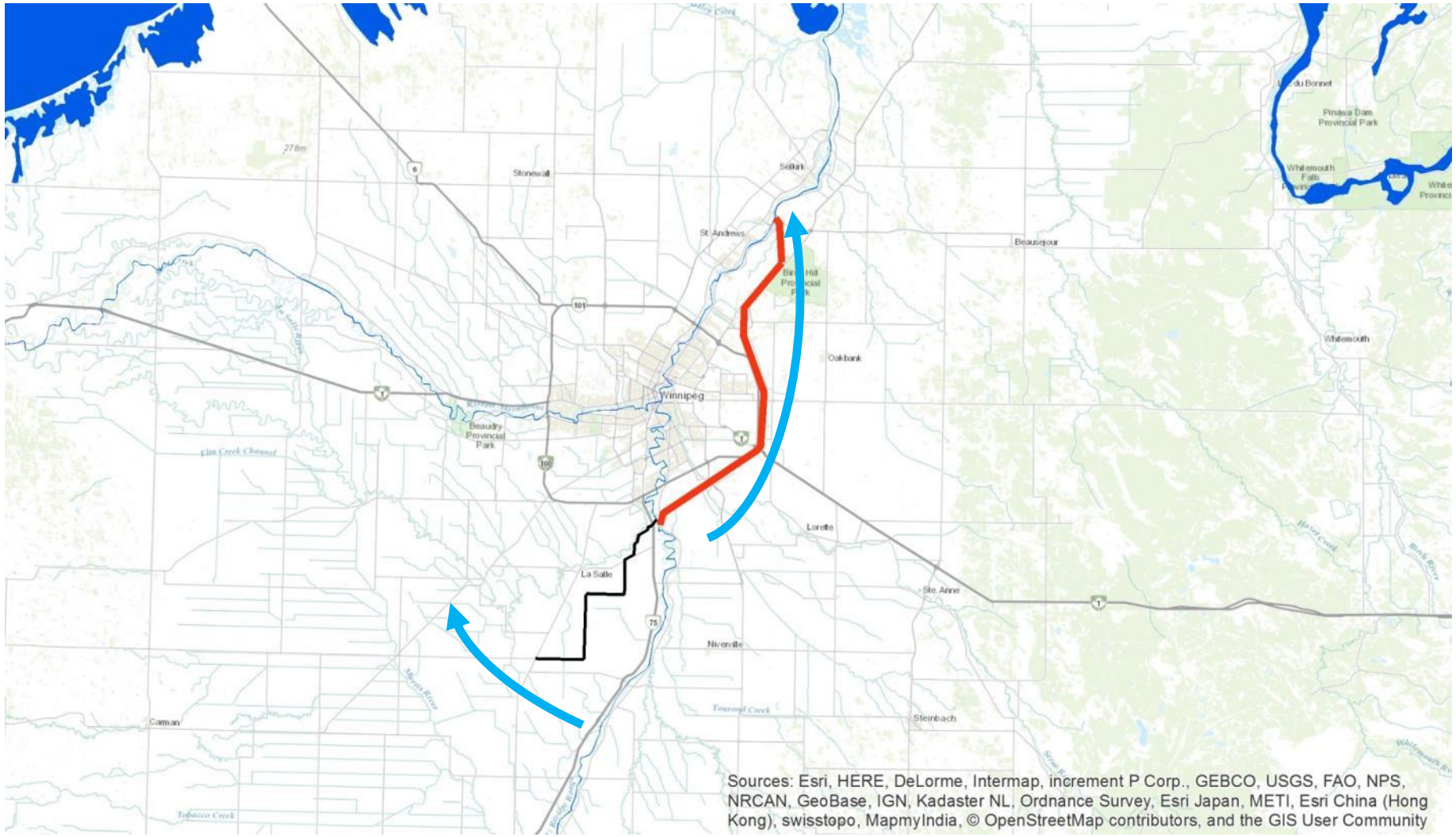
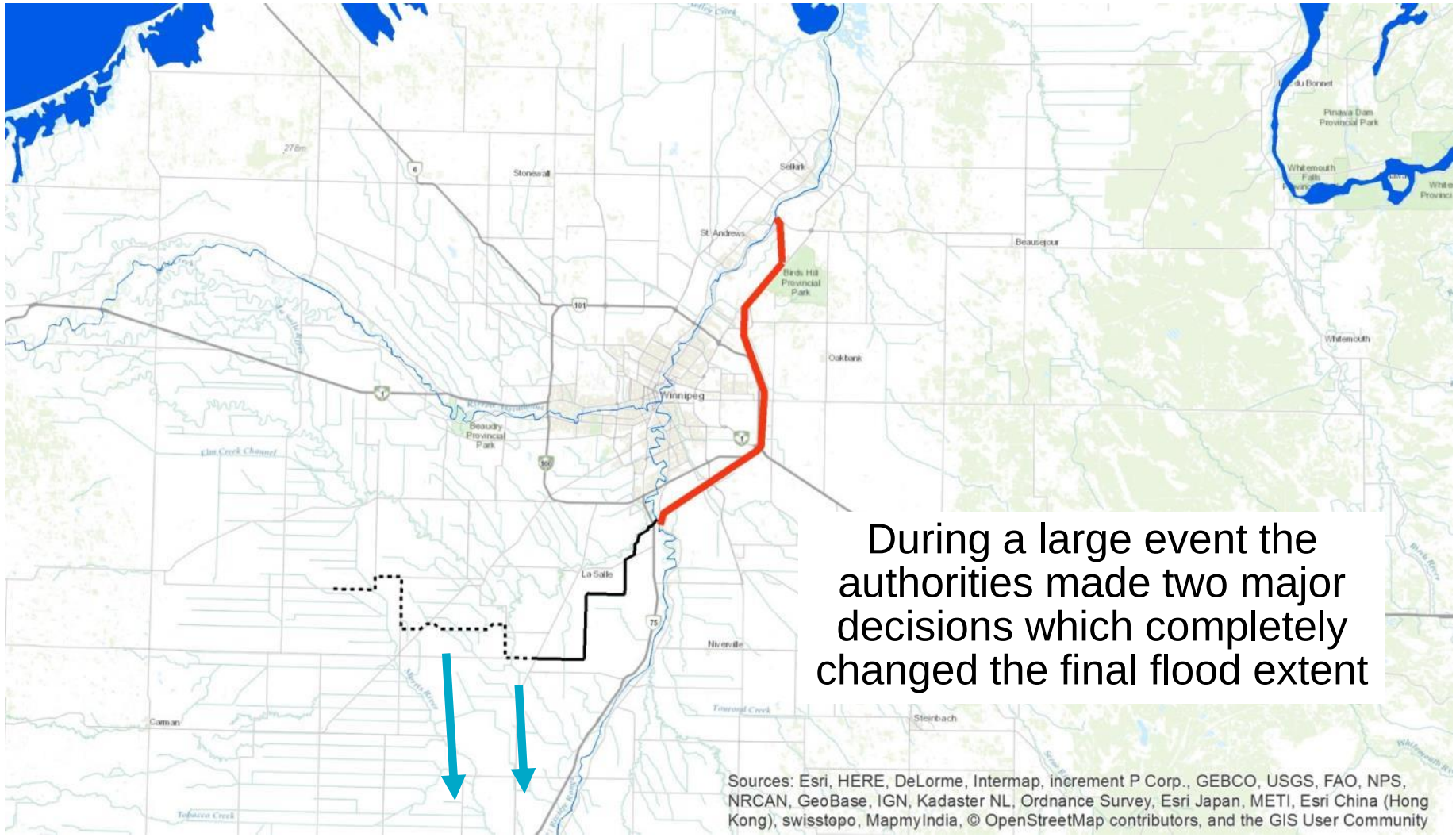


Example : Red River @ Winnipeg
Red River Waterway

Example : Red River @ Winnipeg
“100 Year Flood” in 1997



Example : Red River @ Winnipeg
"100 Year Flood" in 1997



Mobile Defences

Mobile defences are becoming more common

Mobile Defences
Can be quickly deployed and assembled

Source: http://www.geography.org.uk/resources/flooding/bewdley/gallery/

Mobile Defences

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Mobile Defences

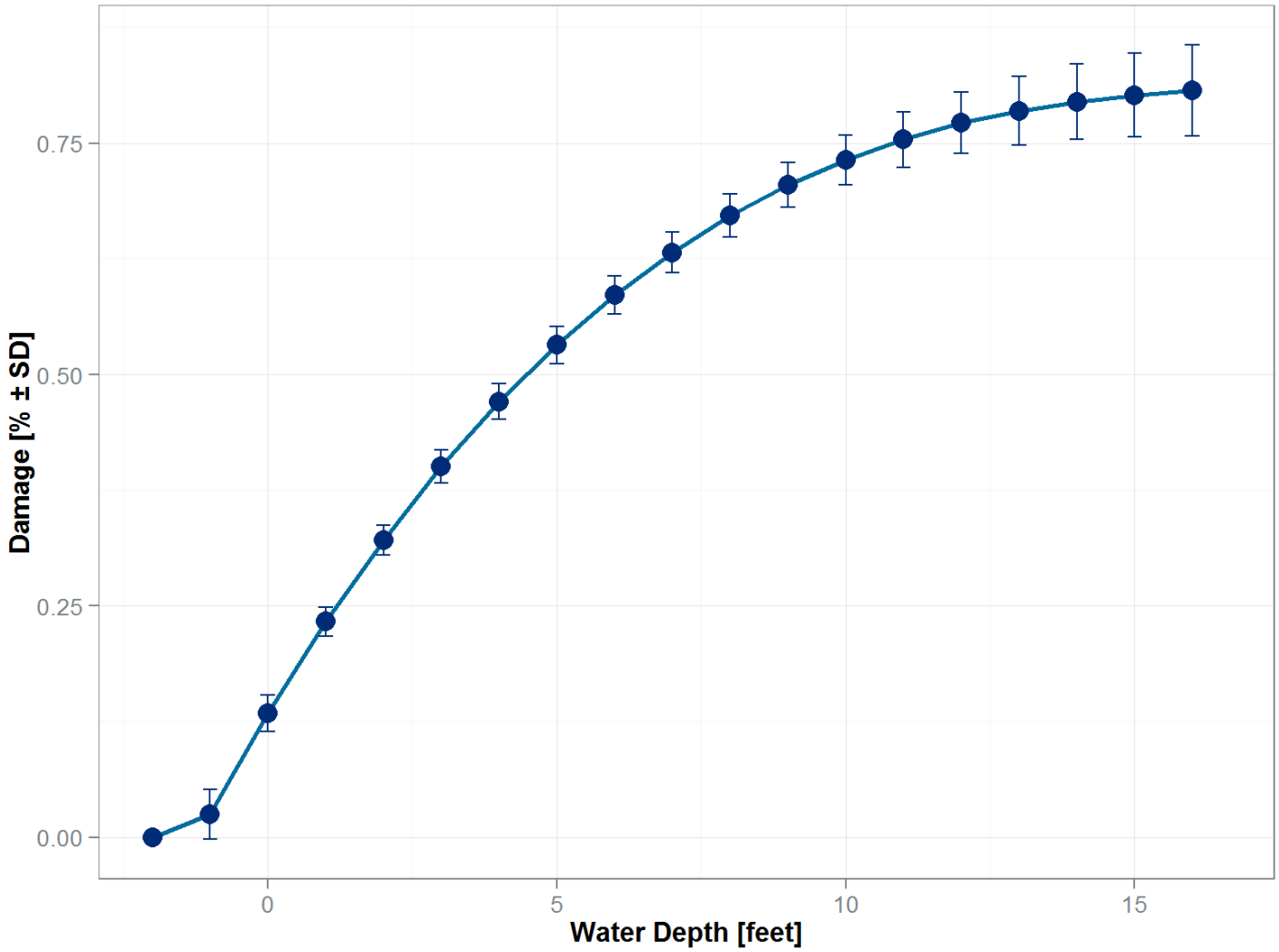
Mobile Defences
Very effective but not always easy to model

The lesson of Prague 2002

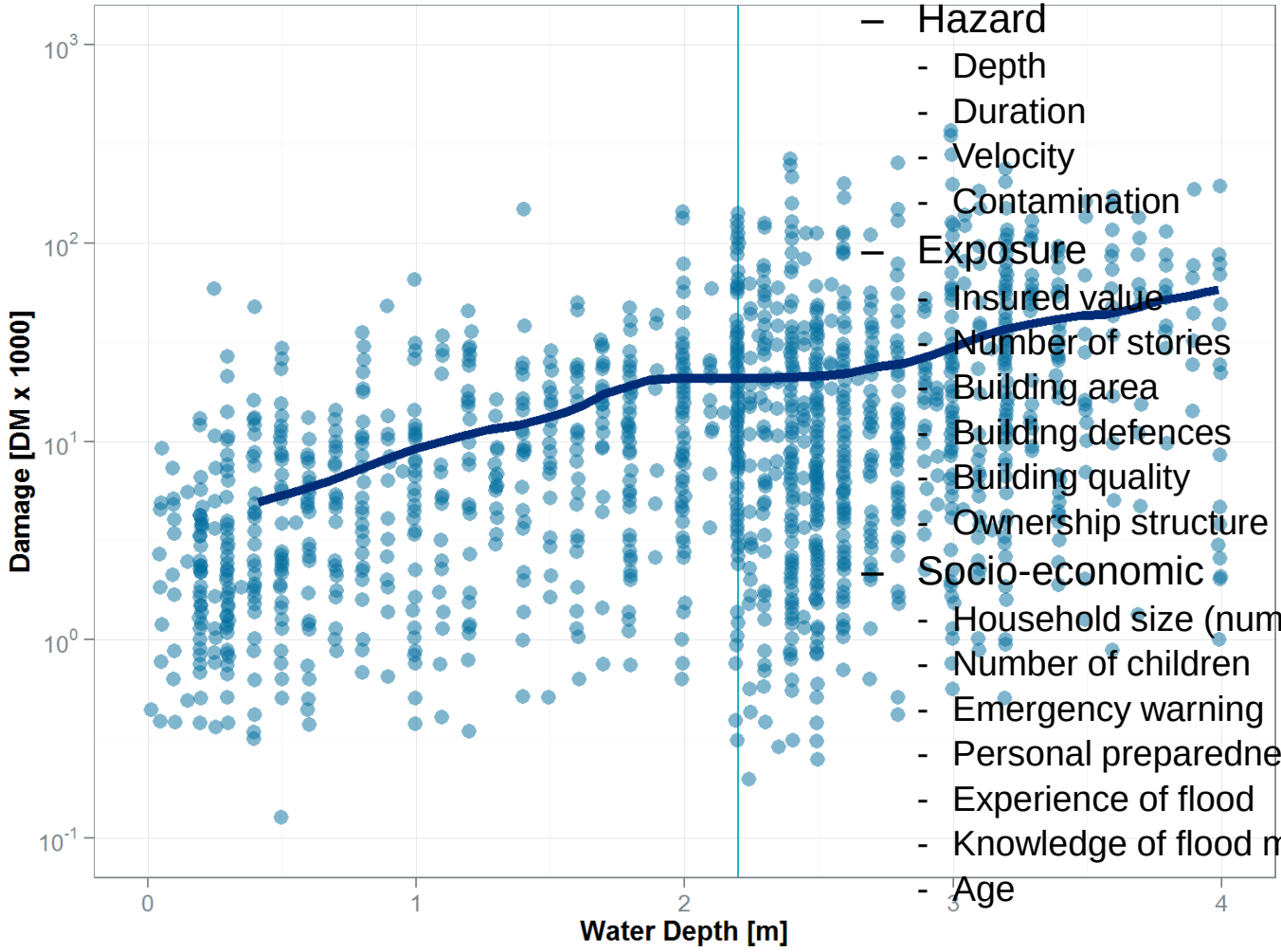
We can’t just assume that standard operating procedures will be followed

Damage Curves

Damage Curve
Hypothetical/Engineering, e.g. US Army Corp of Engineers



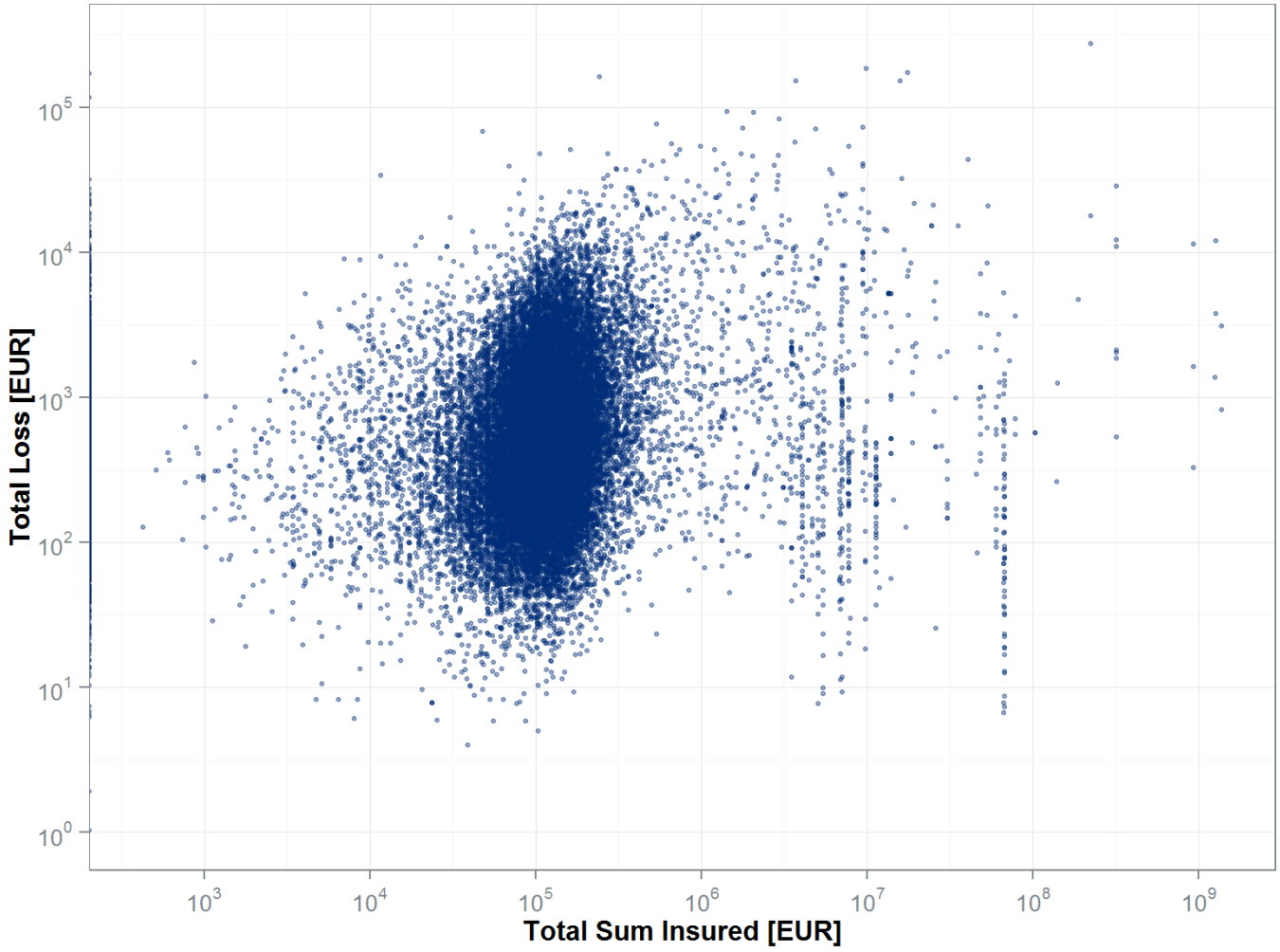
Vulnerability Functions – the Reality
e.g. Merz et al 2004



- Key factors determining loss*
  - Hazard
    - Depth
    - Duration
    - Velocity
    - Contamination
  - Exposure
    - Insured value
    - Number of stories
    - Building area
    - Building defences
    - Building quality
    - Ownership structure
  - Socio-economic
    - Household size (number of people)
    - Number of children
    - Emergency warning
    - Personal preparedness
    - Experience of flood
    - Knowledge of flood mechanism
    - Age

** (Theiken et al., 2005)*

Vulnerability Functions
Losses not always proportional to exposed value



Conclusions

- Flood hazard mapping is becoming a commodity product.
  - The gap is with supporting information such as gauge data
- Human actions, especially in the case of active defences, are particularly difficult to model.
  - Is there some way to take a stochastic view?
- Depth-damage curves are the standard as they are easy to implement and intuitive
  - Unfortunately in reality they explain very little