Back to the drawing board: Engineering and planning to manage risk

Session lead:
Jo da Silva, Director, Arup International Development

Panellists:
Standards – Hayley Gryc, Arup International Development
Performance – Dr. Damian Grant, Arup Advanced Technology
Casualties – Professor Robin Spence, Cambridge Architectural Research Ltd
Modelling – Dr. Matthew Free, Arup Geohazard and Risk Management

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Standards

Hayley Gryc

Associate, Arup International Development

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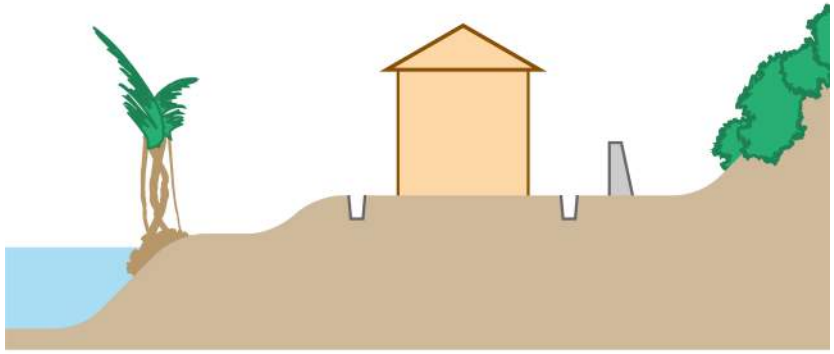
Haitian Earthquake 2010

Location & Environment



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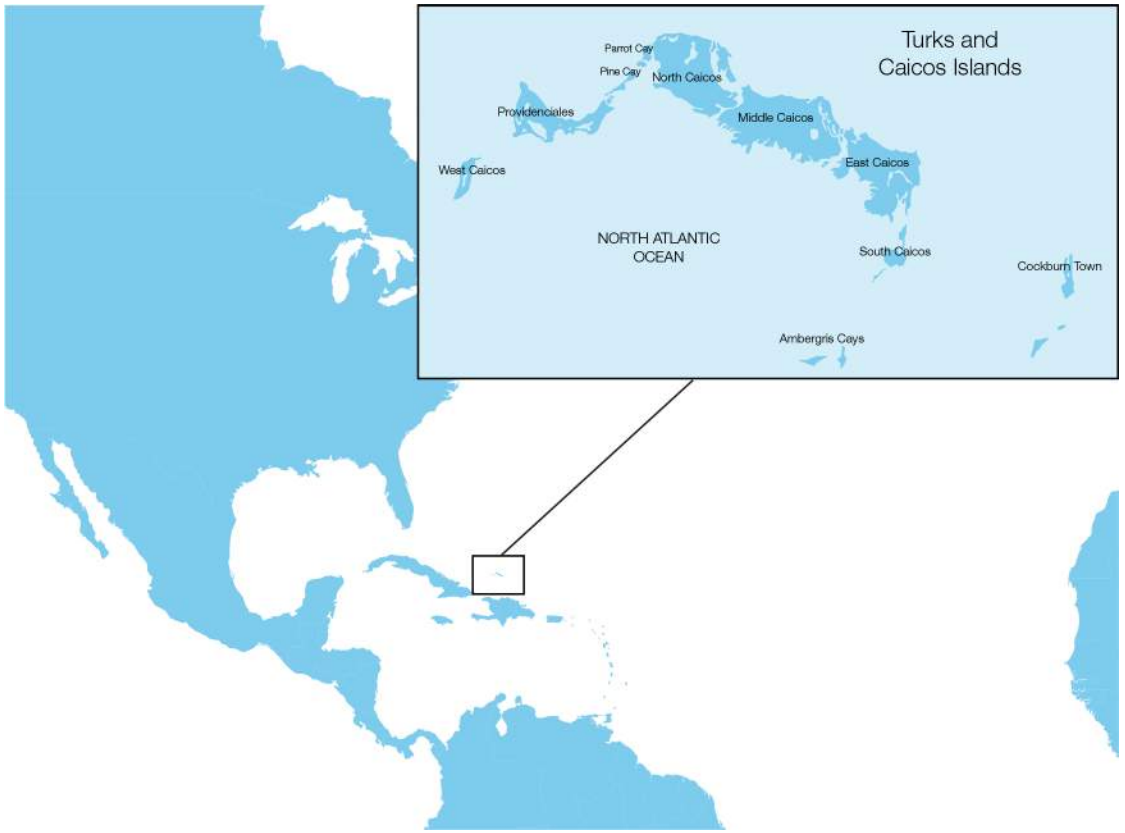
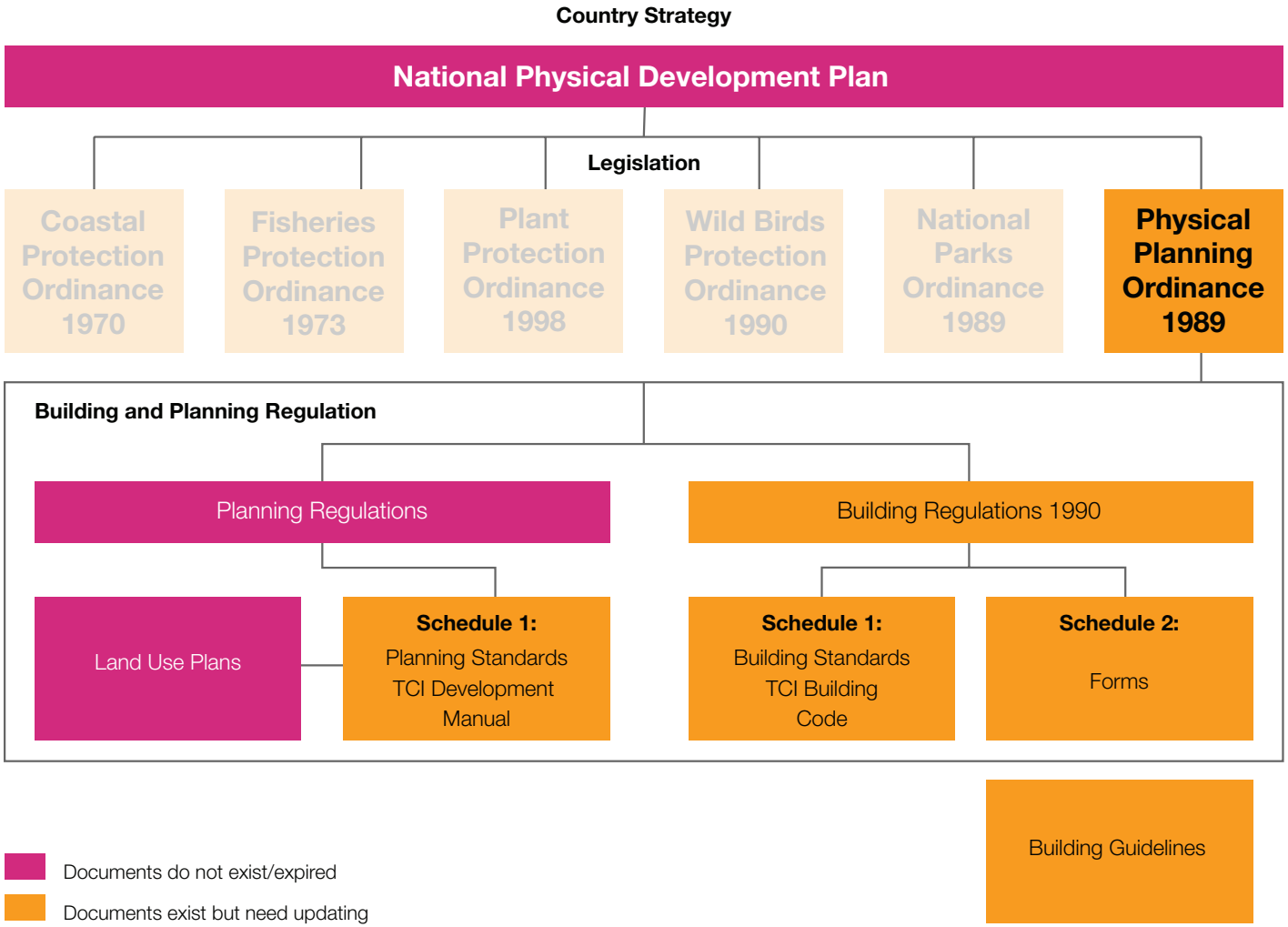
Turks and Caicos Islands: Hurricane Ike, 2008



Turks and Caicos Islands: Regulatory framework



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Coastal Vegetation destroyed

Building Standards (codes) are only effective if:

- They are up to date
- They incorporate current understanding and perceptions of risk
- They are part of a regulatory framework and are enforced
- They reflect local forms of construction
- They are easy to use
- They are part of a wider culture of safety and environment concerns – which includes education and training

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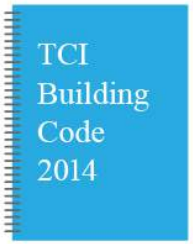

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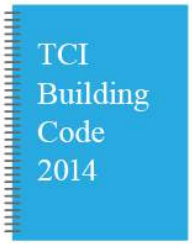
Easy to Use,
Clear and Concise


TCI
Building
Code
2014

1. Self certification
2. Review consultants
3. Skills audit

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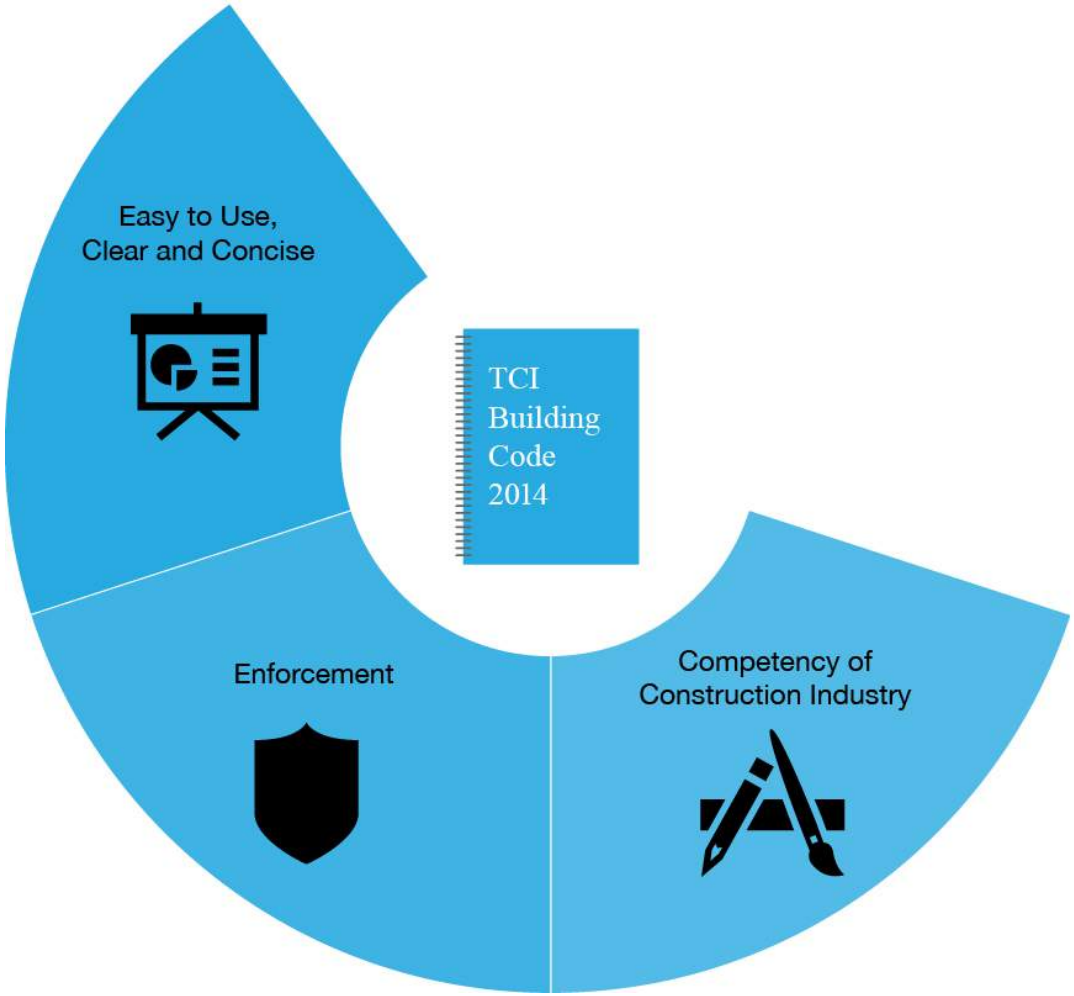

1. Registering designers
2. Building guidelines

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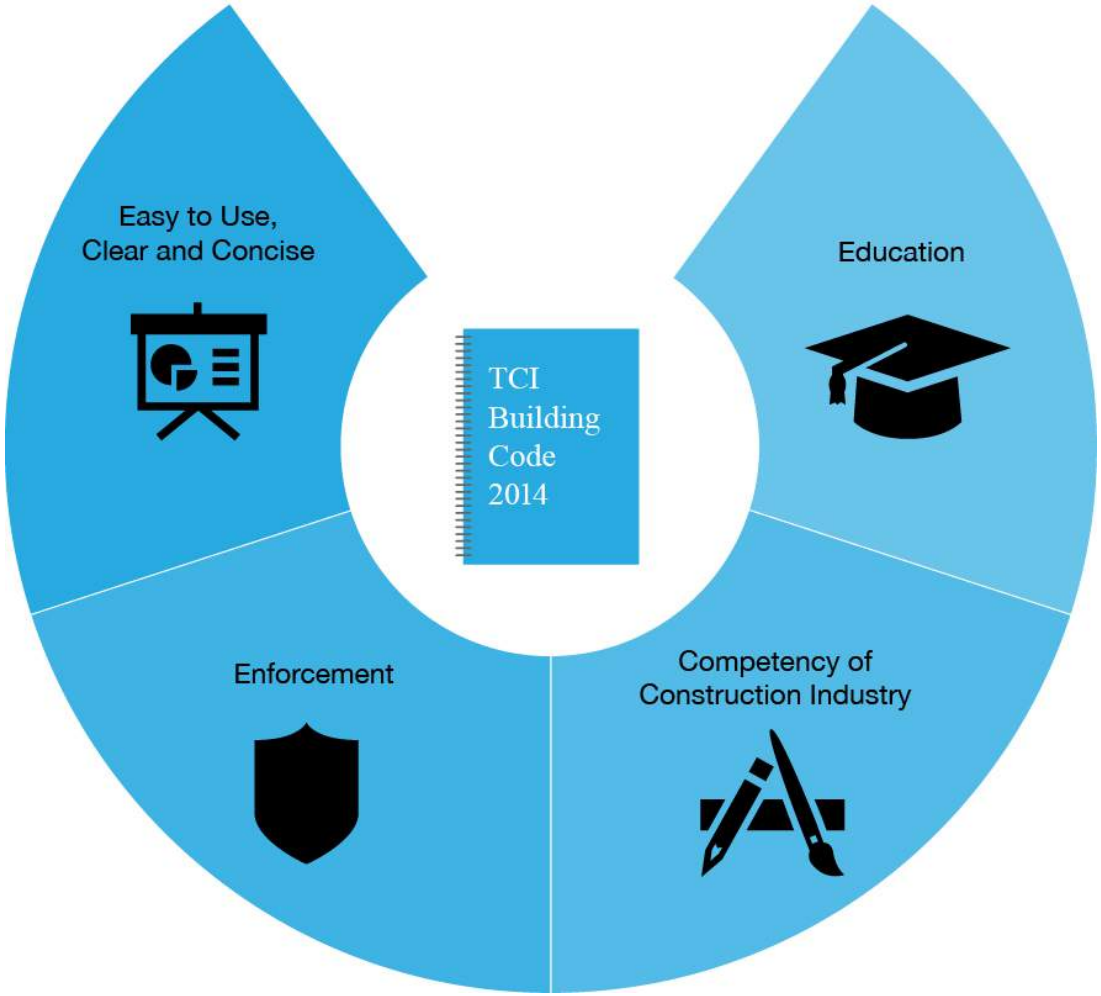

Specific Hazards

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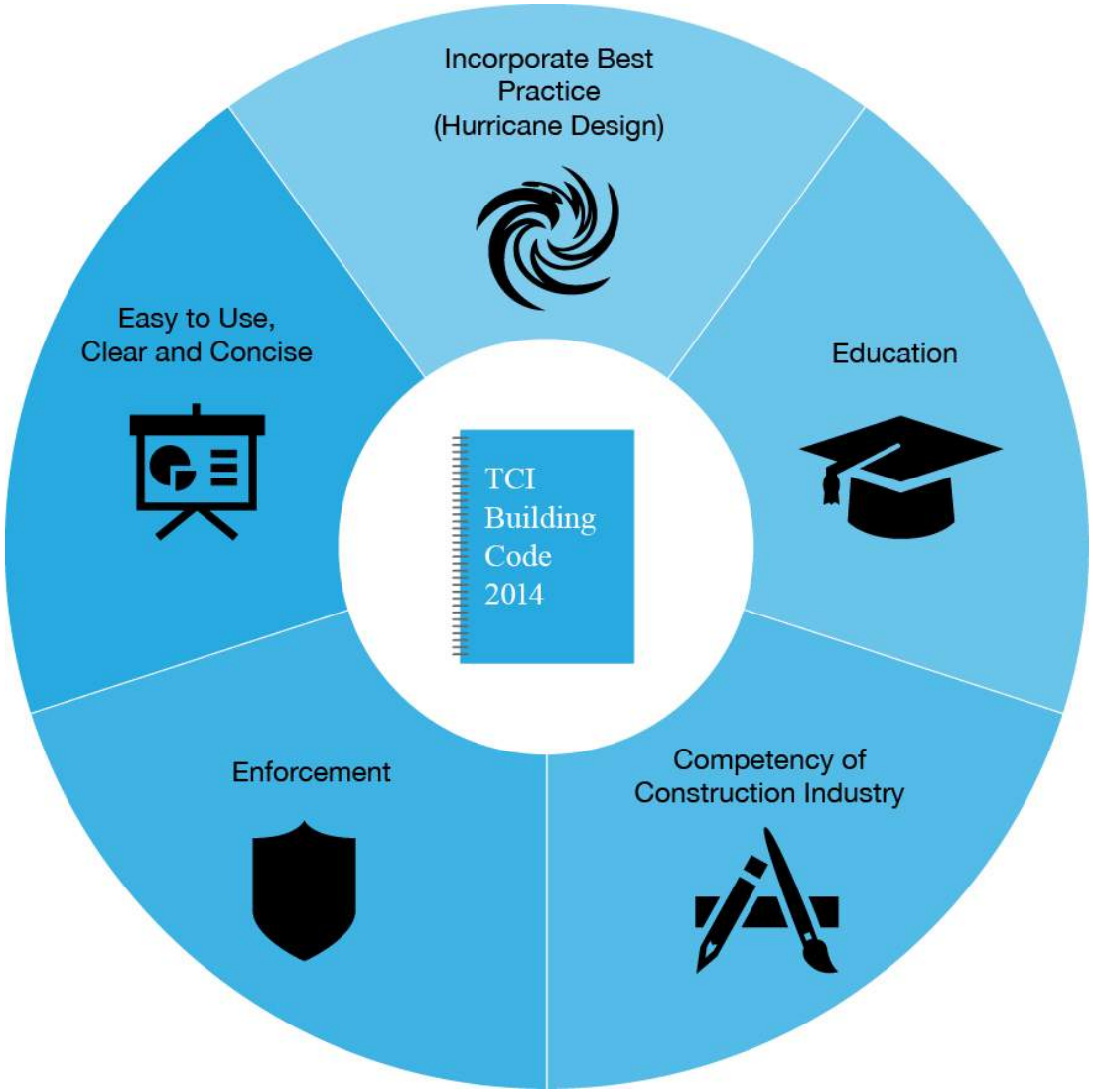

e.g. Timber Design

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Summary

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Performance

Dr. Damian Grant

Associate, Arup Advanced Technology

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Code specific performance

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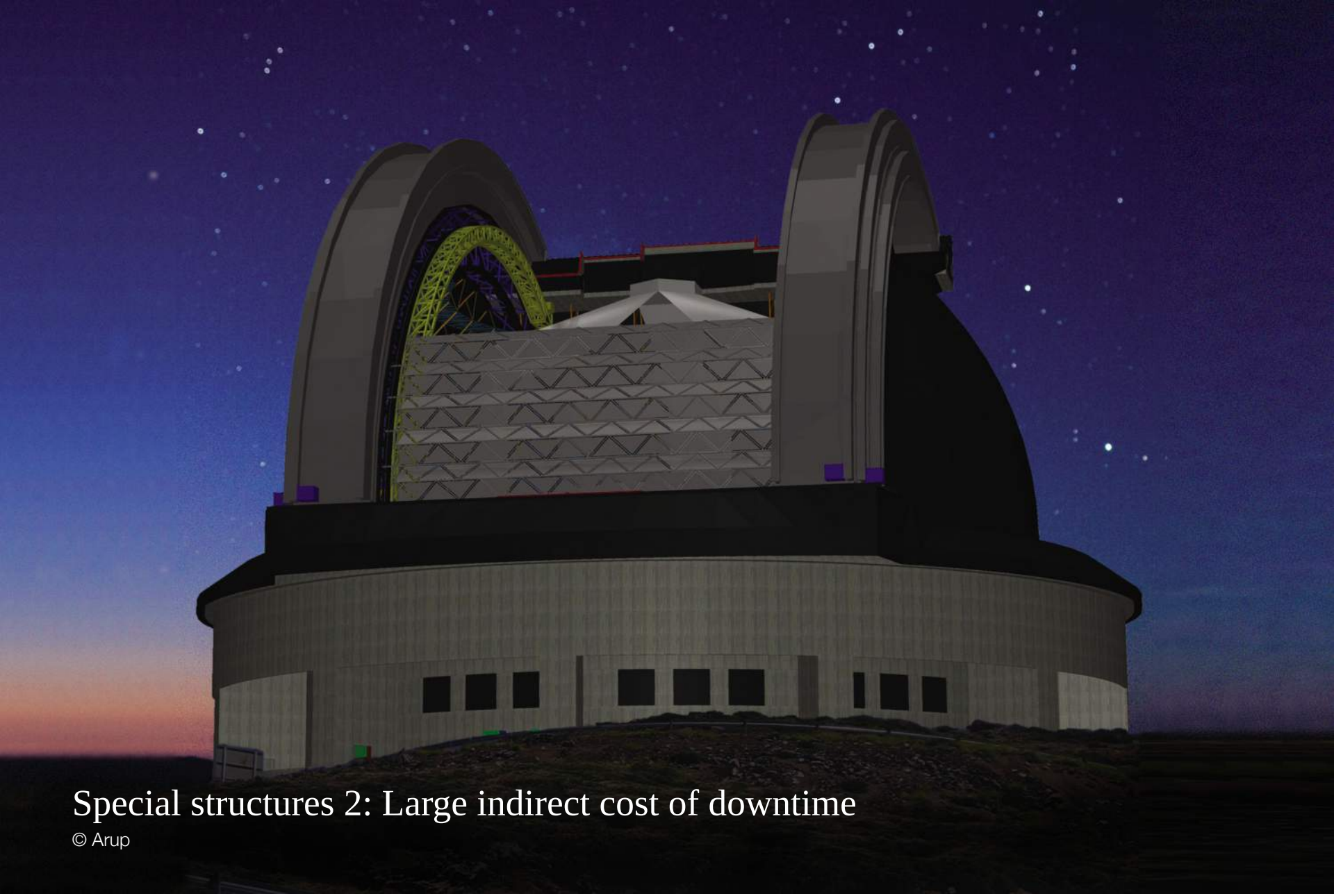
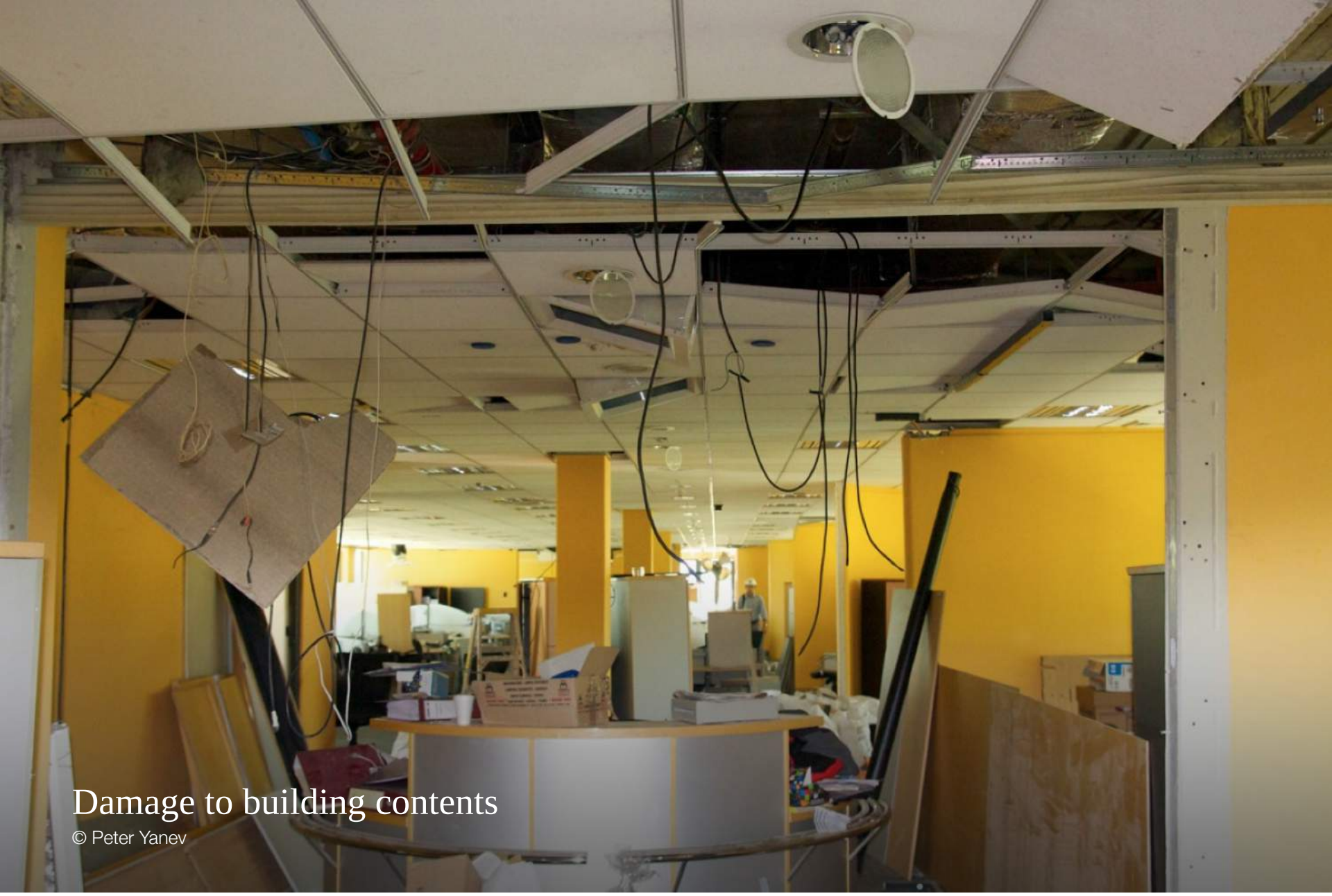
Special structures 1: Irreplaceable cultural heritage



Special structures 2: Large indirect cost of downtime



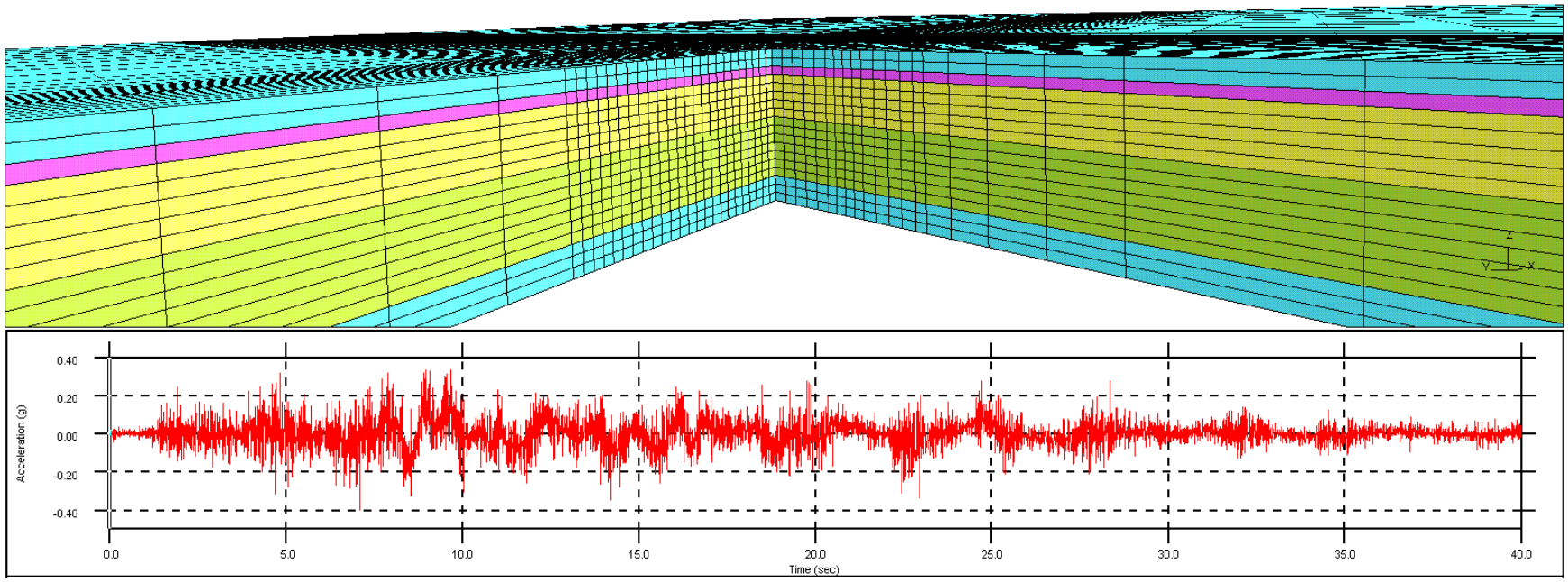
Damage to building contents

Beyond individual building performance

© Reuters

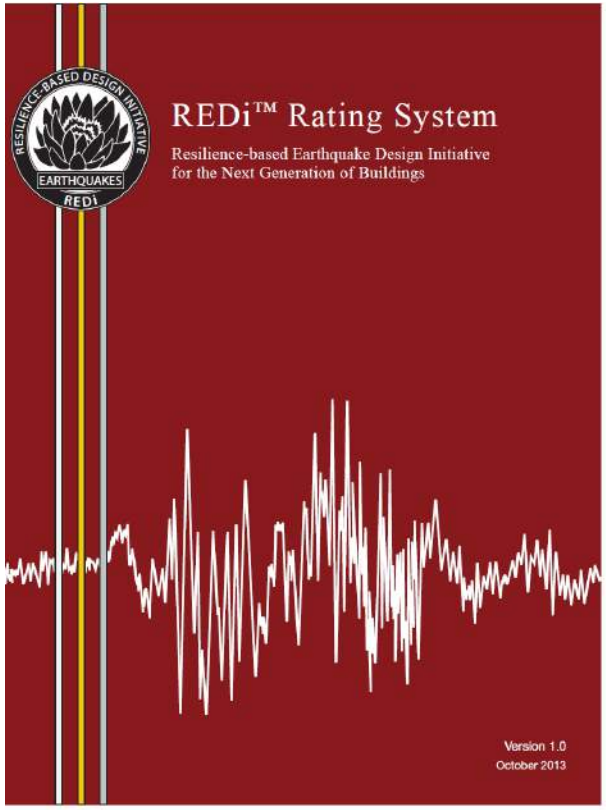
Engineering toolkit 1: Performance based approach

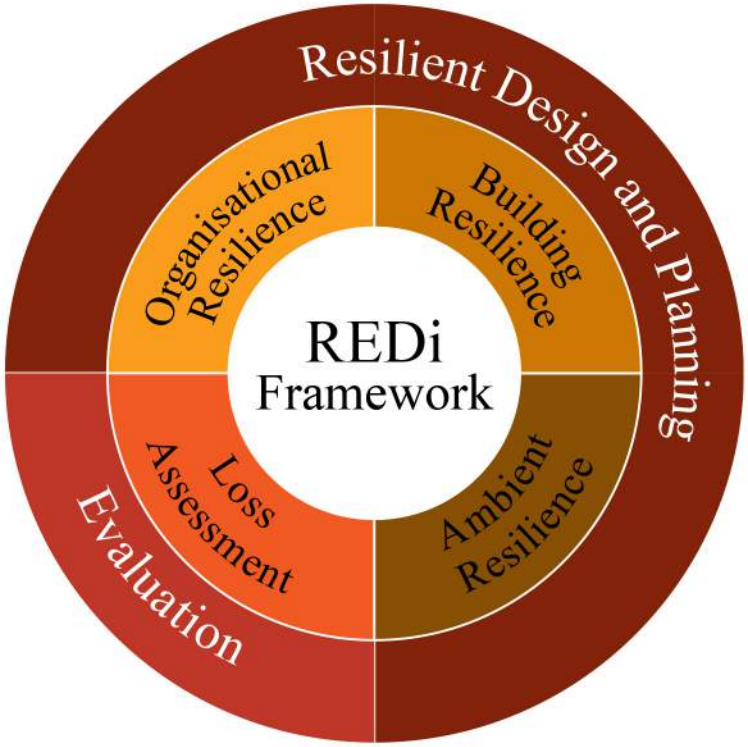
D3PLOT: Nonlinear BRB's - Liquefaction



Engineering toolkit 2: REDi framework

For achieving ‘beyond-code’ resilience objectives.





publications.arup.com/Publications/R/REDi_Rating_System.aspx

Casualties

Professor Robin Spence

Director, Cambridge Architectural Research Ltd

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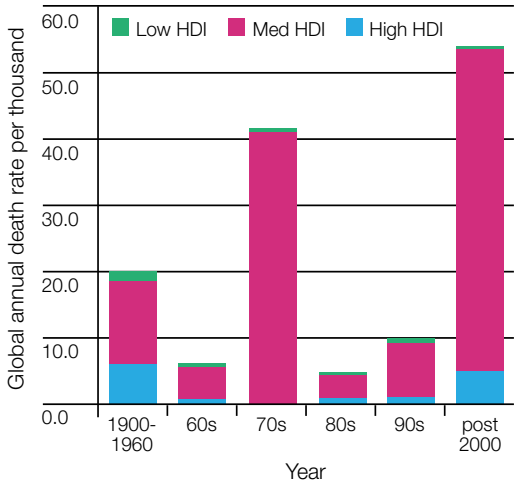
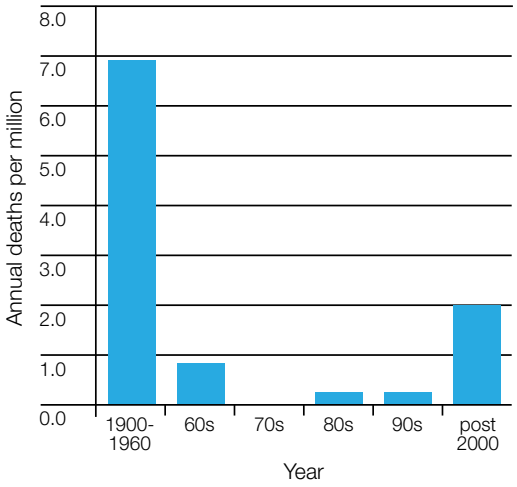
Annual death rates from earthquakes

Annual rates of earthquake deaths since 1900



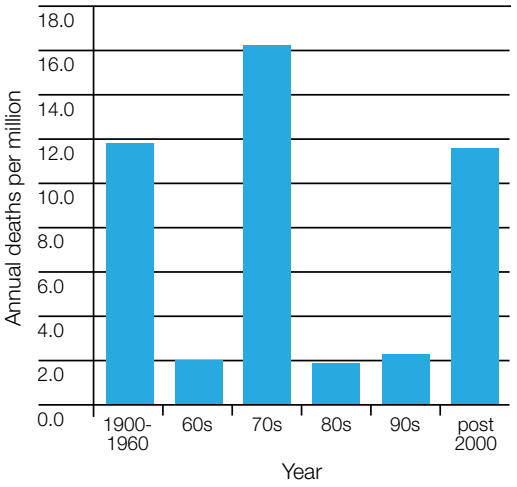
The last decade witnessed the highest annual death rate for the last 100 years.

Earthquake death rates: High HDI countries



Allowing for population growth, in the richer countries the death rate has been sharply reduced...

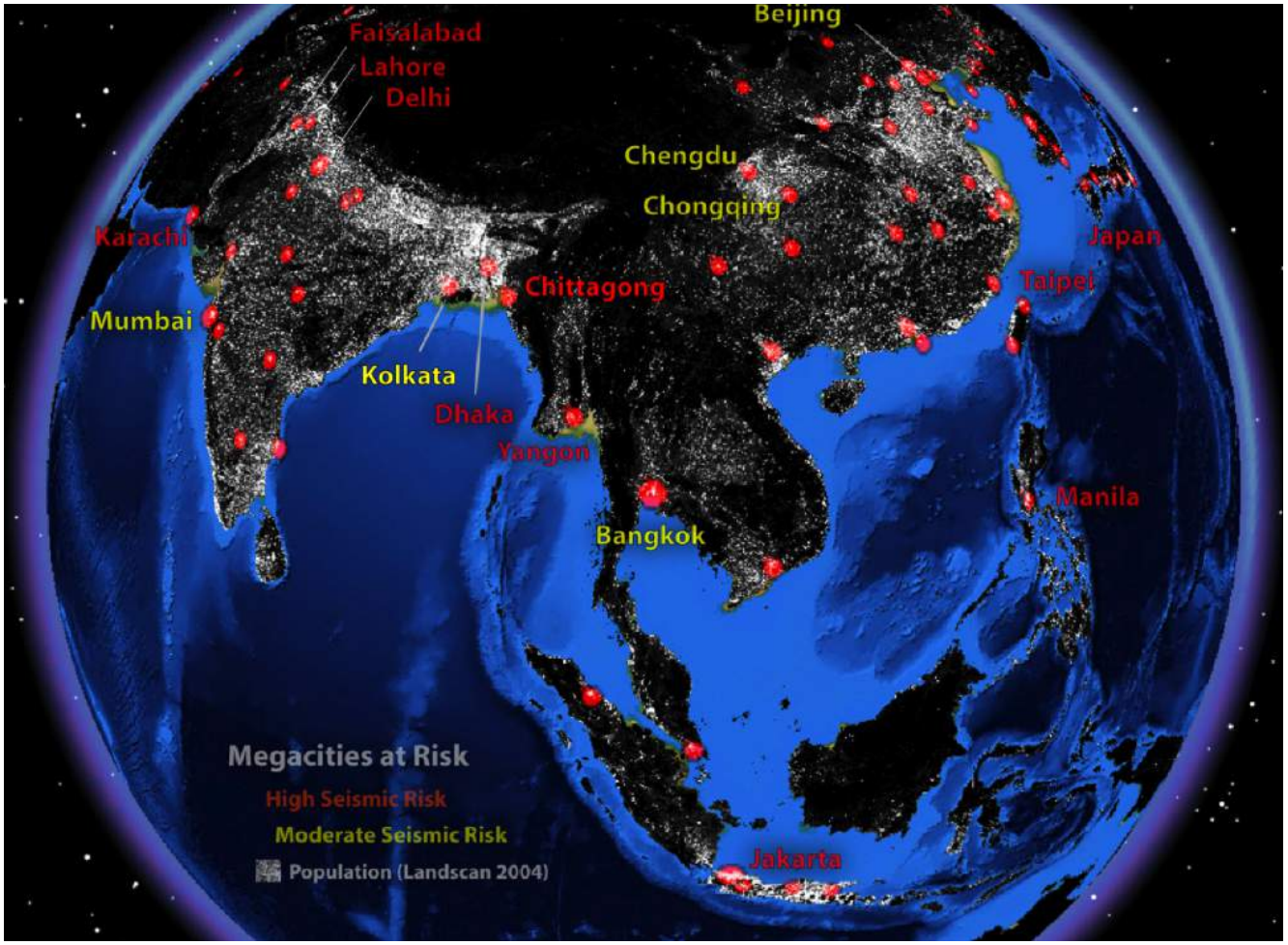
Earthquake death rates: Low + Med HDI countries



But in the poorer countries, there is no evidence of any sustained progress.

Megacities at risk from earthquakes in Asia

The first “million-death earthquake” could occur in one of these



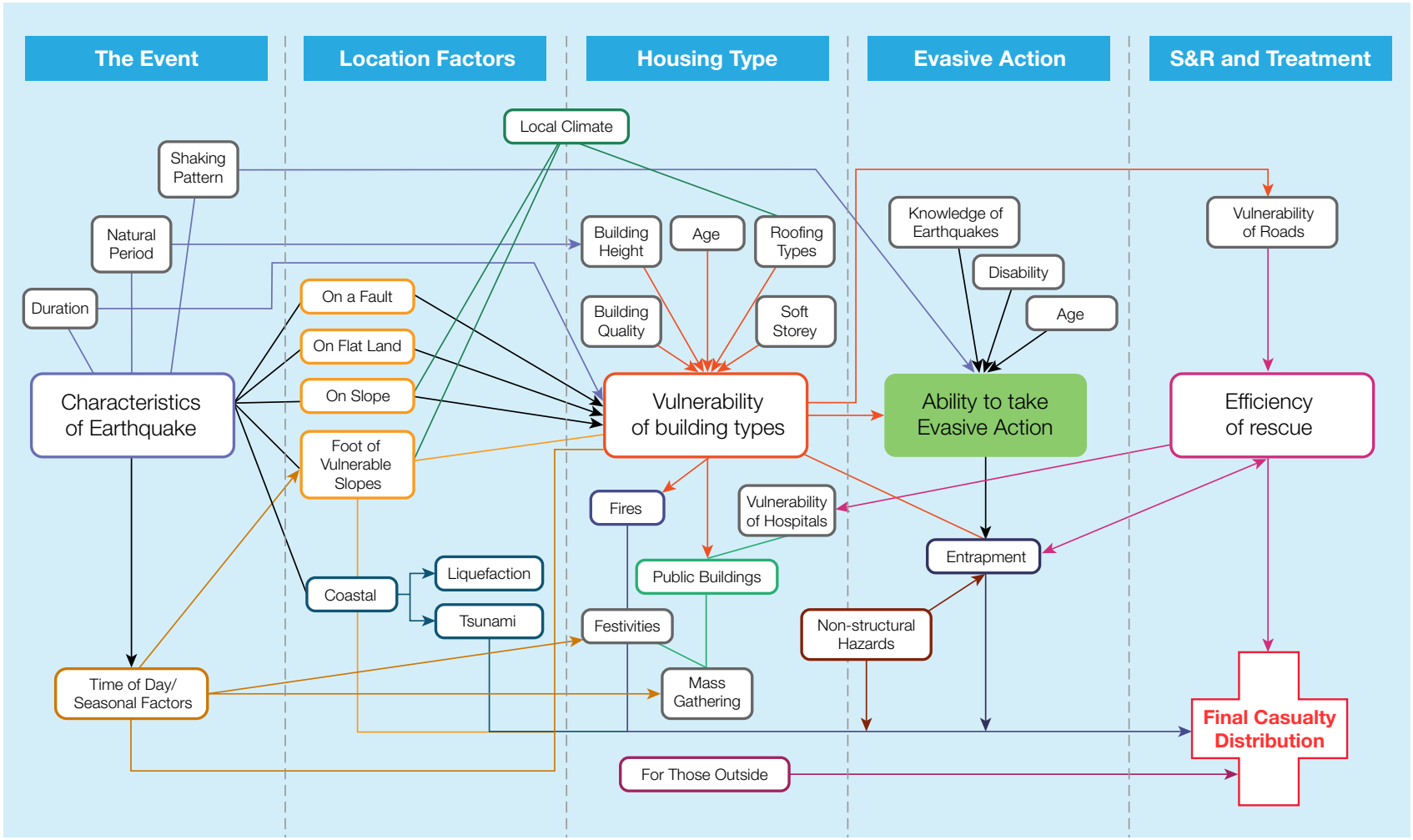
Cause of casualties

Most casualties arise from collapse of buildings...

...though as in Japan 2011 and Aceh 2004, tsunamis can be the main killer in some events.

Earthquakes: Modelling human casualties

Factors affecting casualty rates and their interaction



Factors affecting casualties: building vulnerability

Reinforced concrete frame

Lethality rate for collapsed buildings: about 15-30%

Golcuk: Kocaeli earthquake 1999
Intensity x
High collapse rate: casualty rate about 20%

Bhuj: Gujurat earthquake 2001
Intensity x
Moderate collapse rate: casualty rate ?

Factors affecting casualties: evasive action

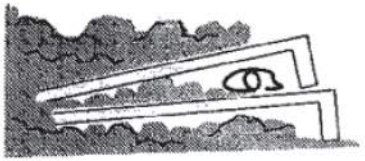
- Mixed and unreliable evidence
- Depends heavily on type of building
- Pattern of earthquake shaking

Factors affecting casualties: search and rescue

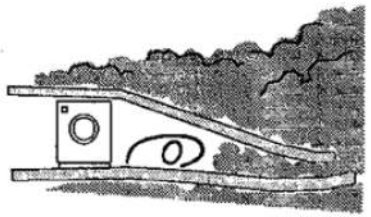
Search and rescue activity can make a considerable contribution to reducing death tolls, but depends on:

- Capacity and training of local teams
- Accessibility of the affected areas for rescuers
- The types of buildings affected and void spaces created by collapse pattern
- Availability of emergency treatment facilities
- Death tolls are hardly affected by well-publicised international team

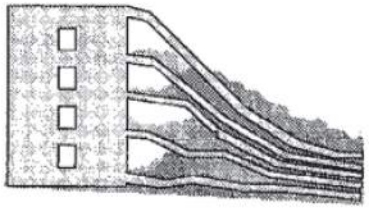
Reinforced Concrete Collapse



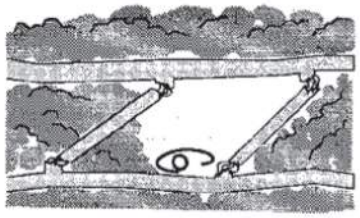
Slab and deep-beam construction may create voids for survival.



Strong furniture, e.g. steel-cased appliances may resist building collapse pressures.



Stronger structural elements, service cores, shear walls etc., may also support collapsed elements to create voids.

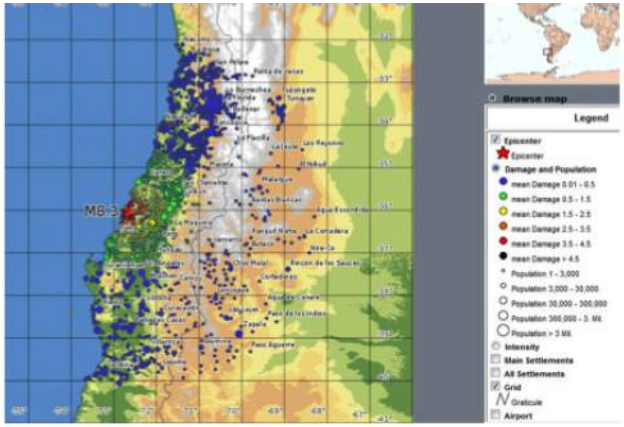


Structural resilience in failed members may also provide sufficient support to maintain thin survival spaces.

Real-time casualty estimation alert: existing systems

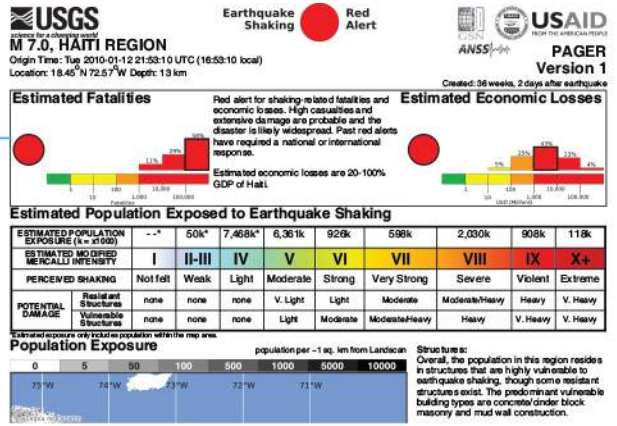
WAPMERR: Uses USGS or GFZ source parameters

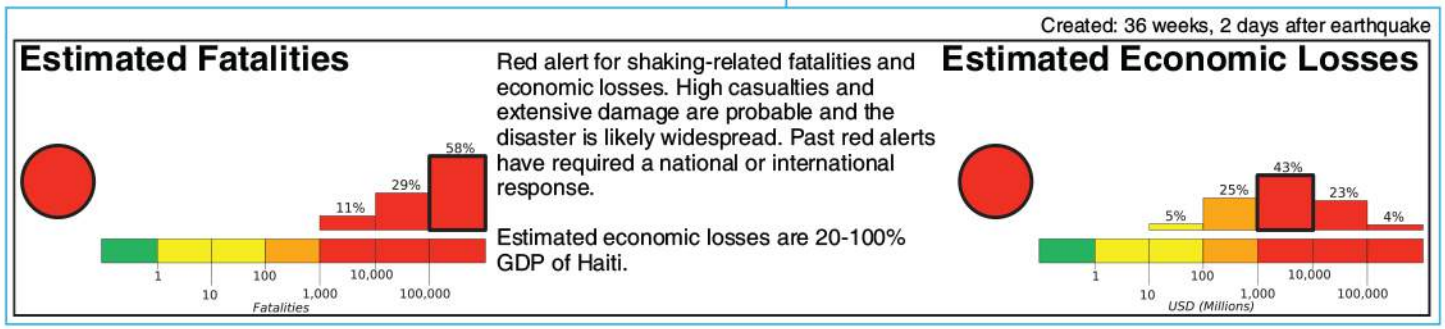
Gives: Min/max deaths
Min/max seriously injured
Map of expected damage by town



USGS-PAGER: Uses USGS source parameters

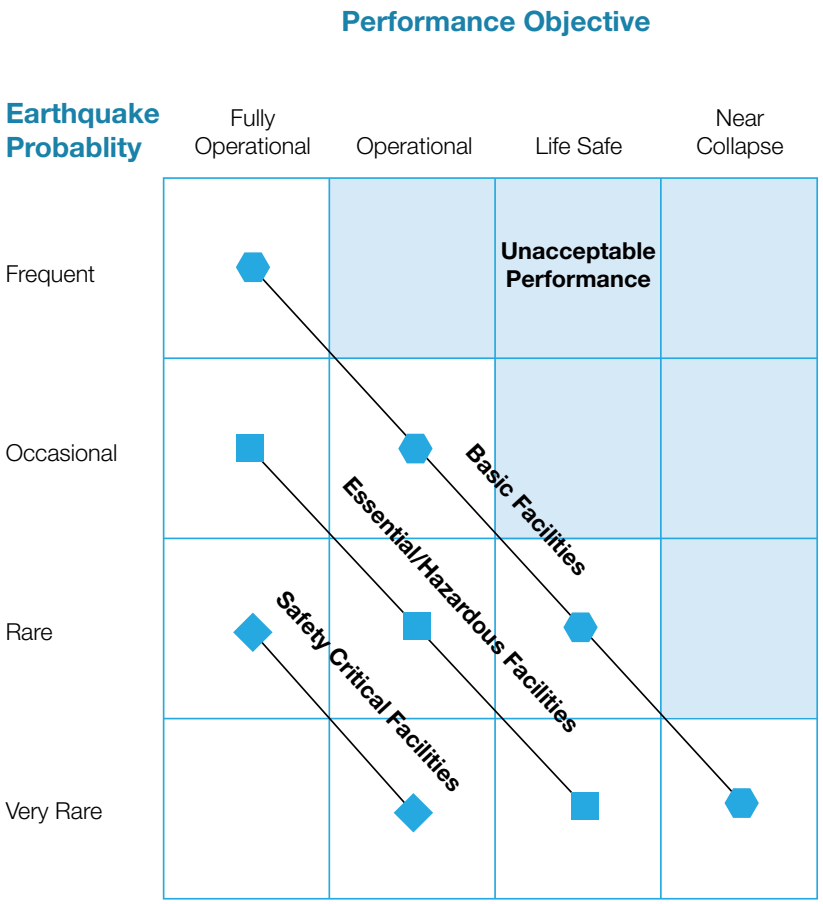
Gives: Shakemap of intensity
Probability distribution of fatalities
Probability distribution of economic losses





Earthquake risk reduction: six elements of a strategy

1. Improving codes of practice for design of new buildings



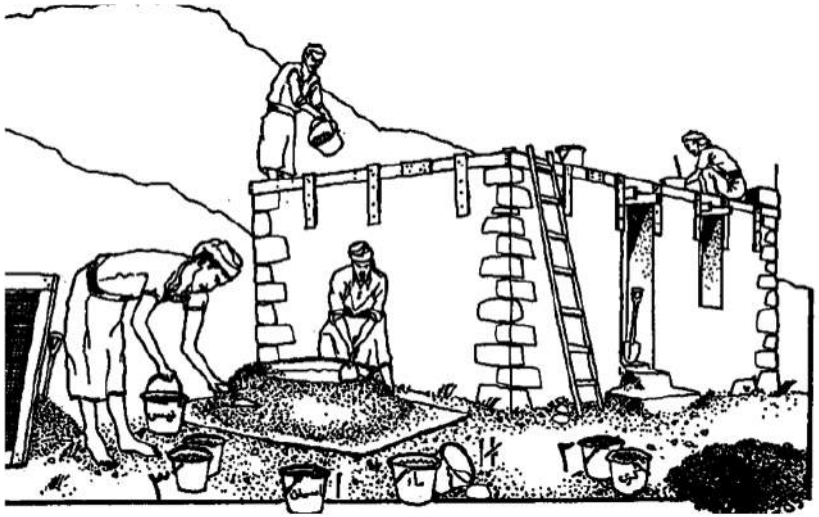
After SEAOC, 2000

Earthquake risk reduction: six elements of a strategy

1. Improving codes of practice for design of new buildings
2. Improving building control

Earthquake risk reduction: six elements of a strategy

1. Improving codes of practice for design of new buildings
2. Improving building control
3. Building for Safety programmes for non-engineered buildings



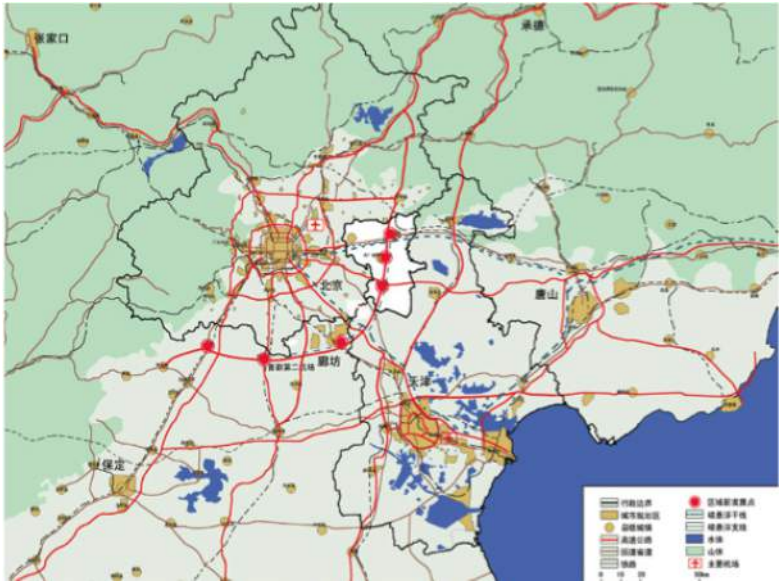
Earthquake risk reduction: six elements of a strategy

1. Improving codes of practice for design of new buildings
2. Improving building control
3. Building for Safety programmes for non-engineered buildings
4. Strengthening programmes for high-risk buildings

Shear wall strengthening, Bolu, 2000

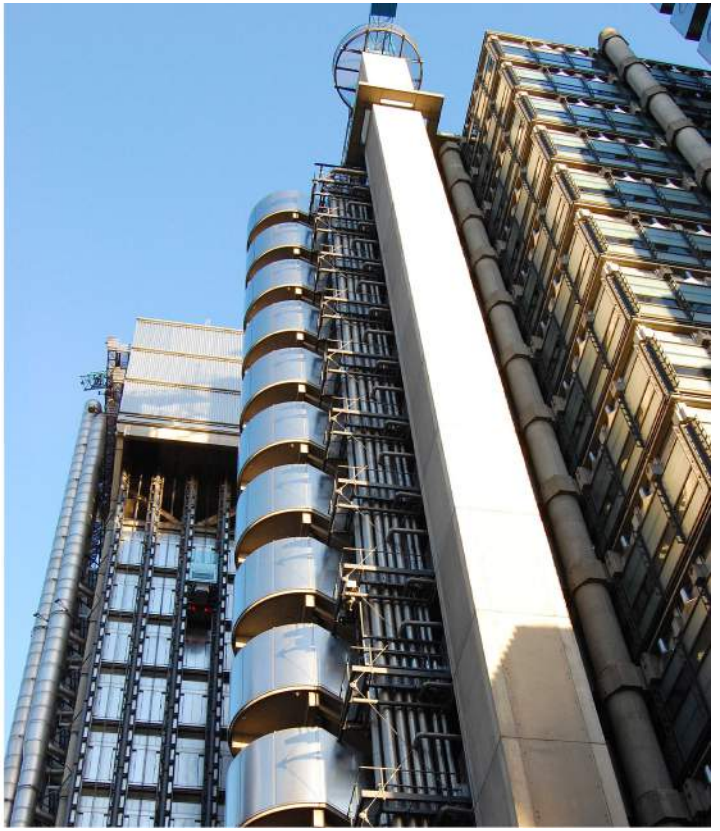
Earthquake risk reduction: six elements of a strategy

1. Improving codes of practice for design of new buildings
2. Improving building control
3. Building for Safety programmes for non-engineered buildings
4. Strengthening programmes for high-risk buildings
5. Guiding future urban development



Earthquake risk reduction: six elements of a strategy

1. Improving codes of practice for design of new buildings
2. Improving building control
3. Building for Safety programmes for non-engineered buildings
4. Strengthening programmes for high-risk buildings
5. Guiding future urban development
6. Extending earthquake insurance cover



Modelling

Dr. Matthew Free

Director, Arup Geohazard and Risk Management

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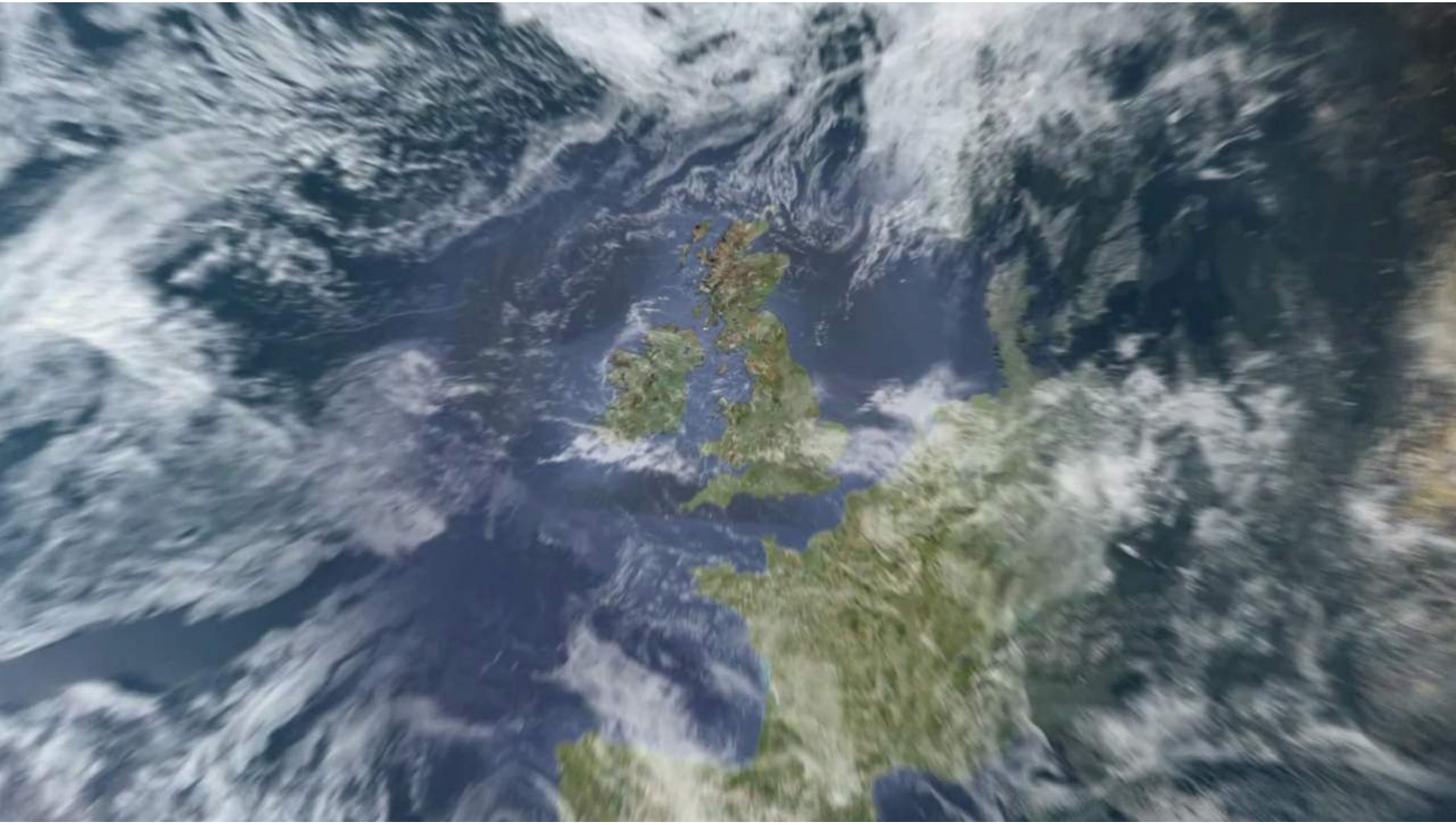
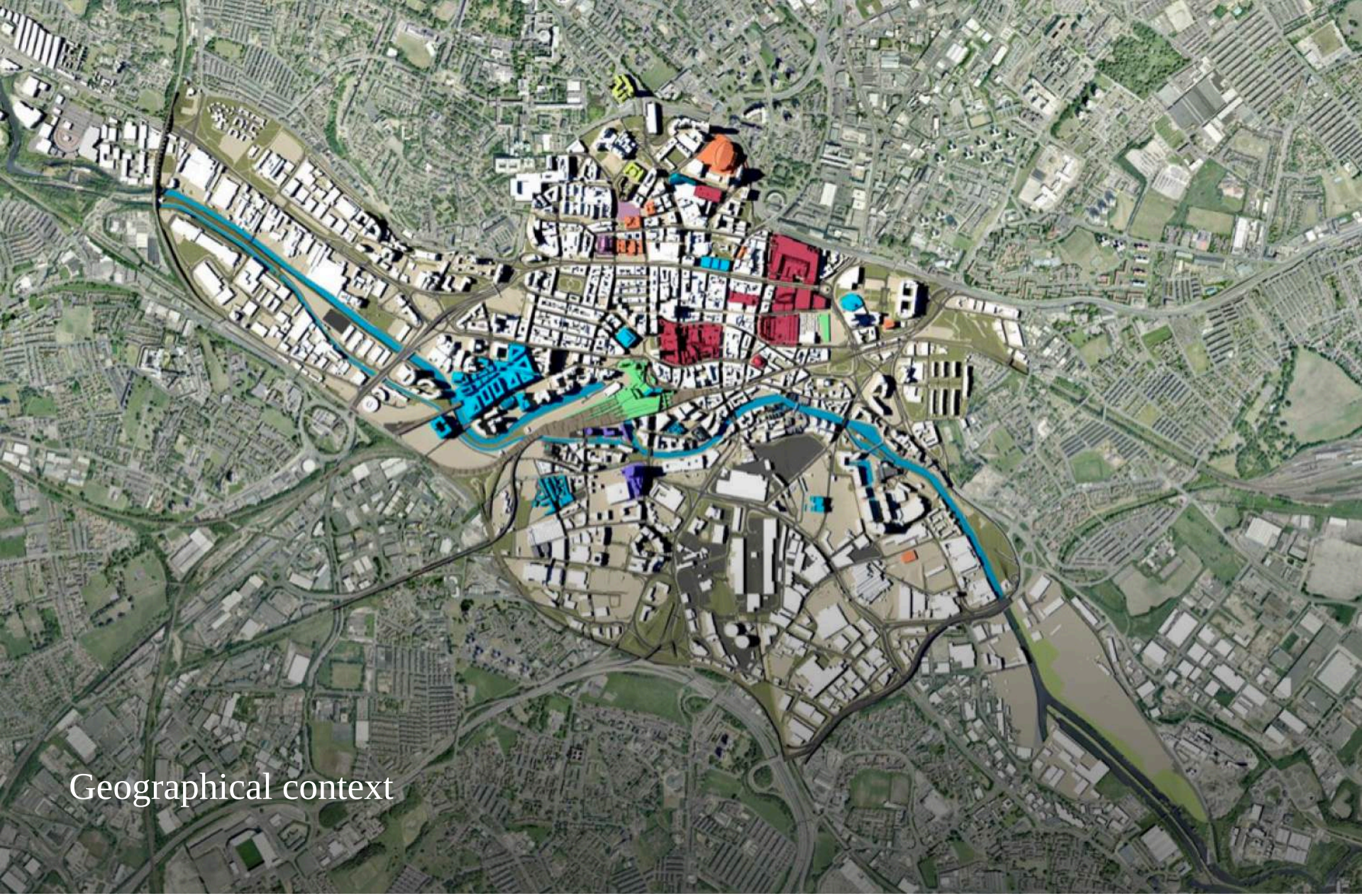


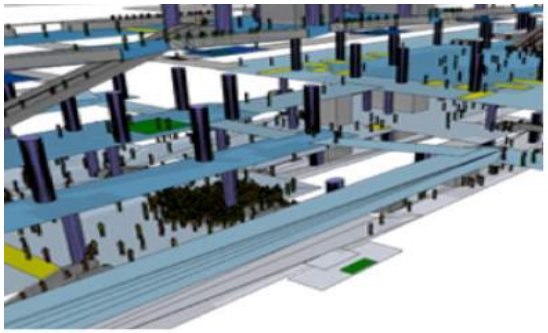

Geographical context

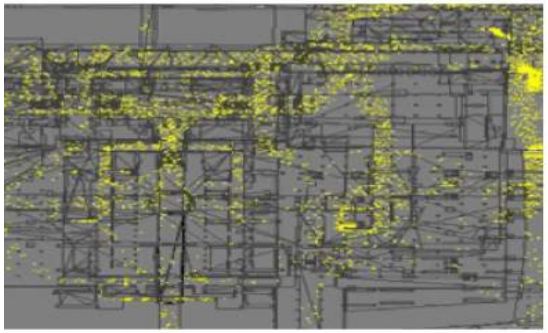
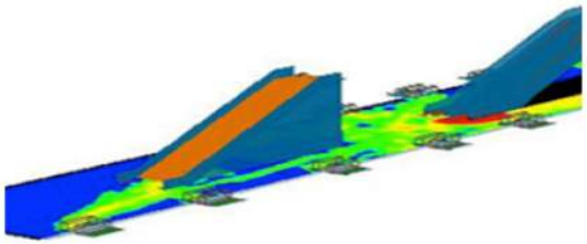
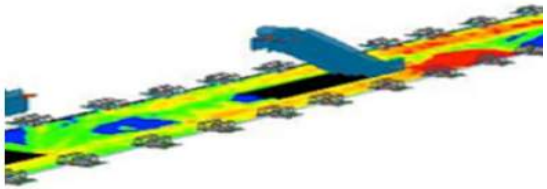
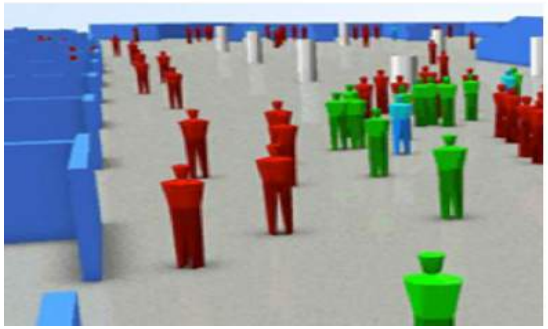
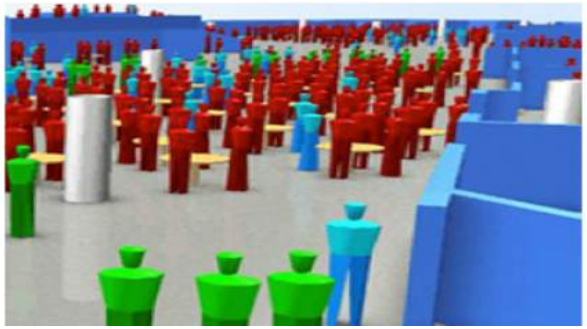
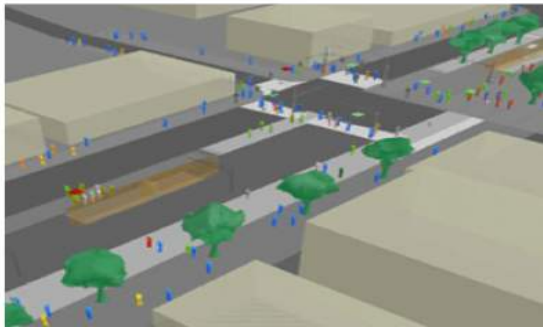

Improved communication

Modelling of people


Communicating complex data to design teams and stakeholders...
BUS STOP
BUS TAXI AND LANE
BUS STOP

Modelling the behaviour of people



Standards

Performance

Casualties

Modelling

Back to the Drawing Board:
Engineering and planning to manage risk

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