RISK FRONTIERS

Quantifying Natural Disaster Risks with Geoinformation

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Overview

- Some background
- Where are the risks?
  - Individual address based risk rating
  - National Level risk Information databases
- What is exposed?
  - Probability of Hazard
  - Potential for Loss
  - Risk & catastrophe loss modelling
- What do we do with the results?

Introducing Risk Frontiers

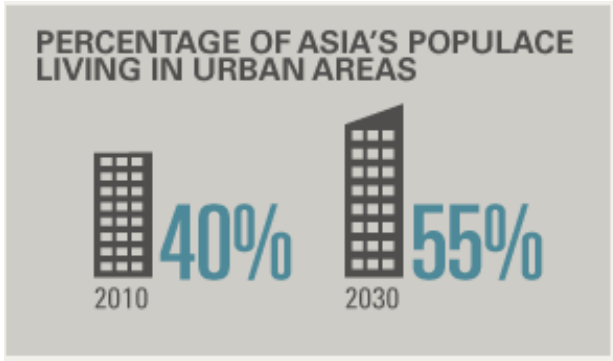
- Risk Frontiers is an independent, not-for-profit, R&D company operating from Macquarie University, Sydney
- We have been working closely with the (re)insurance industry since our creation in 1994
- We exist to improve the understanding of natural hazards and to transform scientific knowledge into intelligence useful to the business of risk management

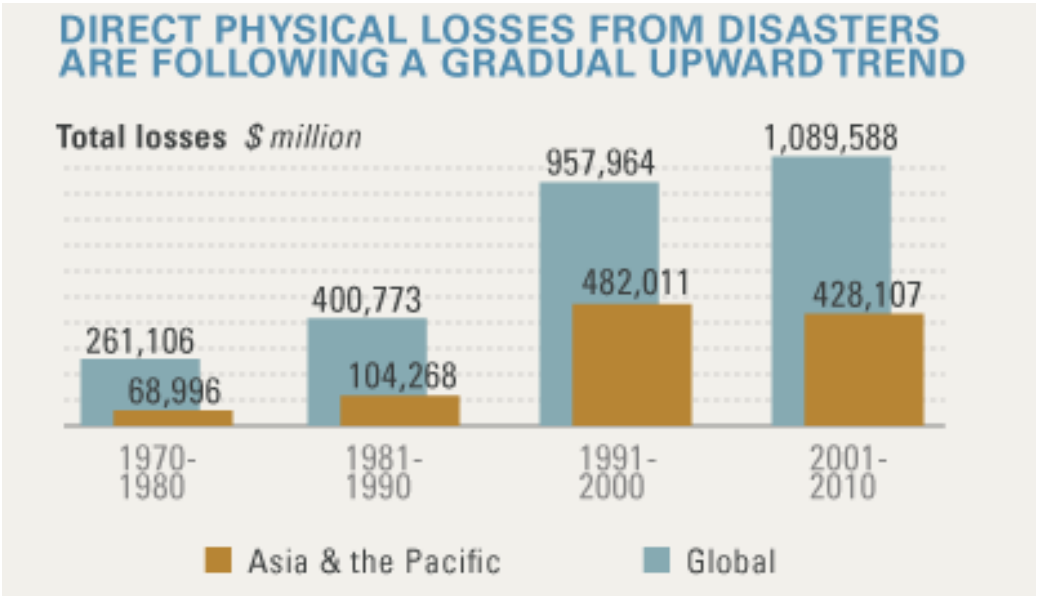
What are the issues?

- Increasing concentration of populations in cities (often in disaster prone regions)
- Changing climate & perhaps a trend towards more frequent events
- Greater financial losses

Risk = *f* (Hazard, Exposure, Vulnerability)

The risks are significant

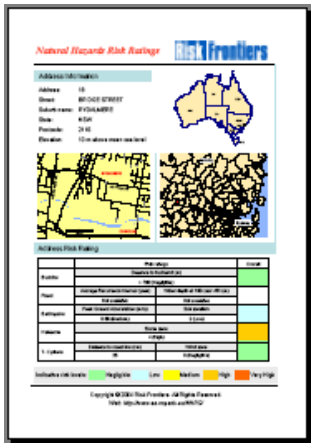




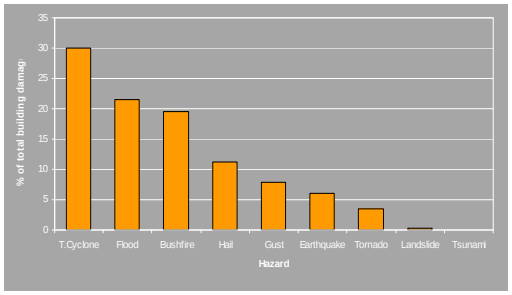
Source: ADB (2013) *Investing in Resilience: Ensuring a Disaster-Resistant Future*

How can we model risk?

- Address based risk rating database
  - Risk selection, portfolio engineering, resource allocation



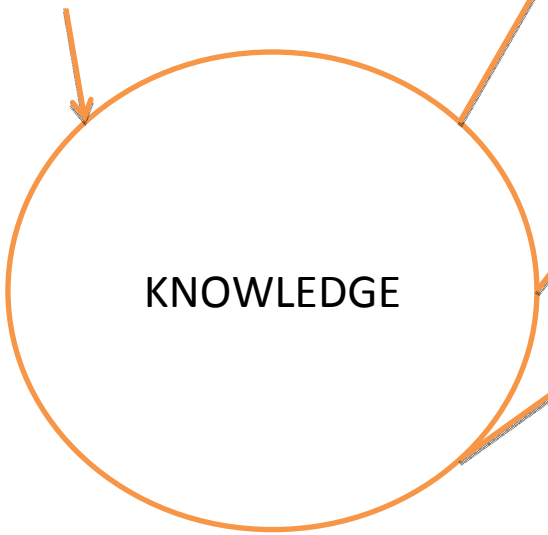
- Historical databases & other analytical resources
  - Benchmarking, spatial analysis, etc…



- Catastrophe loss models
  - Pricing of losses, Adaptation Cost/Benefit analyses

Knowledge / data flow

Government Data Sources
Private Data Sources
Aerial imagery
Satellite data
Individual Risk Rating Databases
Historical Databases
Catastrophe Loss Models
Fieldwork
Social media



Loss Models

Risk Pricing

Cost / Benefit Analysis

Reports / Policy Documents

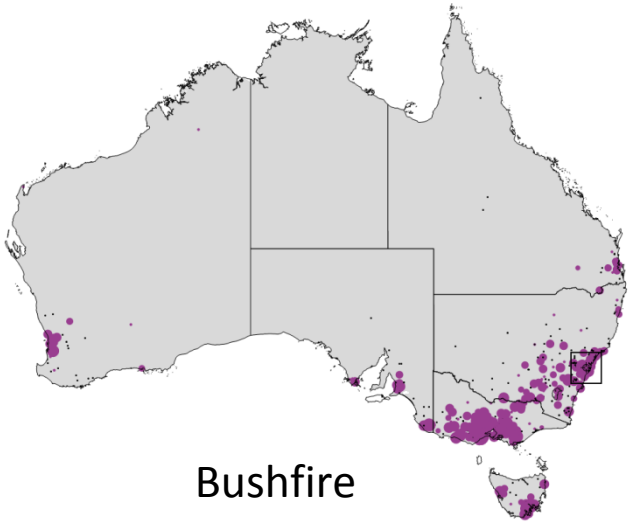
Government Agencies etc.

Risk Communication

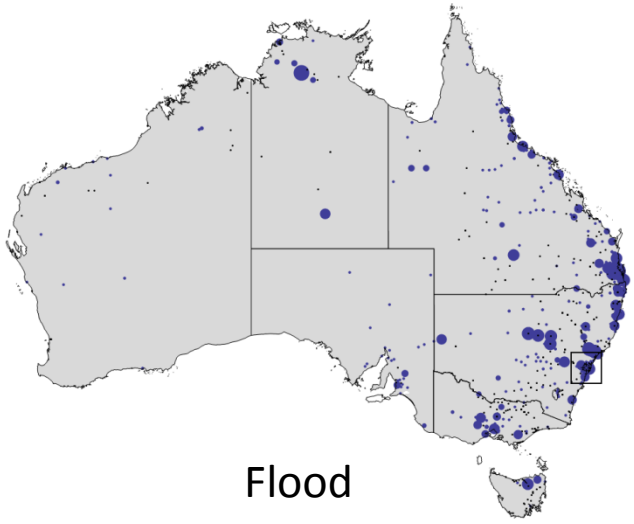
Community Engagement

Mapping

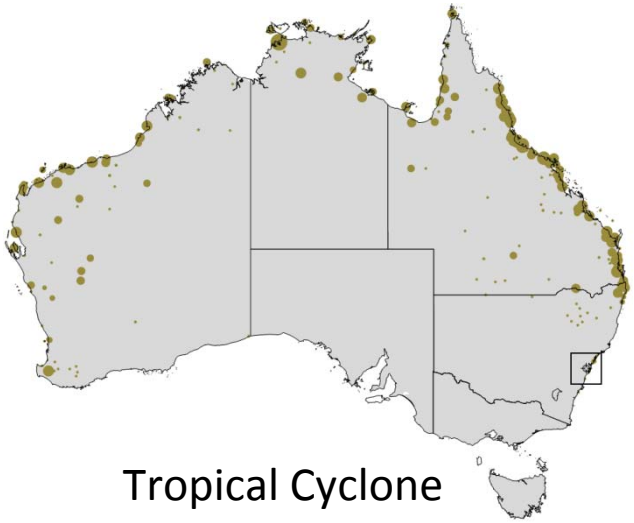
Quantifying the historical risk



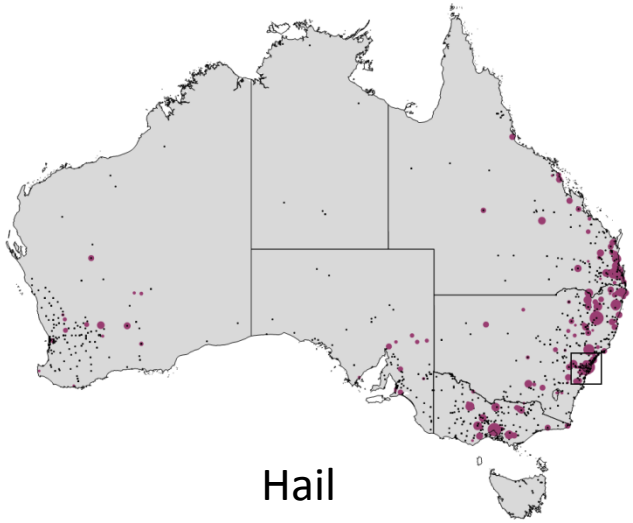
Bushfire



Flood



Tropical Cyclone



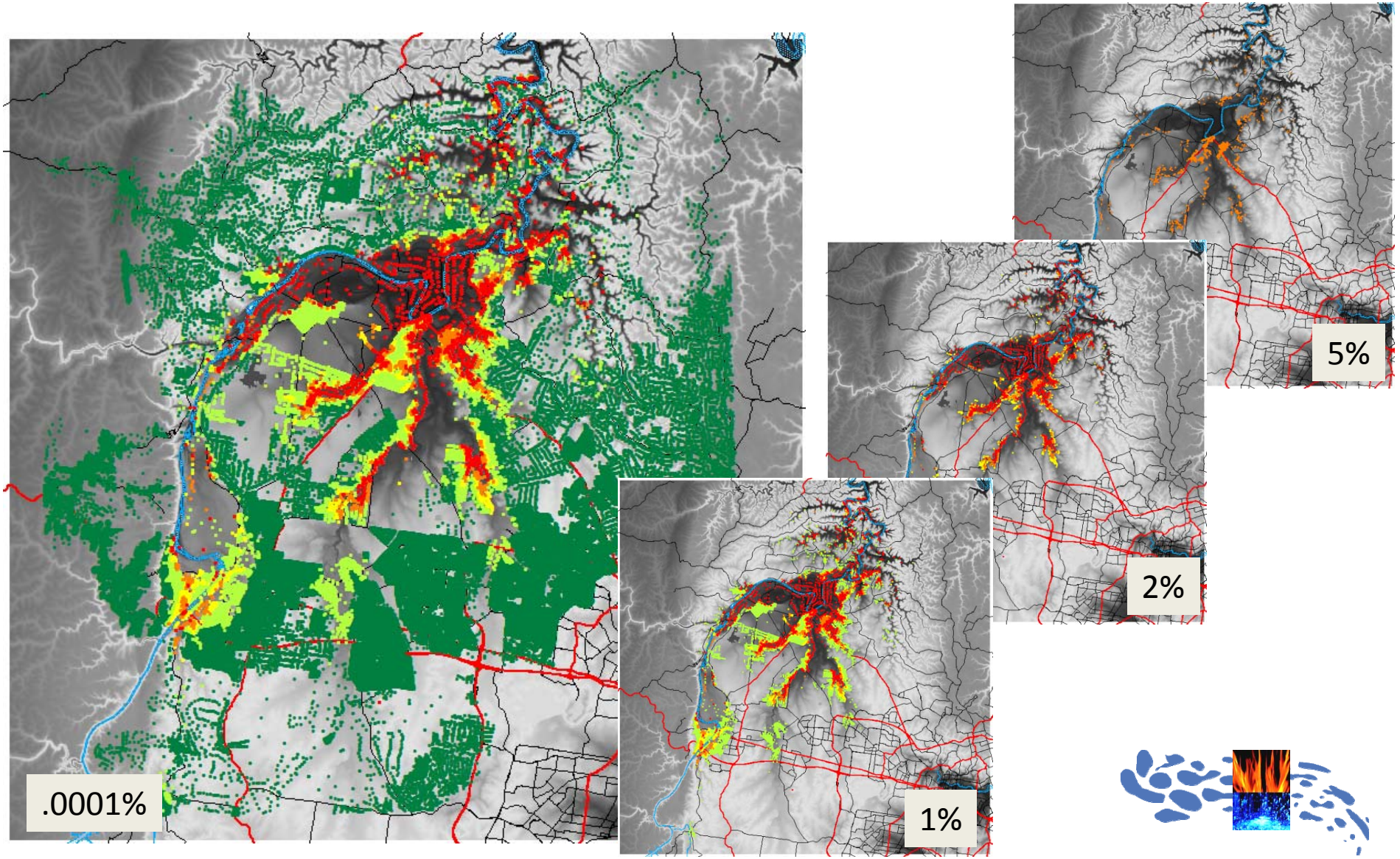
Hail

Source: Risk Frontiers' PerilAUS database

Uses of historical databases

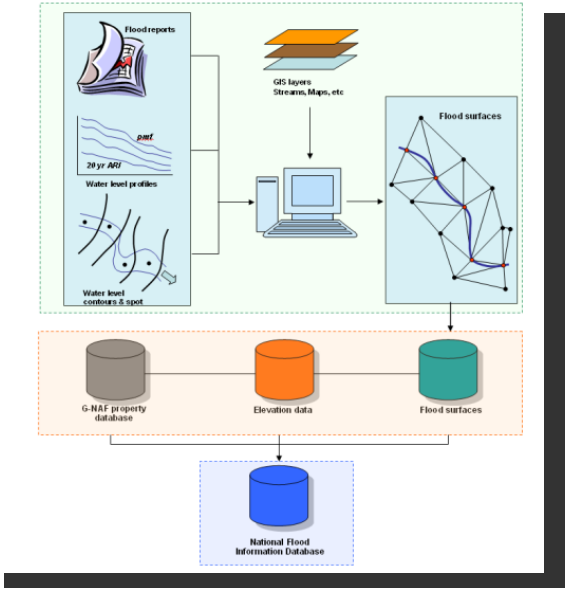
- Develop / test catastrophe loss models
- Fill modelling gaps (lightning strike, rainfall, gust, tornadoes, areas out of existing models' scope)
- Benchmark experienced losses against market
- Correlations between losses and historical hazard data (ENSO, BoM rainfall)

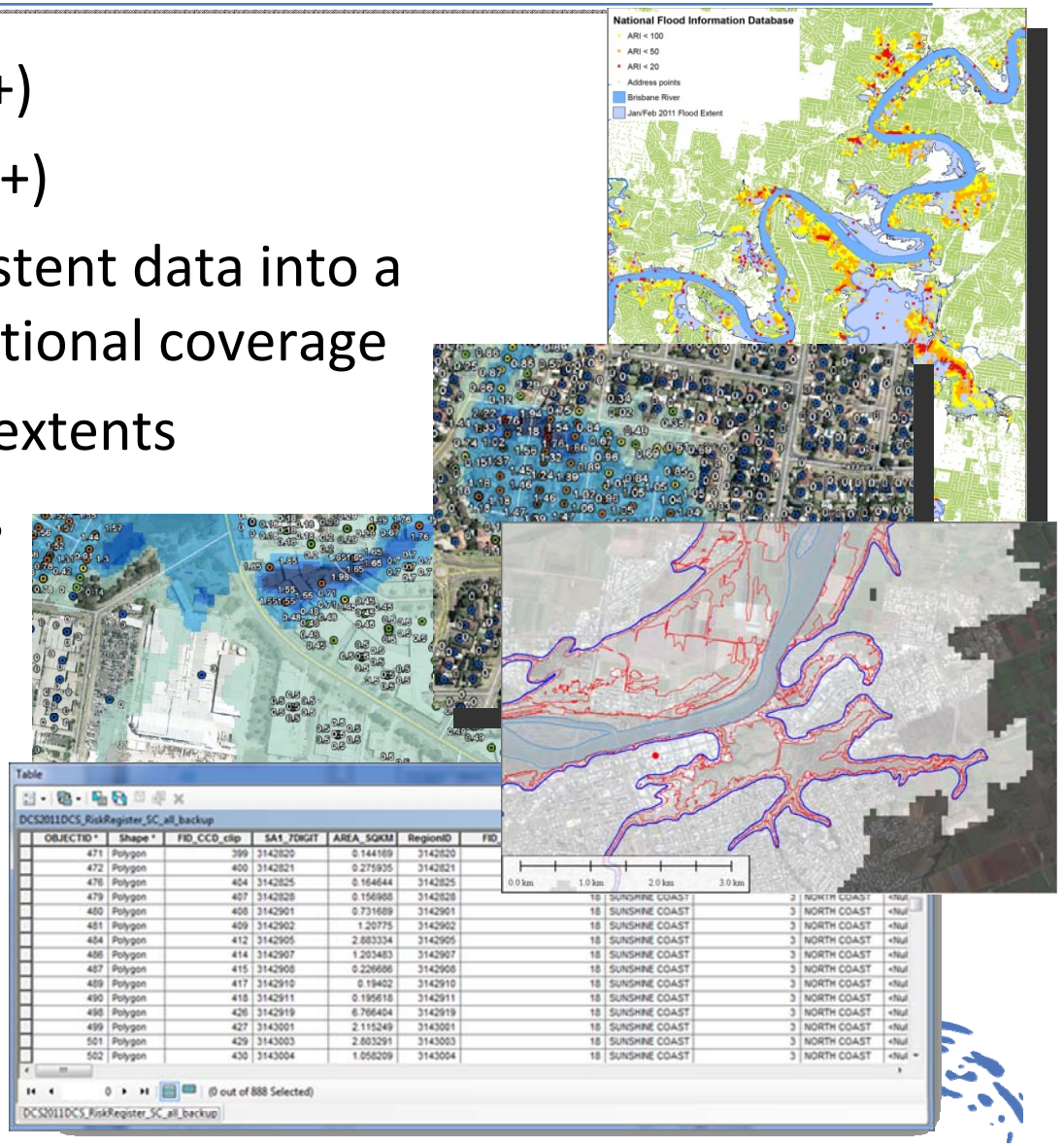
Quantifying the modelled risk



National Level Hazard Information

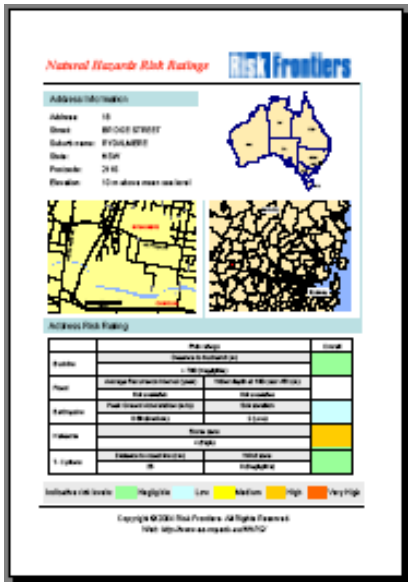
- Many addresses (12M+)
- Many study areas (140+)
- Aggregation of inconsistent data into a common format for national coverage
- Many flood surfaces / extents
- Metadata & QA checks





Risk-Rating databases

- Build national, hazard specific representations of exposure



Address Risk Rating

	Risk ratings		Overall
Bushfire	Distance to bushland (m)		3
	200-400 (Medium)		
Flood	Average Recurrence Interval (year)	Water depth at 100-year ARI (m)	2
	Above 100	None	
Earthquake	Peak Ground Acceleration (m/s²)	Ground zonation	2
	0.62 (Low)	2 (Low)	
Hailstorm	Storm zone		4
	4 (High)		
T. Cyclone	Distance to coast line (km)	Wind zone	2
	30	2 (Low)	

Indicative risk levels: 1 Negligible 2 Low 3 Medium 4 High 5 Very High

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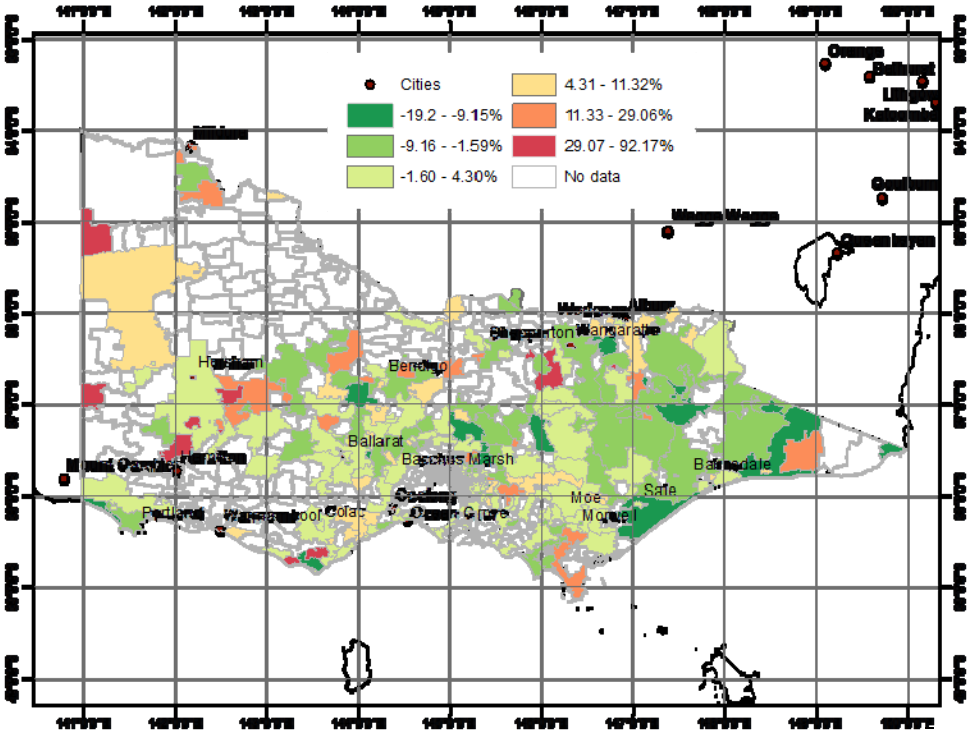
Web: http://www.es.mq.edu.au/NHRC/

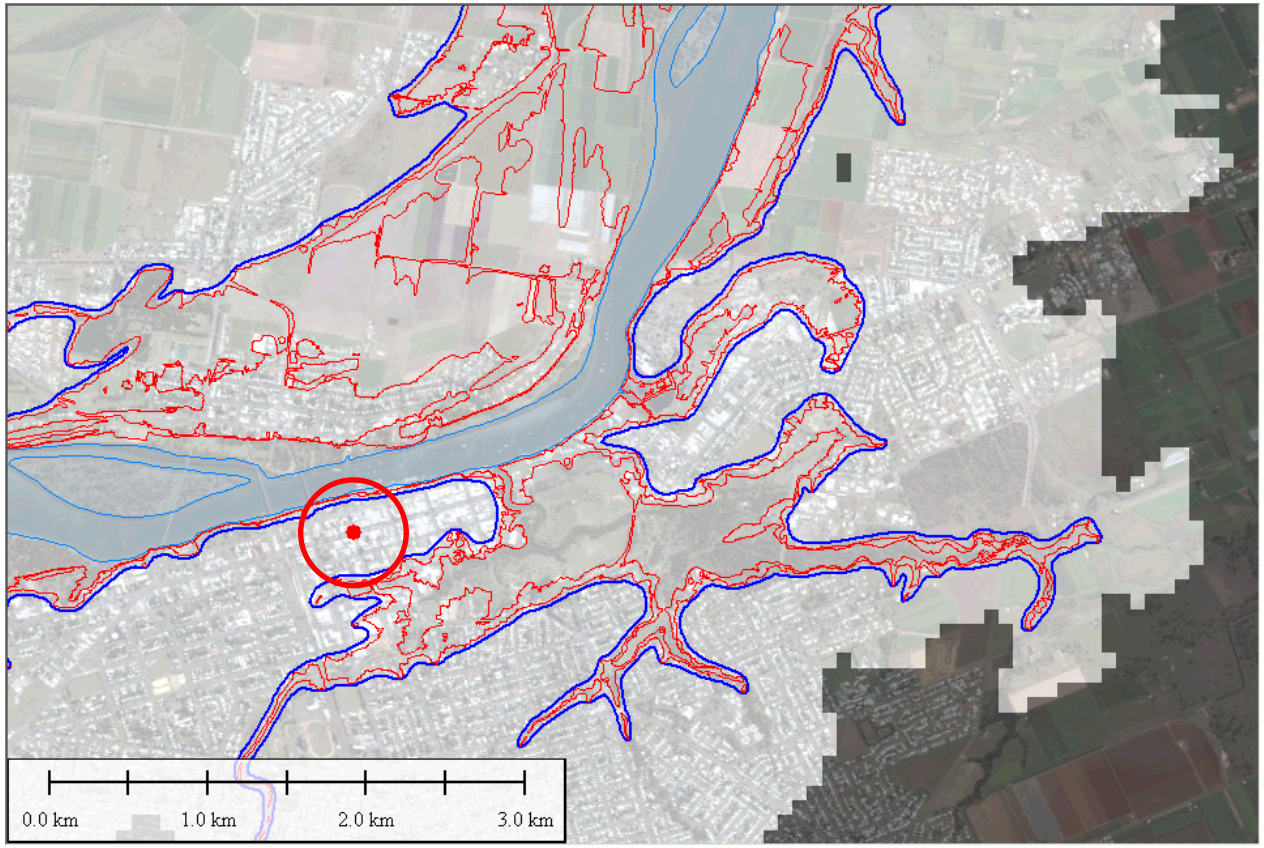
Applying Individual Risk Ratings

Risk Ratings Database (Market) – Portfolio =



Risk Selection:

Sometimes when flood studies don't exist you need to build your own



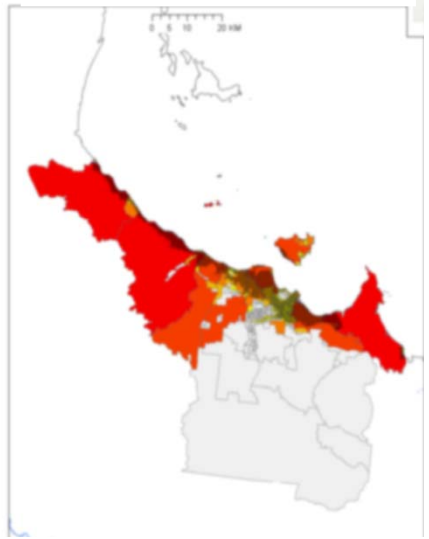
- Red outline – observed flood extent from 2010-2011 flooding
- Blue outline – flood-prone areas delineated by QRA flood overlay project
- White area – flood-prone areas in FEZ™ classification

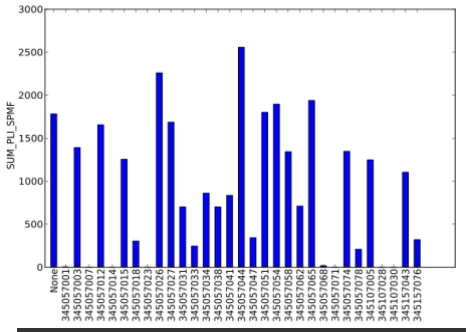
Exposure Analysis

Rapid Regional Risk Assessments

- Multi-peril & multi-attribute
- Inconsistent (but regularly updated) data sets (e.g. updated flood modelling, changing population or infrastructure data)
- Multiple reporting methods
- Easily updated by non-experts
- Reproducible analysis

Sample Risk Map Data





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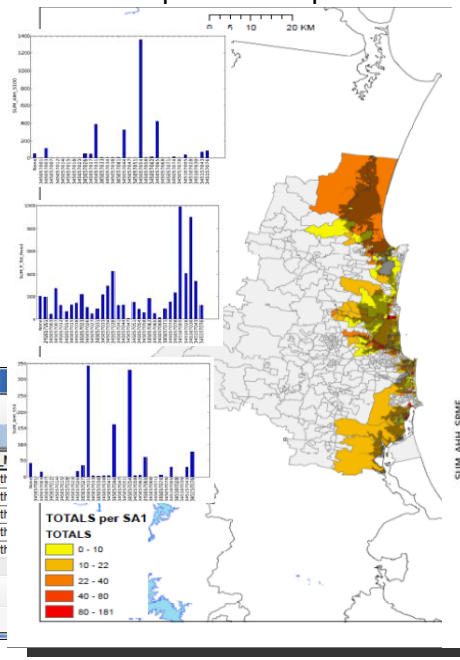
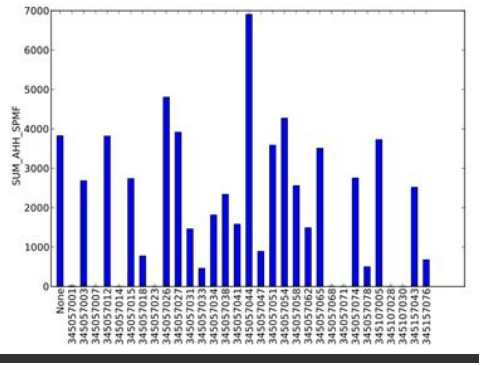
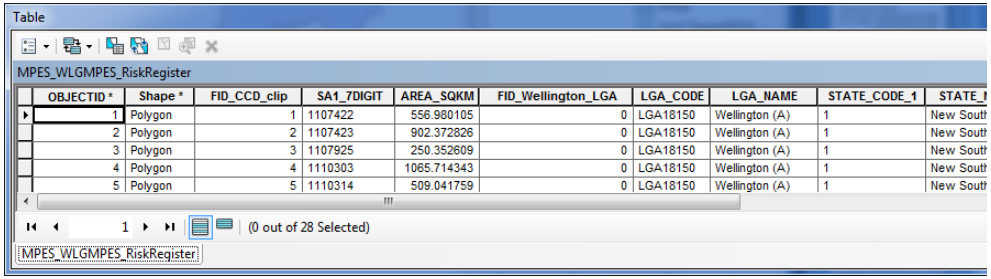
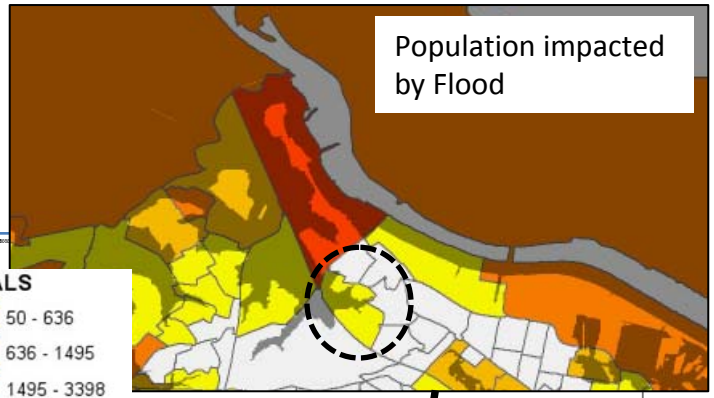


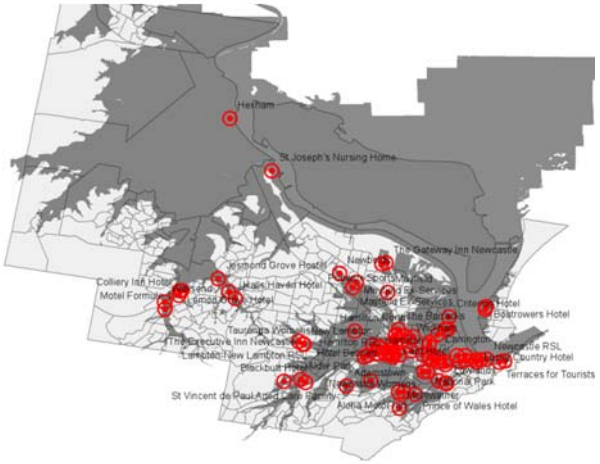




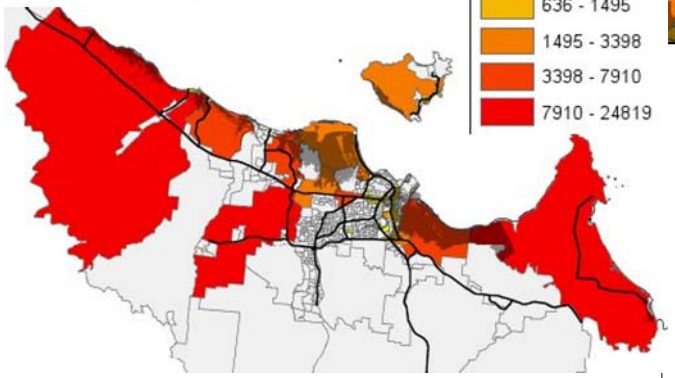
Exposure Analysis

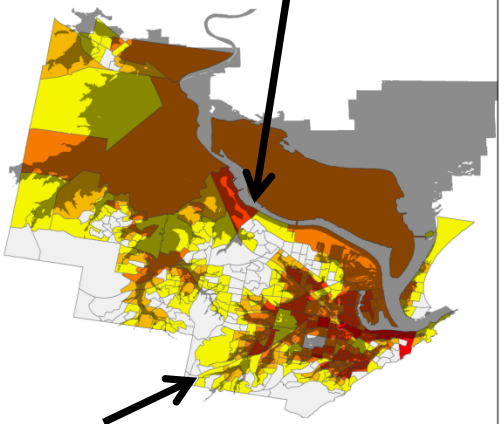


Accommodation impacted by Flood

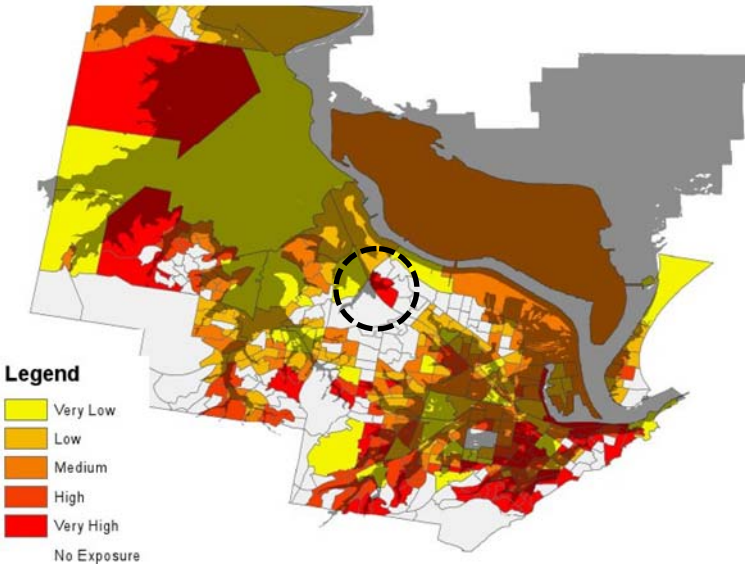


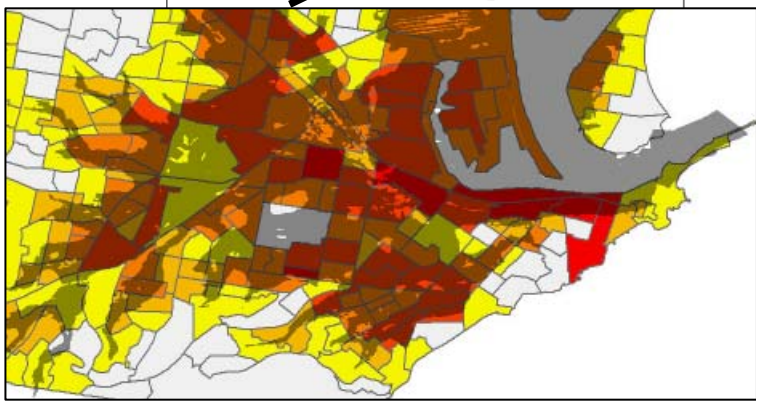
Evacuation Routes impacted by Storm Surge





Socially vulnerable populations impacted by Flood





Multi-Peril Analysis

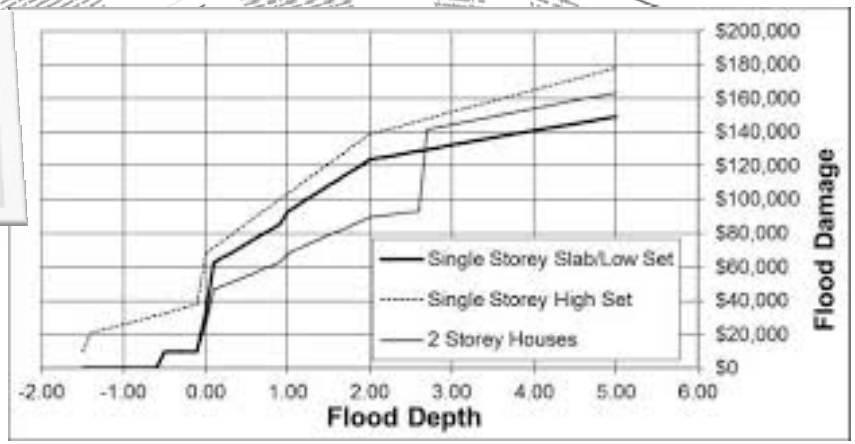
- Suite of Catastrophe loss models for Australia & selected Asia-Pacific countries
- Calculates exceedance probability curves for a range of catastrophe risks
- Varying Input resolutions: address, postcode or larger
- Combines curves of different perils, flexible financial modelling

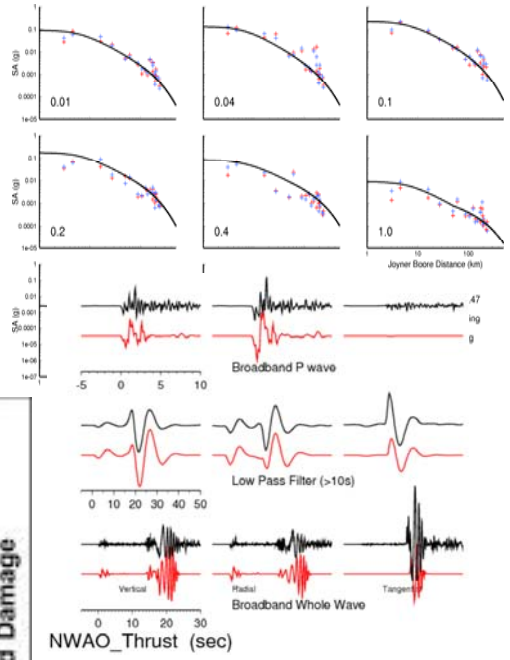
From Models to Multi-Peril

Research
Post-Event Analysis
Historical Records
Statistics
Physical Processes
Numerical Methods

Monte Carlo Methods

Event Database

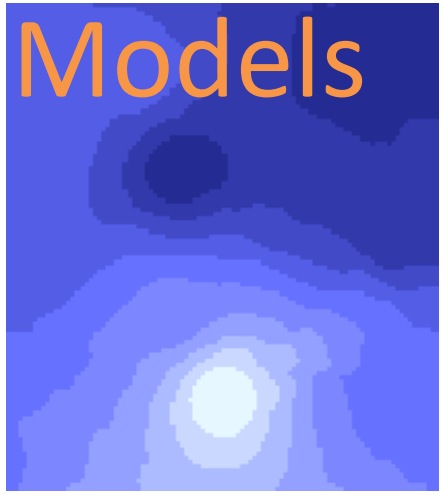




General Framework of Risk

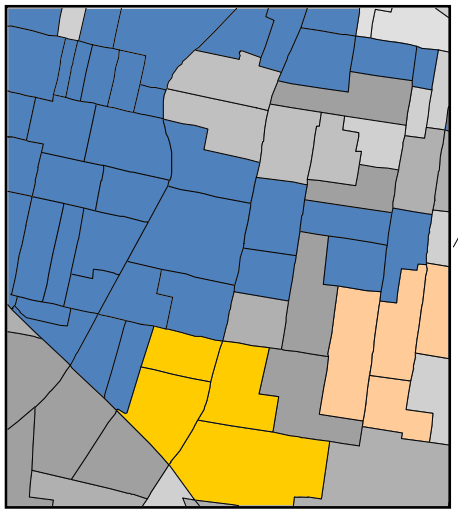
Risk = *f* (Hazard, Exposure, Vulnerability)

Hazard Events

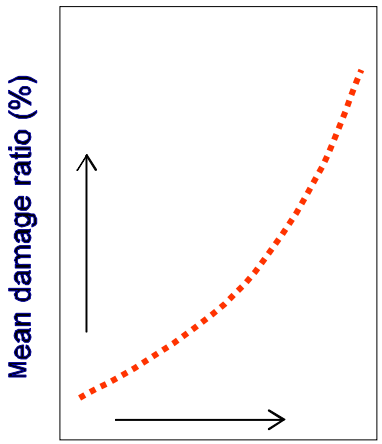


(a)

Exposure

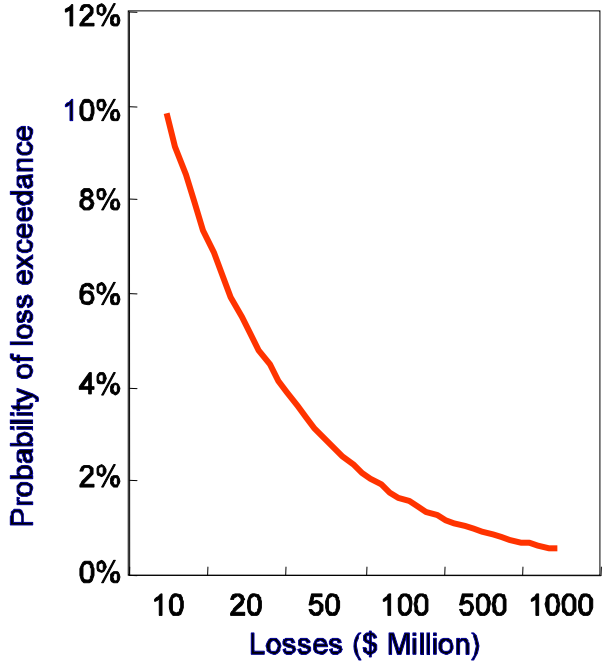


(b)



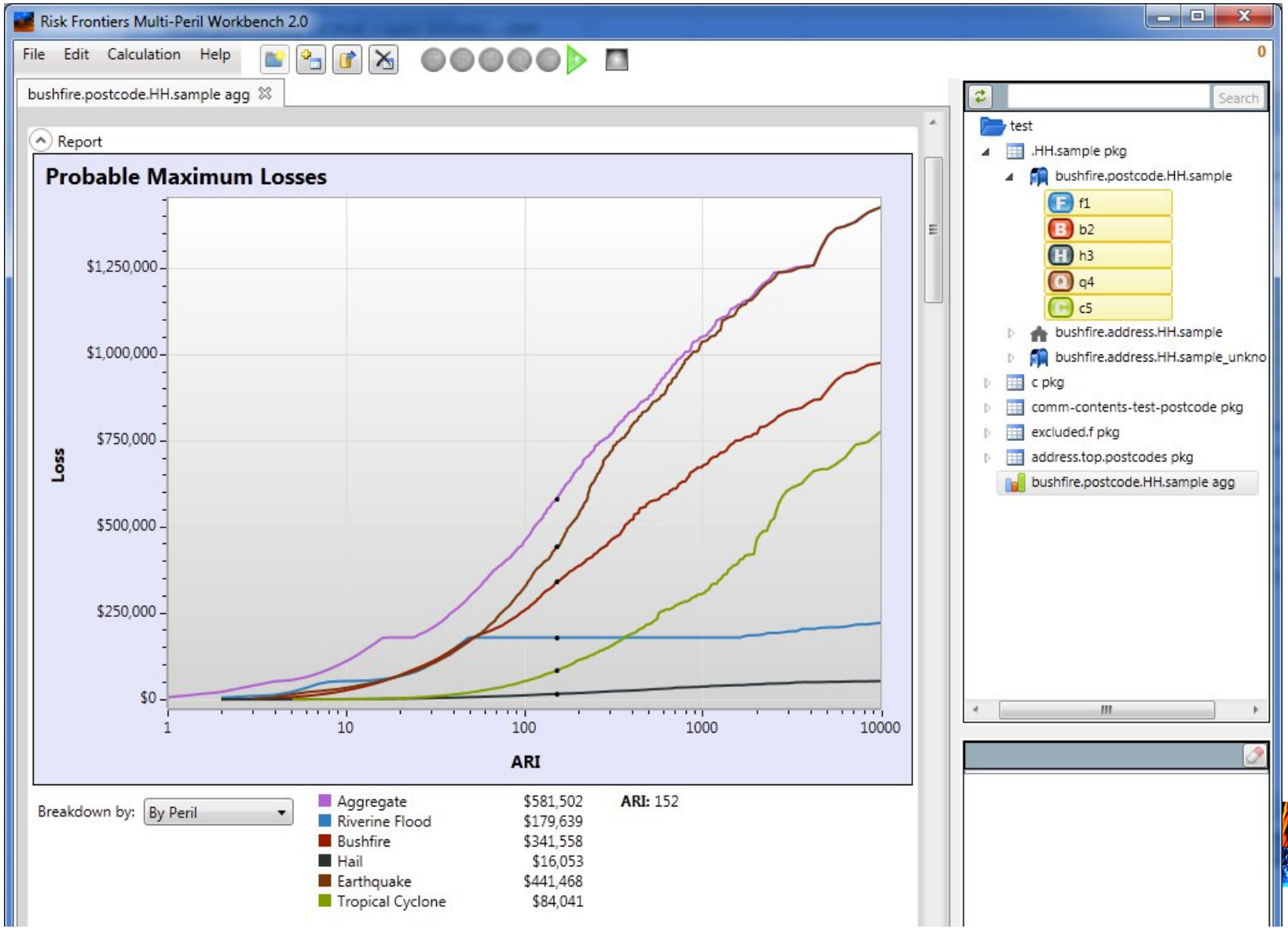
(c)

Vulnerability



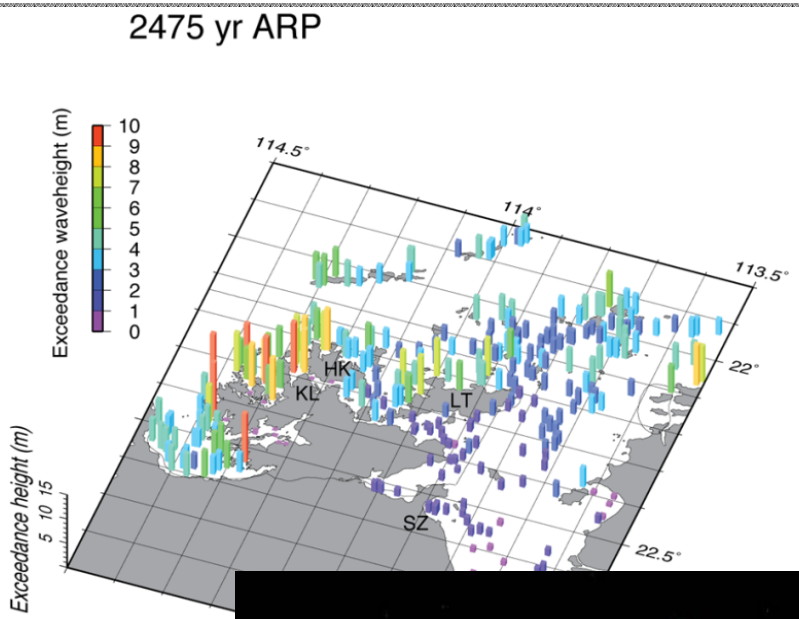
(d)

Catastrophe Loss Models

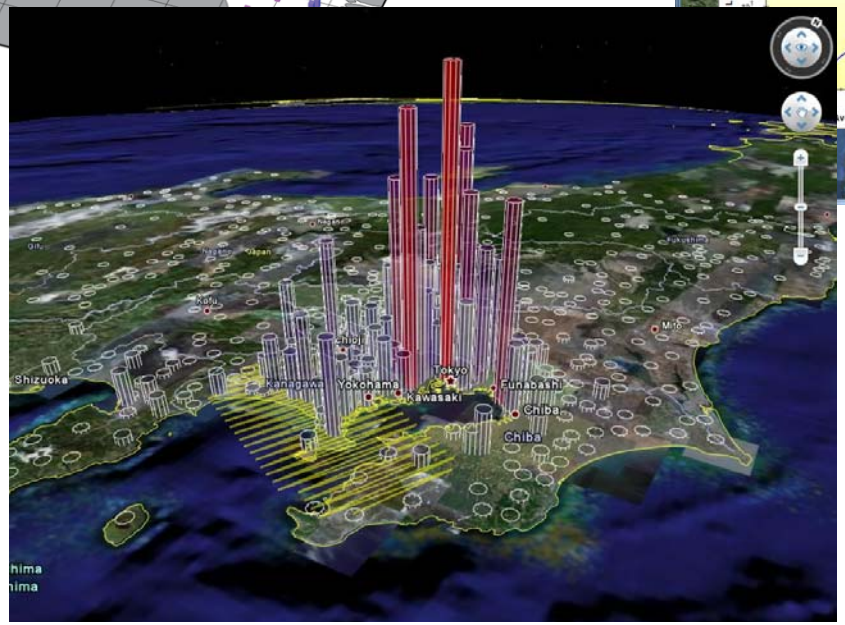


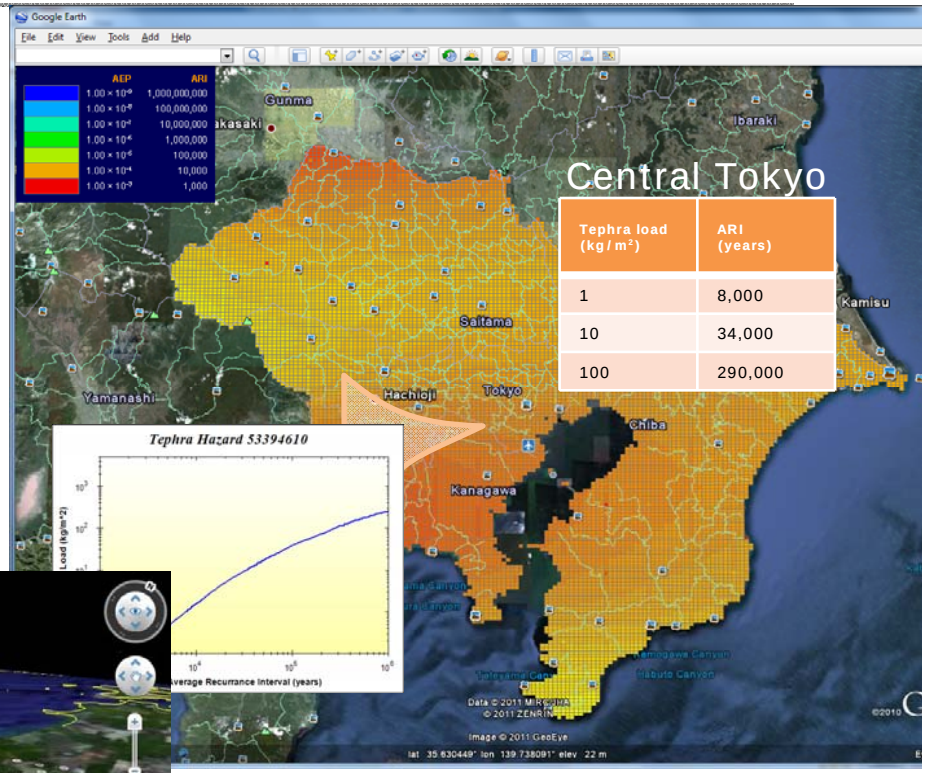
Catastrophe Loss Model Outputs

Loss Visualisation



Tsunami Risk

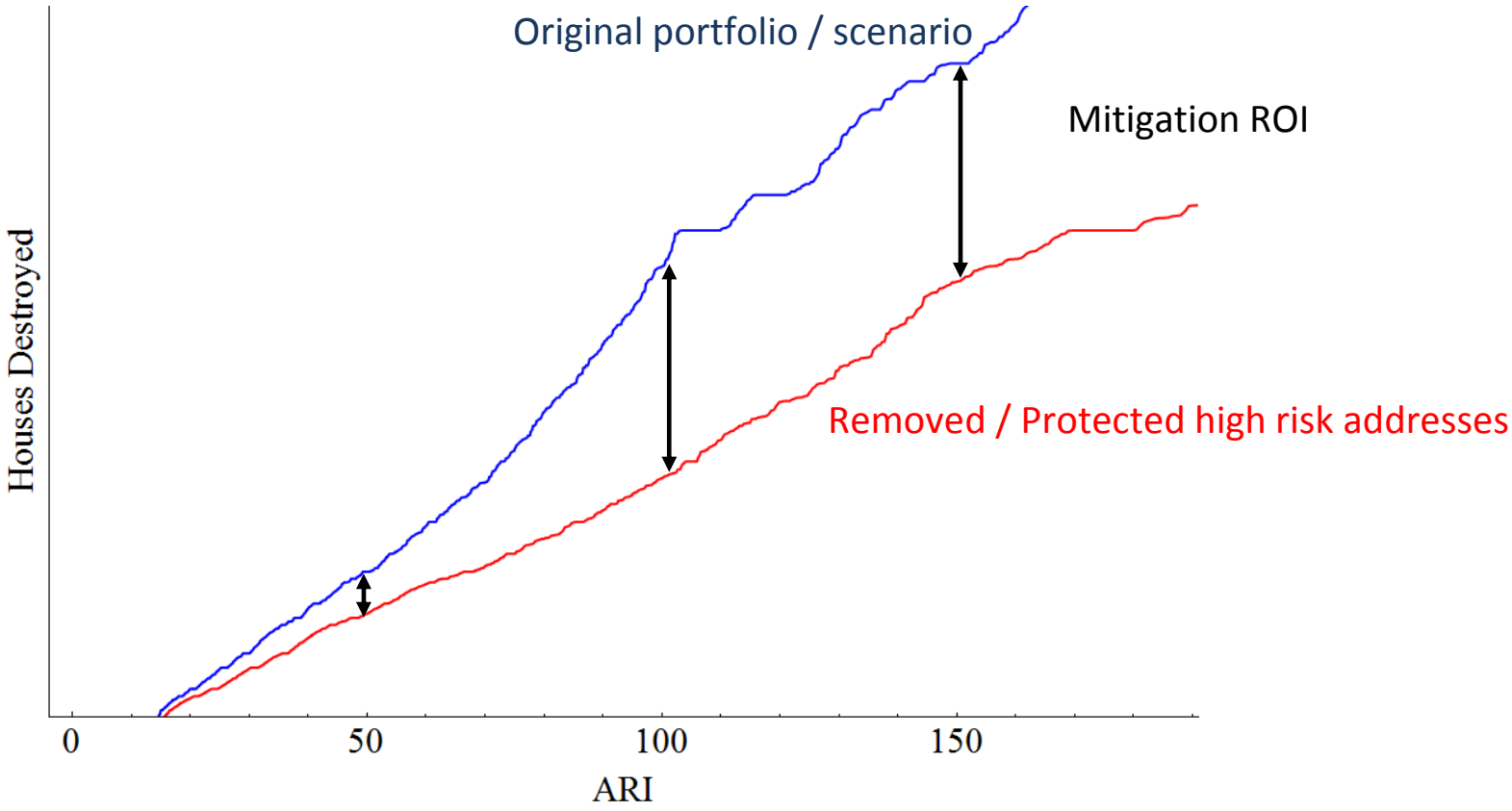




Tokyo Volcanic Ash Losses

QuakeJAPAN losses

Risk Selection Benefits

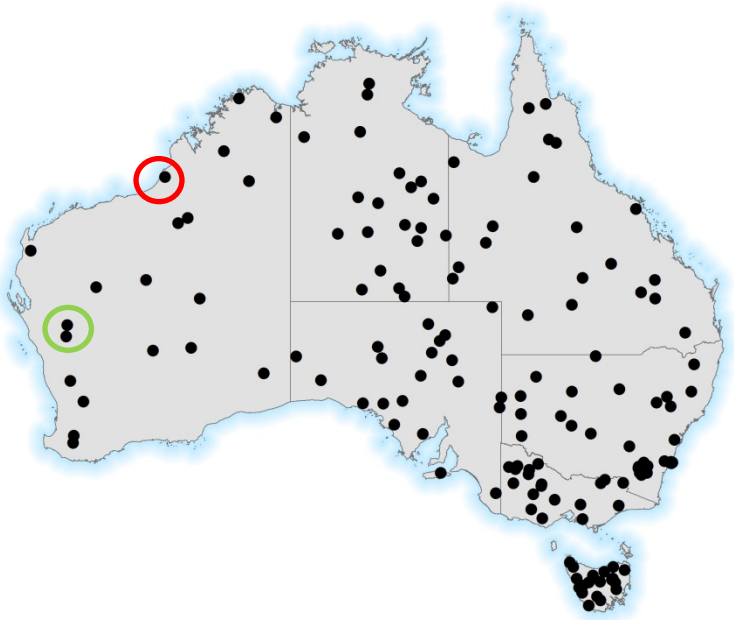


Blue: Market-distributed portfolio EP-Curve

Red: Removed / protected properties within 100m of the peril

Resource Allocation Benefits

	Site #	1	2	3	4	5
Modelled	Riverine flood	2%	0%	1%	No Risk	5%
	Bushfire	No Risk	No Risk	No Risk	No Risk	No Risk
	Earthquake	0%	0%	0%	0%	1%
	Severe wind	1%	1%	1%	1%	13%
	Hail	No Risk	No Risk	No Risk	No Risk	1%
Historical	Bushfire	8%	50%	No Risk	No Risk	20%
	Earthquake	5%	5%	1%	4%	3%
	Hail	100%	100%	No Risk	8%	25%
	Flood (riverine & flash)	50%	50%	13%	20%	33%
	Grassfire	3%	8%	1%	No Risk	2%
	Gust	50%	25%	4%	100%	50%
	Heatwave	17%	7%	2%	9%	2%
	Landslide	1%	5%	No Risk	3%	5%
	Lightning	25%	33%	No Risk	No Risk	33%
	Rain	17%	5%	No Risk	No Risk	4%
	Tornado	33%	25%	No Risk	5%	13%
	Tropical Cyclone	No Risk	No Risk	17%	No Risk	50%
	Tsunami	No Risk	No Risk	11%	No Risk	No Risk



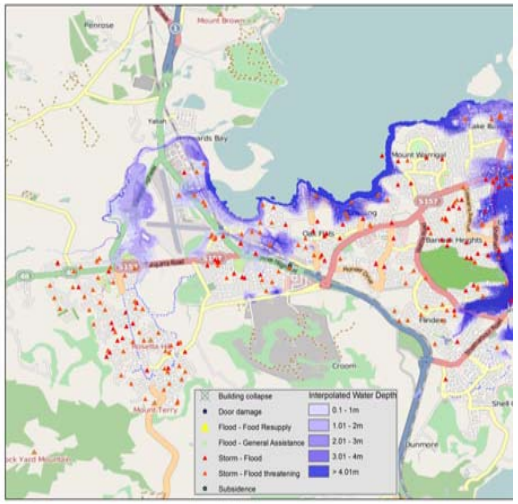
Site #	1	2	3	4	5
P(Modelled Perils)	3%	1%	1%	1%	48%
P(Historical Perils)	200%	167%	45%	143%	200%

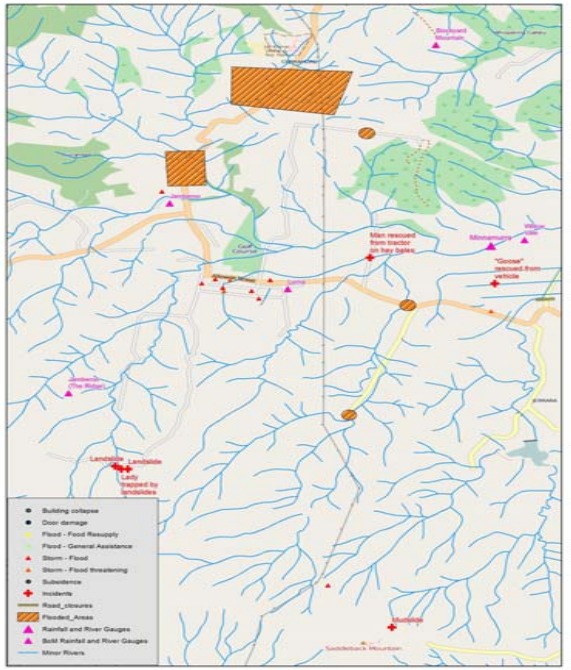
Values represent annual probability of an event

Risk Communication

Emergency Services required a review of regional flooding risks

- Flood depth / extent data collection
- Examine behavioural factors
- Review Flood Response Plans
- Resource Allocation





Conclusions

- Access to high quality data is important
- A blend of historical & modelled results
- Reduce risks through improved land use planning & sustainable development
- Calculate costs/benefits of mitigation
- Determine social & financial vulnerability
- Must be able to communicate the risk

Thank you

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