Catastrophe Risk Modelling

Foundational Considerations Regarding

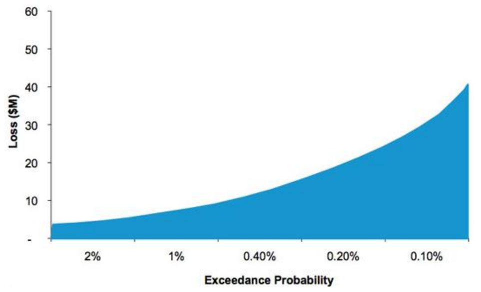
Catastrophe Analytics

What are Catastrophe Models?

Computer Programs

Mathematically Represent the Characteristics of the Peril via Simulations

Tools that Quantify and Price Risk



Inform about Event Frequency and Severity

Industry Standard Practice

Why do we need probabilistic catastrophe models?

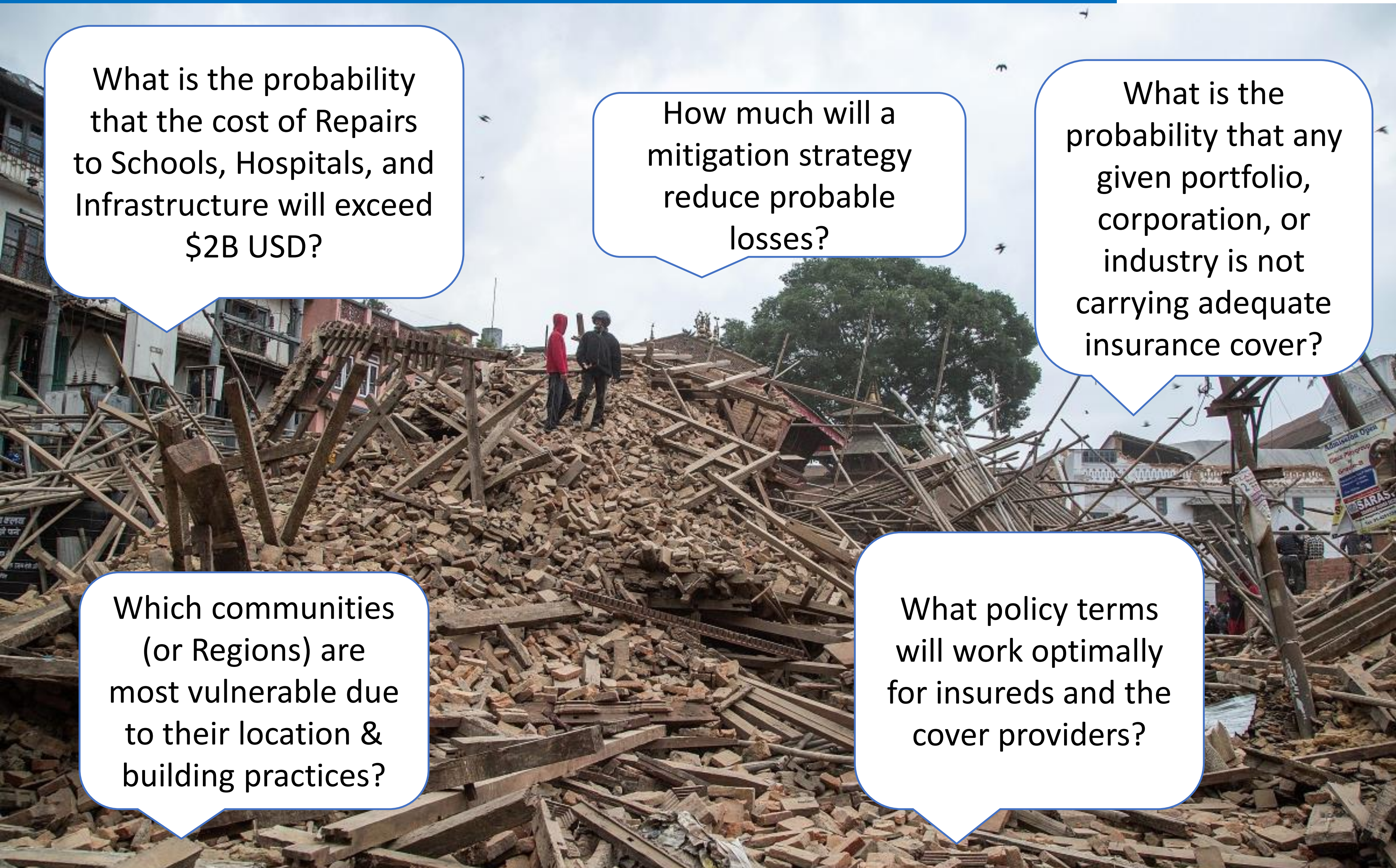
Traditional methods may not be good predictors of possible loss

Fuente: Ing. Jack Lopez -Buffalo University

The constantly changing landscape of exposure data limits the usefulness of past loss experience

Fuente: ULMA

What Questions are Catastrophe Models Designed to Answer?



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Catastrophe Modelling Framework

Hazard

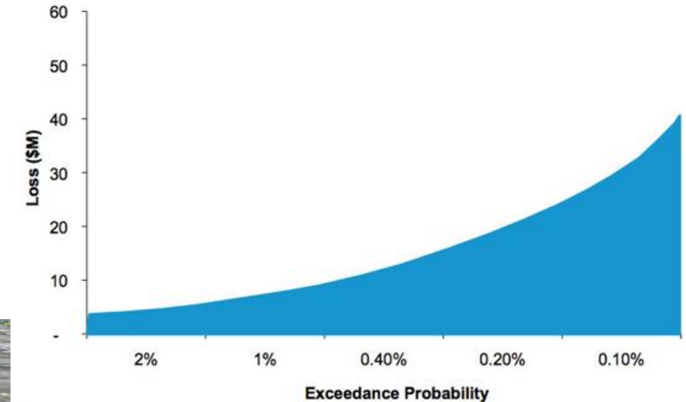
Vulnerability

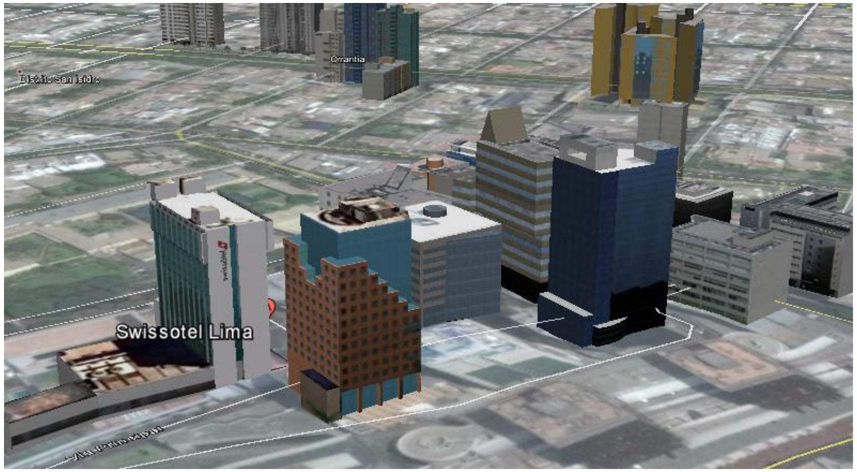
Financial Analysis

Event Simulation [Frequency]

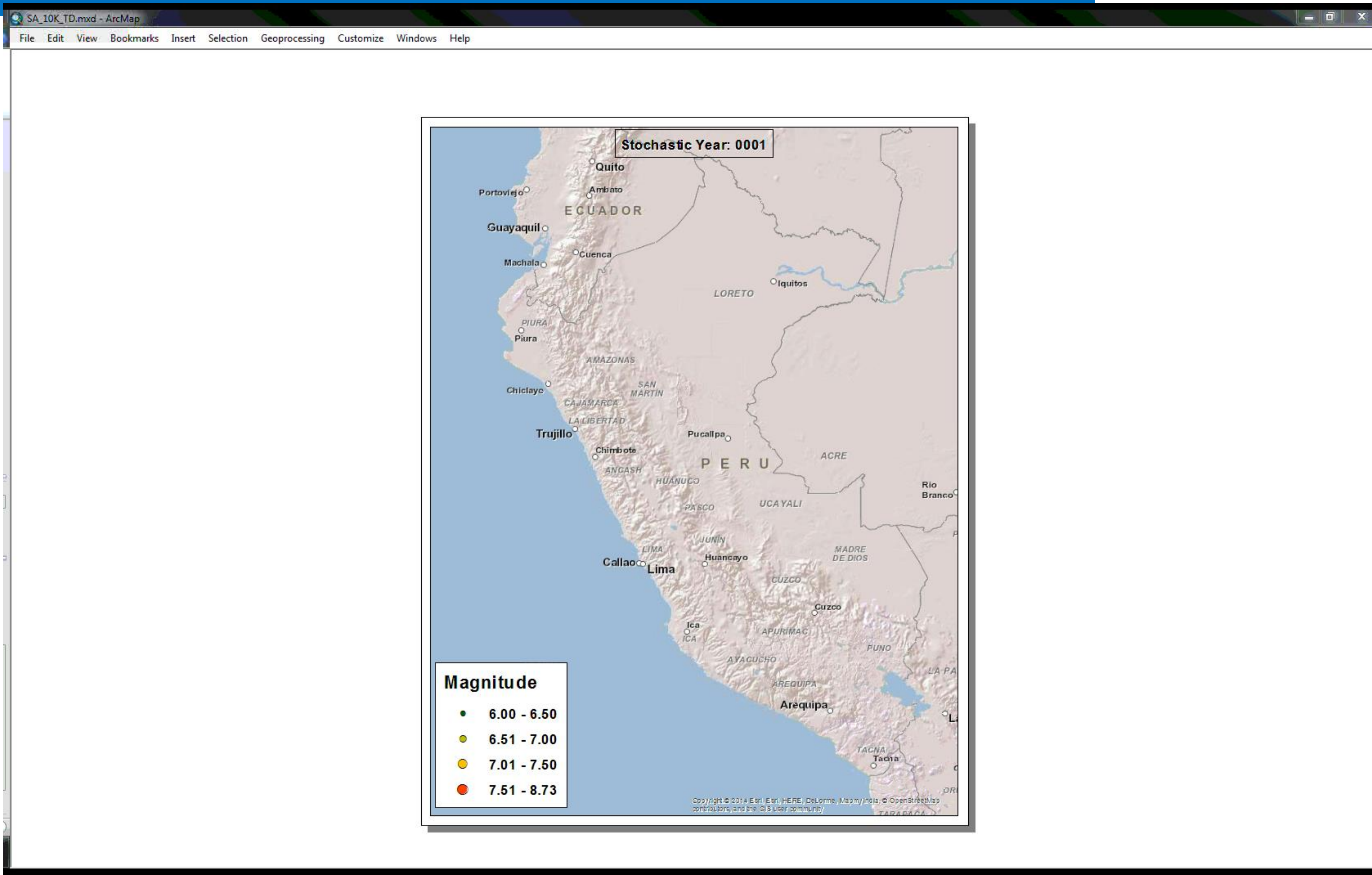
Event Intensity

Exposure Data

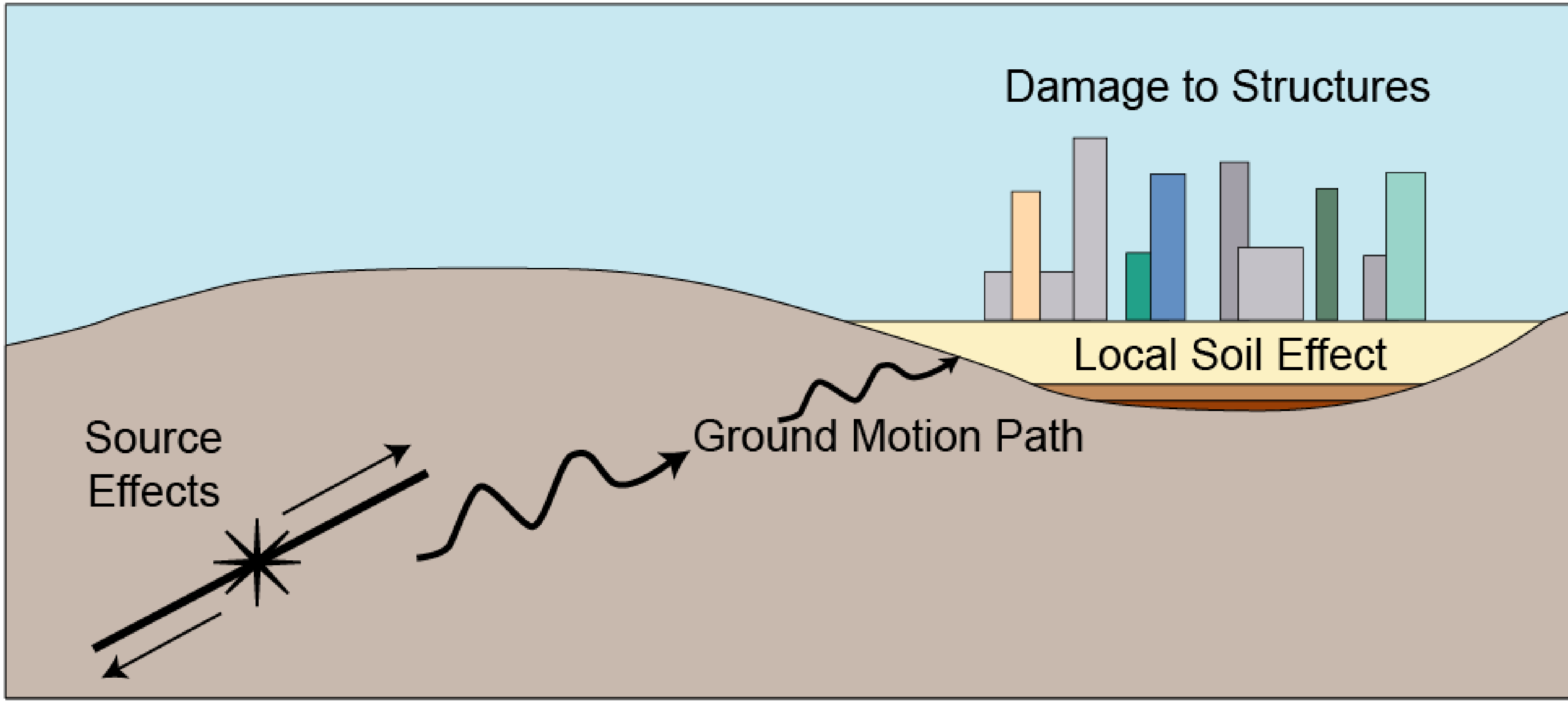




Model Building: Hazard - Event Frequency

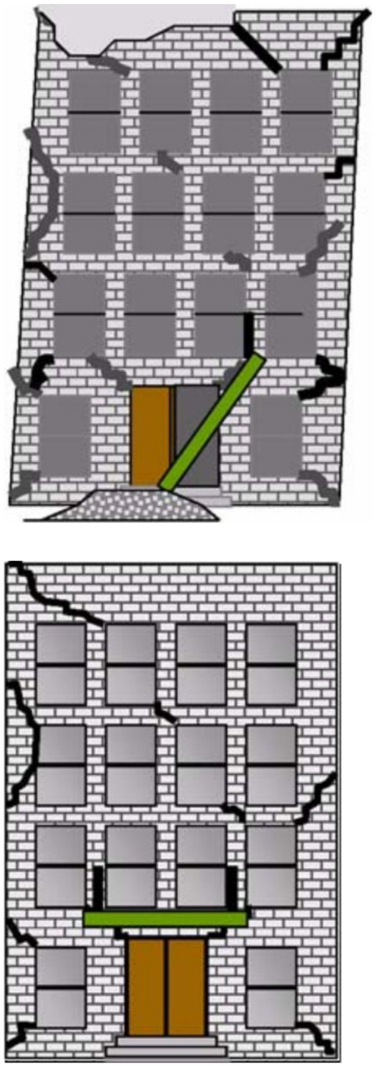


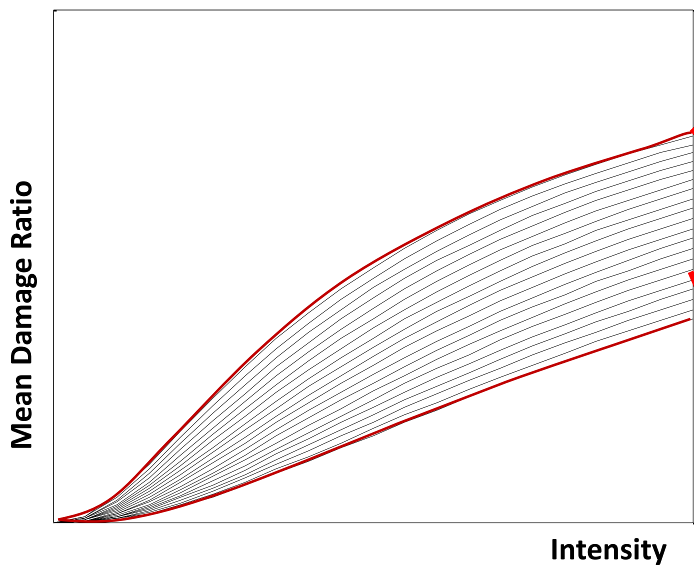
Model Building: Hazard - Event Intensity



Earthquake Intensity - Key Terminology:
"**PGA**" = Peak Ground Acceleration (Quantitative)
"**S.A.**" = Spectral Acceleration (Quantitative)
"**MMI**" = Modified Mercalli Intensity – (Subjective, based on Observed Effects / Damage)

Vulnerability Module Represents Diversity of Construction Practices and Corresponding Losses





Seismic Code Levels to Classify Vulnerability in AIR Model

Code Level		Description
Pre		Without seismic consideration
Low	I	With minimal seismic consideration
	II	
Moderate	I	With moderate seismic consideration
	II	
	III	
High	I	With stringent seismic consideration
	II	
	III	
Special	I	With very stringent seismic consideration
	II	
	II	
	IV	

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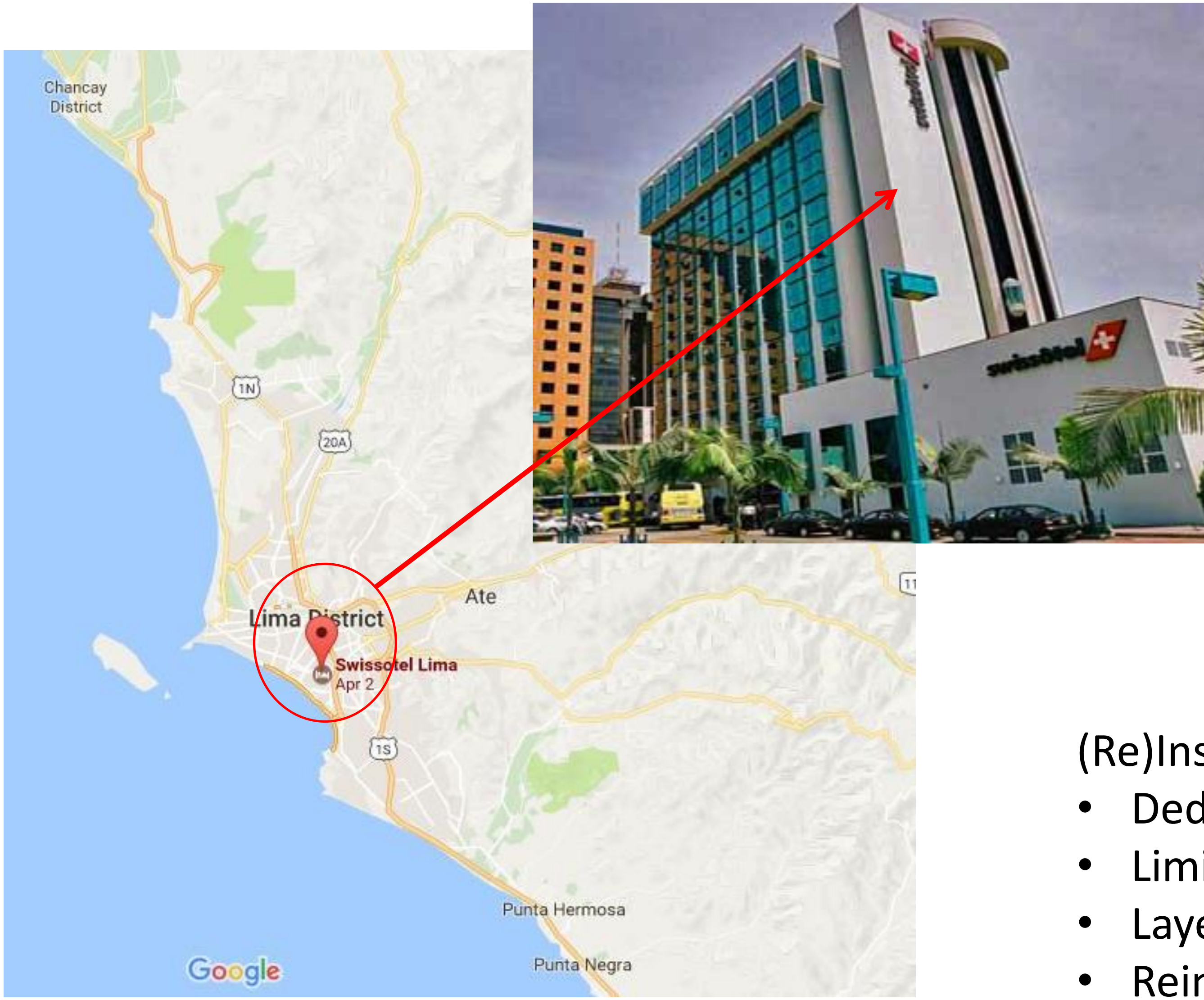
Exposure Data Drives Quality of Modelling Results



Location
- Where is it?

Replacement value
- How much is it?

Characteristics
- What is it made of?
- What is it used for?
- When was it built?
- How tall is it?

(Re)Insurance Information
- Deductibles
- Limits
- Layer information
- Reinstatements

What are Some of the Primary Challenges to Leveraging Catastrophe Models?

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CHALLENGE	SOLUTION / BEST PRACTICE
Exposure Data Quality & Availability	Leverage Existing Data Sets / Understand Limitations / Make Investments in Data Collection
Comparing Outputs from Different Models	Understand Model Differences on Component Level & Treat Comparisons Carefully
Single Numerical Representations of Risk Can Be Misleading	Leverage Measures like TVAR / Use Multiple Outputs to Better Understand the Risk
Commonly Used Terminology Can Be Misleading: "PML", Return Period "250-year Loss"	Return Periods = Exceedance Probabilities / Make Sure to Interrogate & Define "PML"
Modelling Skill Development Requires Training & Time	Available: Training Programs, Software Access, Peers Who Share "Risk" Vocabulary

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What is the State of Modelling Today?

ADVANCES	BENEFITS to RISK MANAGEMENT
Scientific Advancements / Discoveries	Risk Quantification of New Perils: Cyber, Pandemic & Improved Understanding of Key Perils: Earthquakes, Hurricanes, Floods
Aerial & Satellite Imagery, Drone Surveying, Mobile Data Capture	Improvements in Exposure Data Quality, Claims Data Collection
Increasing Computing Power & New Flexible Architecture	Reduced Model Uncertainty, Analysis Speed, Improved Risk Mapping, Access Anywhere, Reduce User's Technology Costs, Systems Integration Improved
Increased Information & Number of Models Available	Increased Options & Competition Drives Quality of Offered Solutions
Models Increasingly Used by Governments, Capital Markets, and Corporations	Common Language of Model Outputs Means Increased Access to Risk Transfer Solutions & Improvements in Resiliency

Risk Modelling

Analytics Role in Building Resilience

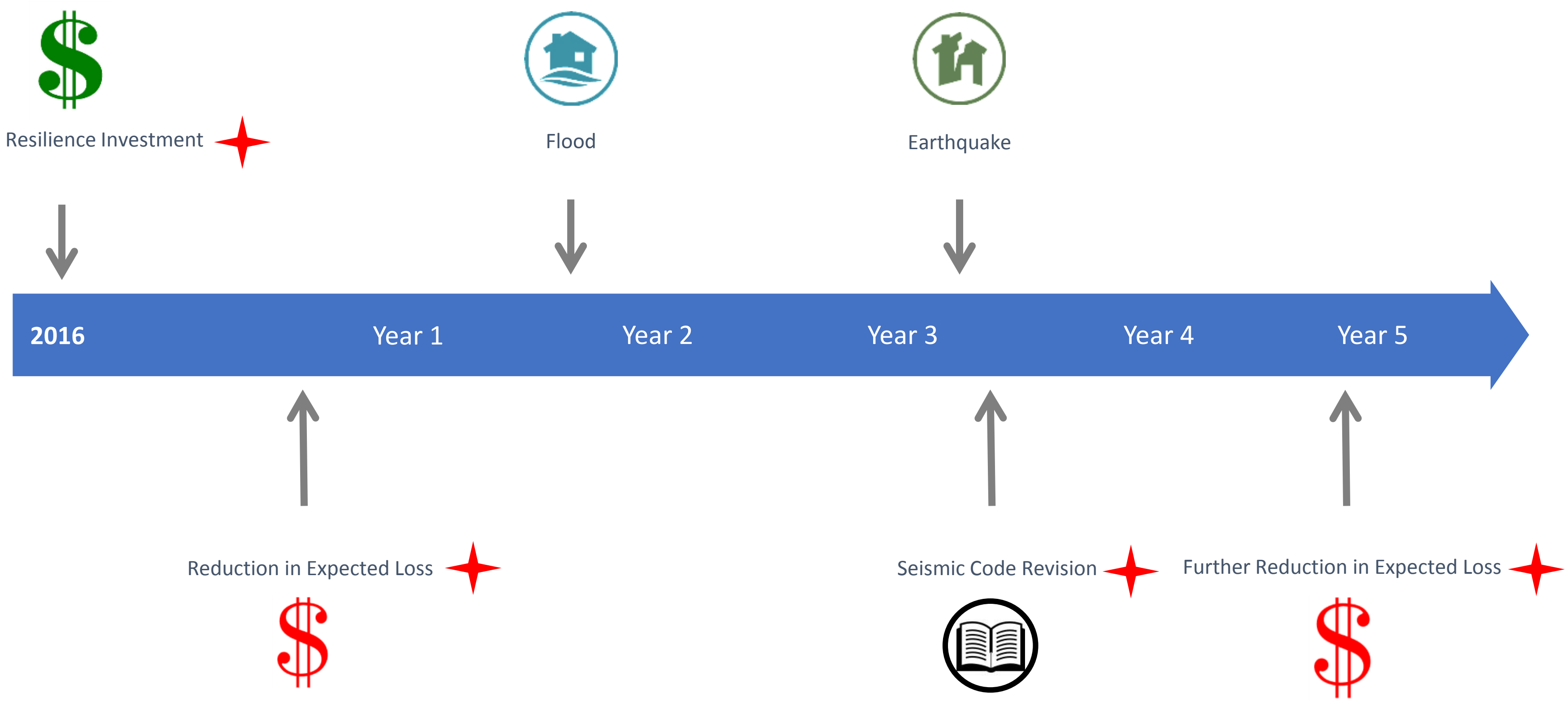
Why Does modelling Matter?

Truly Understand Your Risk

Choose Right Solution

Instil Investor Confidence

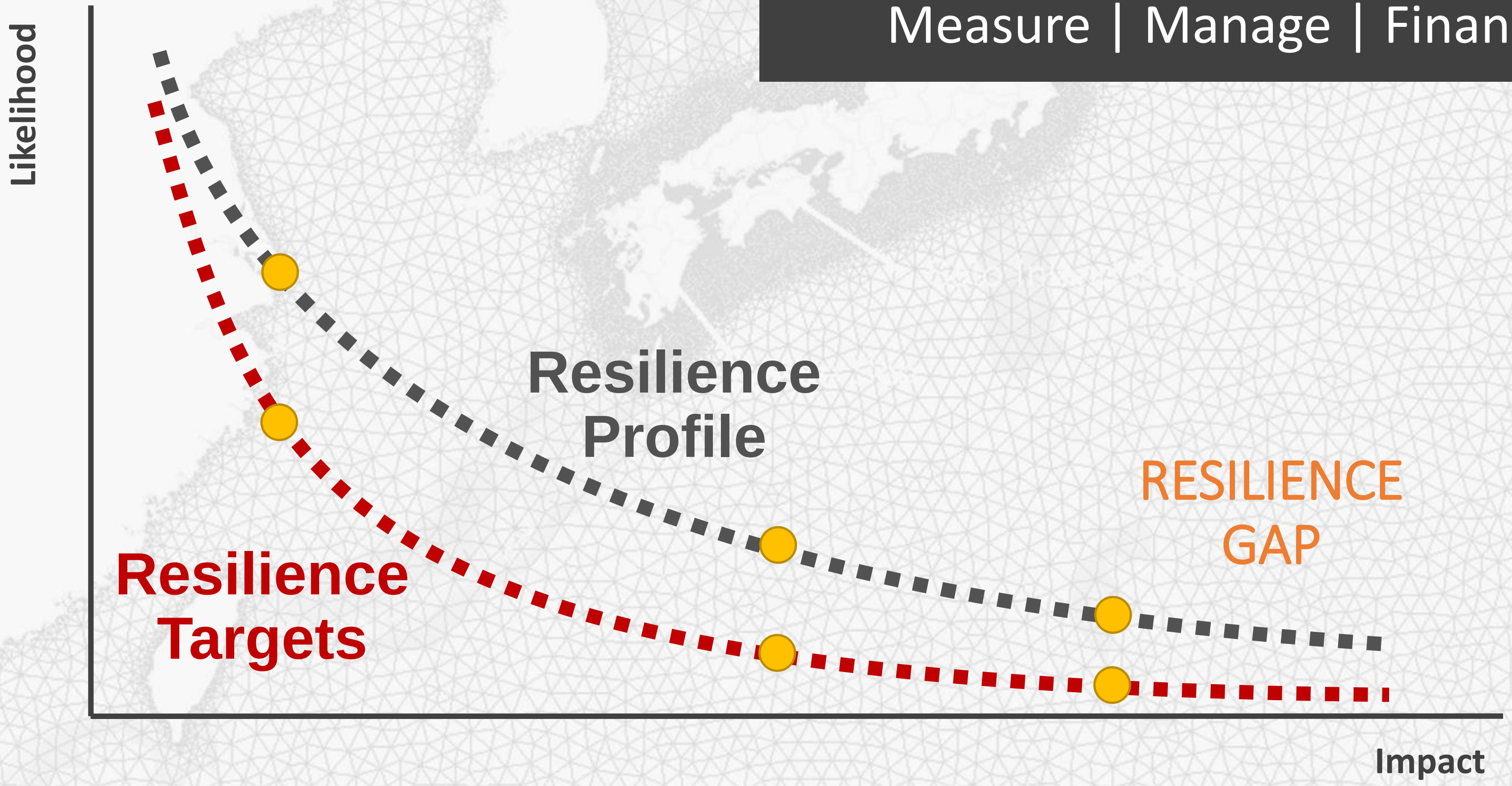
Resilience timeline



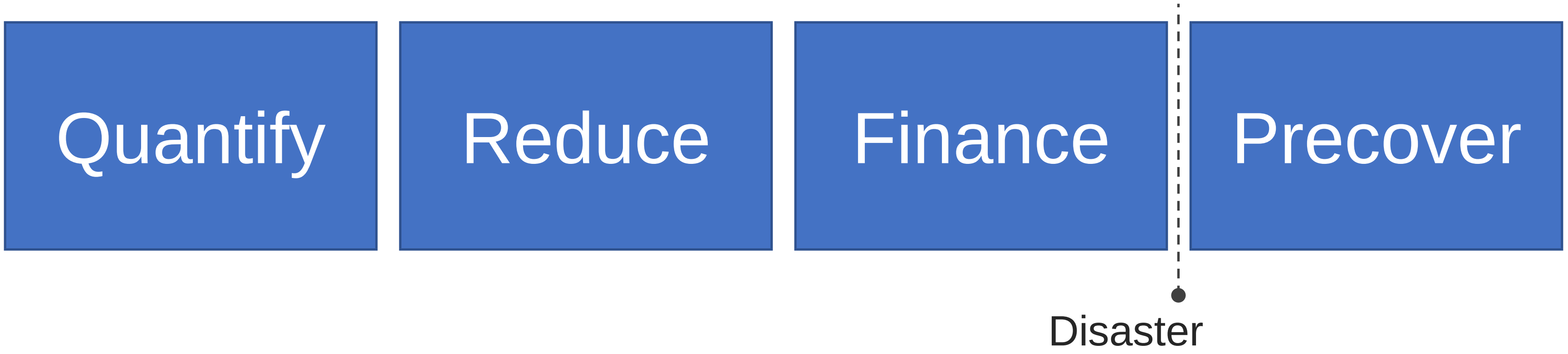
✦ **Analytics**

If you take away one thing…

Measure | Manage | Finance

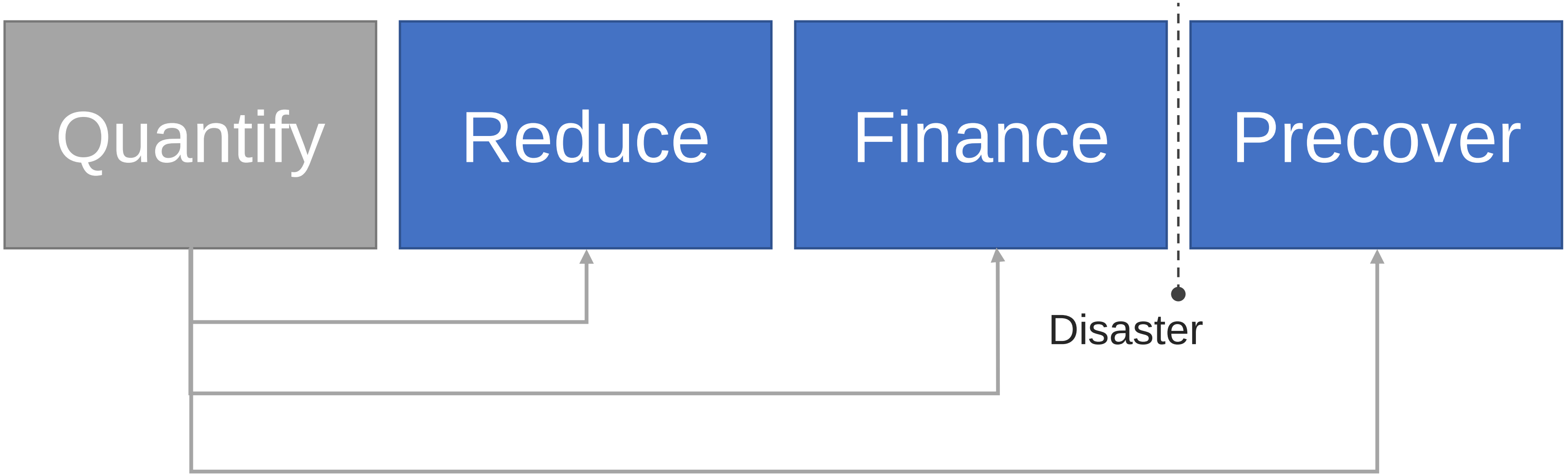


Four essential Disciplines of Resilience



Four essential Disciplines of Resilience

ANALYTICS ARE FUNDAMENTAL TO ACTION



Four essential Disciplines of Resilience

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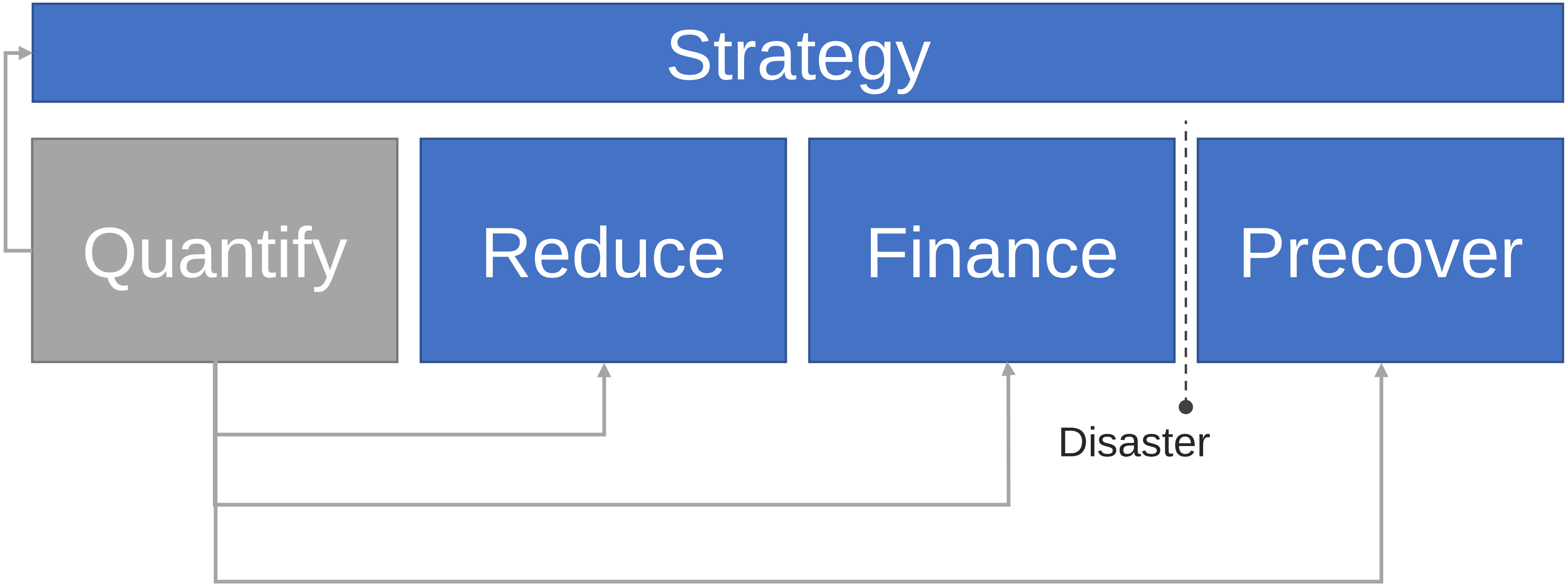
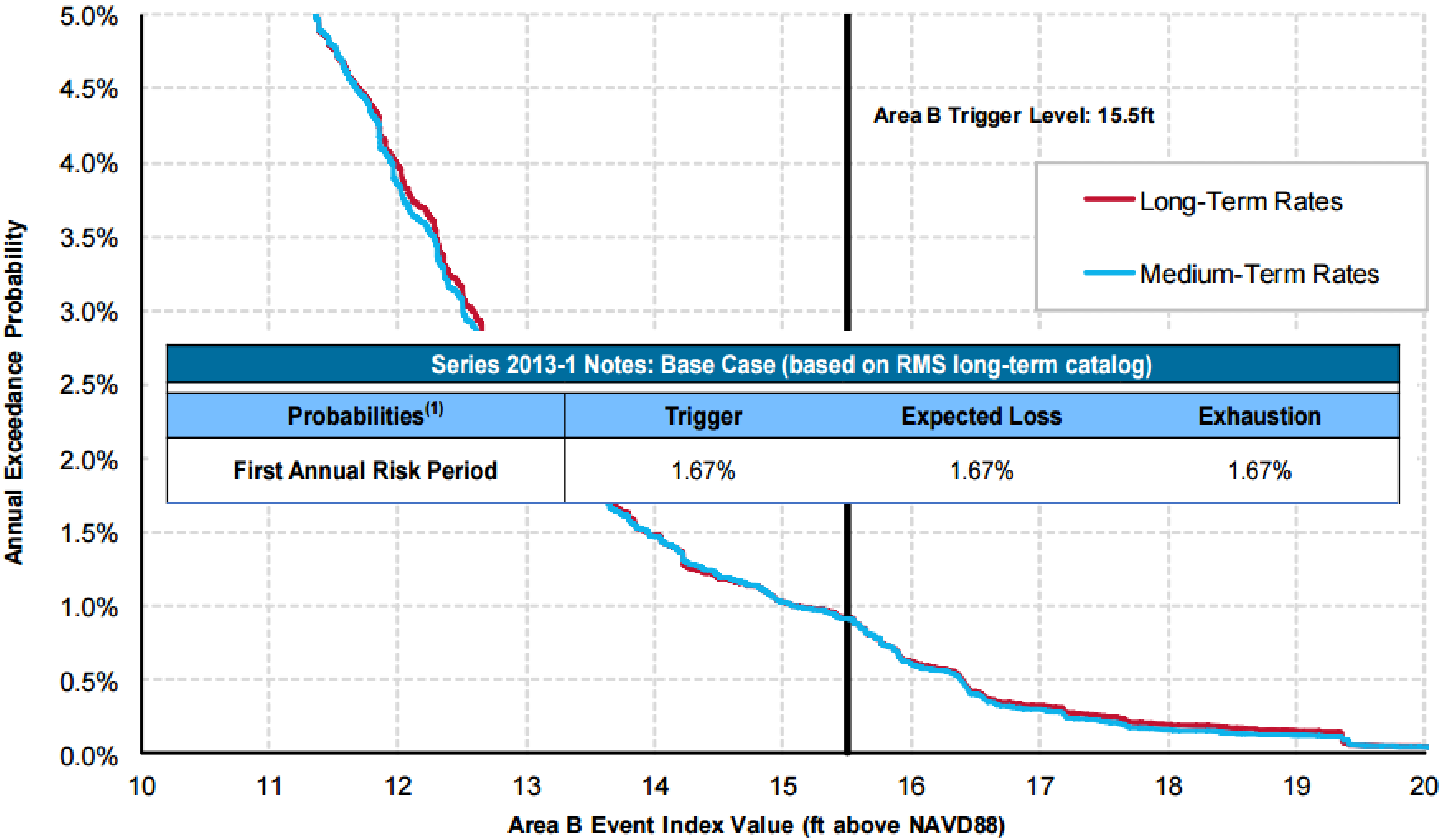


IMPOSSIBLE TO ACCESS ALTERNATIVE MARKETS UNLESS YOU CAN ARTICULATE YOUR RISK PROFILE



Series 2013-1 Notes: Base Case (based on RMS long-term catalog)			
Probabilities[(1)]	**Trigger**	**Expected Loss**	**Exhaustion**
First Annual Risk Period	1.67%	1.67%	1.67%

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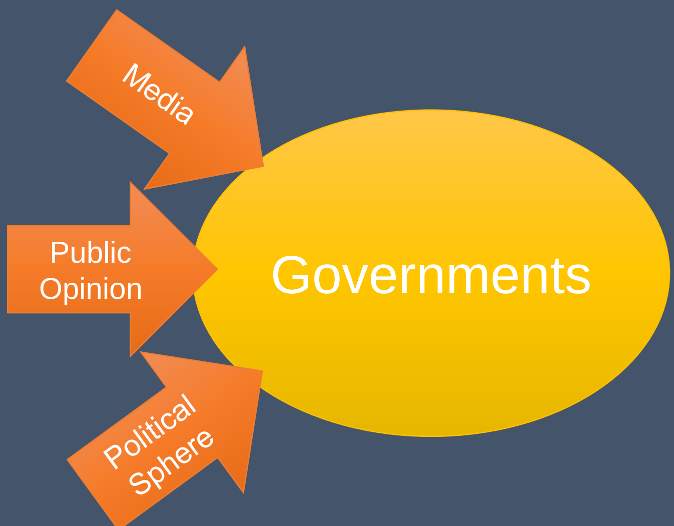
MODELS HELP GOVERNMENTS DESIGN & DEMONSTRATE RESILIENCE-BUILDING STRATEGIES, PREDICATED ON MATURE, METRIC-BASED UNDERSTANDING OF CURRENT & FUTURE RISK



Respond to pressure to…

1. Build more resilient economies
2. Prepare for 'Acts of God'
3. Fulfil duty of care to citizens
4. Securing funding
5. Use tax payers' money efficiently
6. Be seen as 'world leading'

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Storm Surge Defence

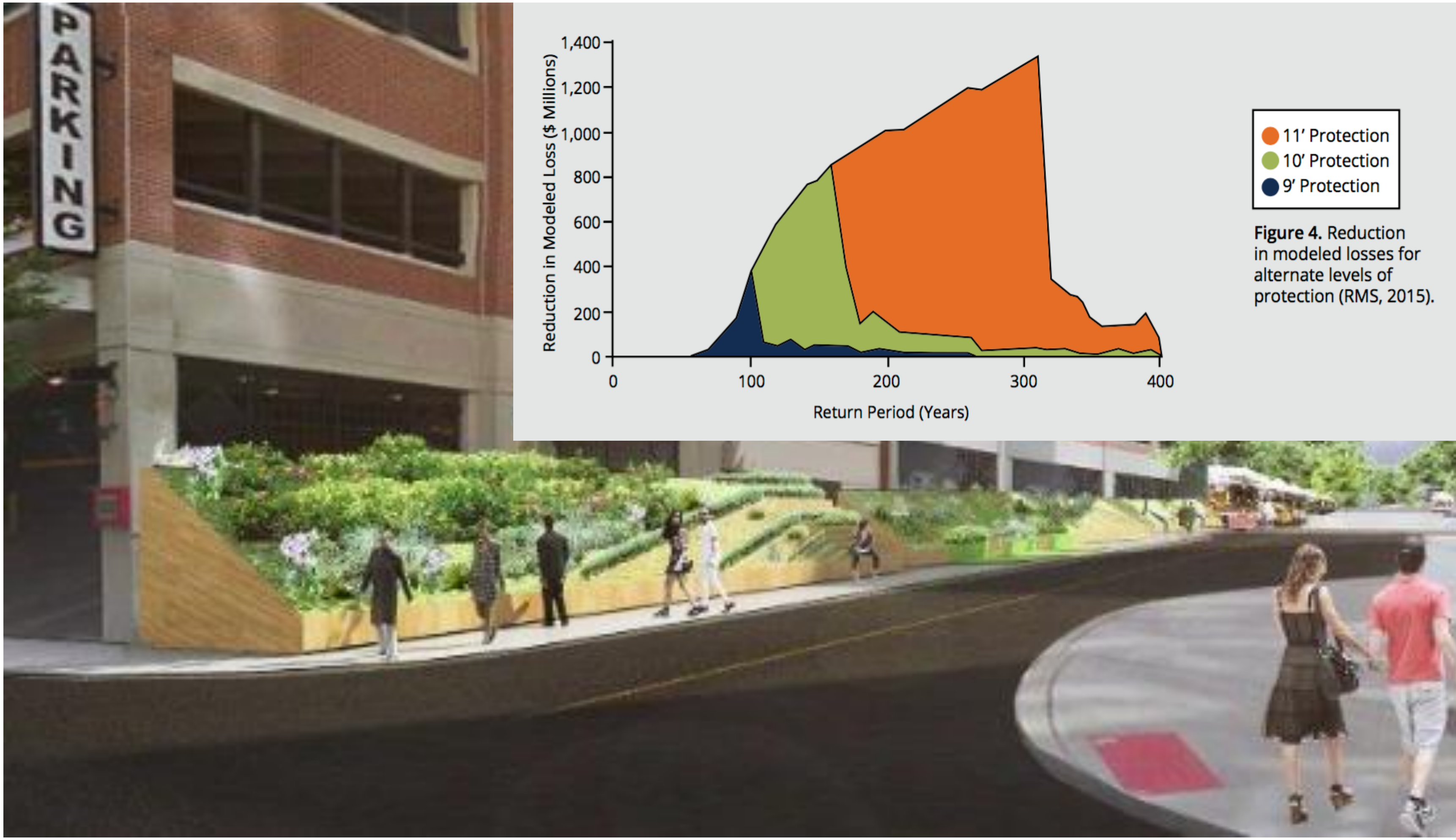
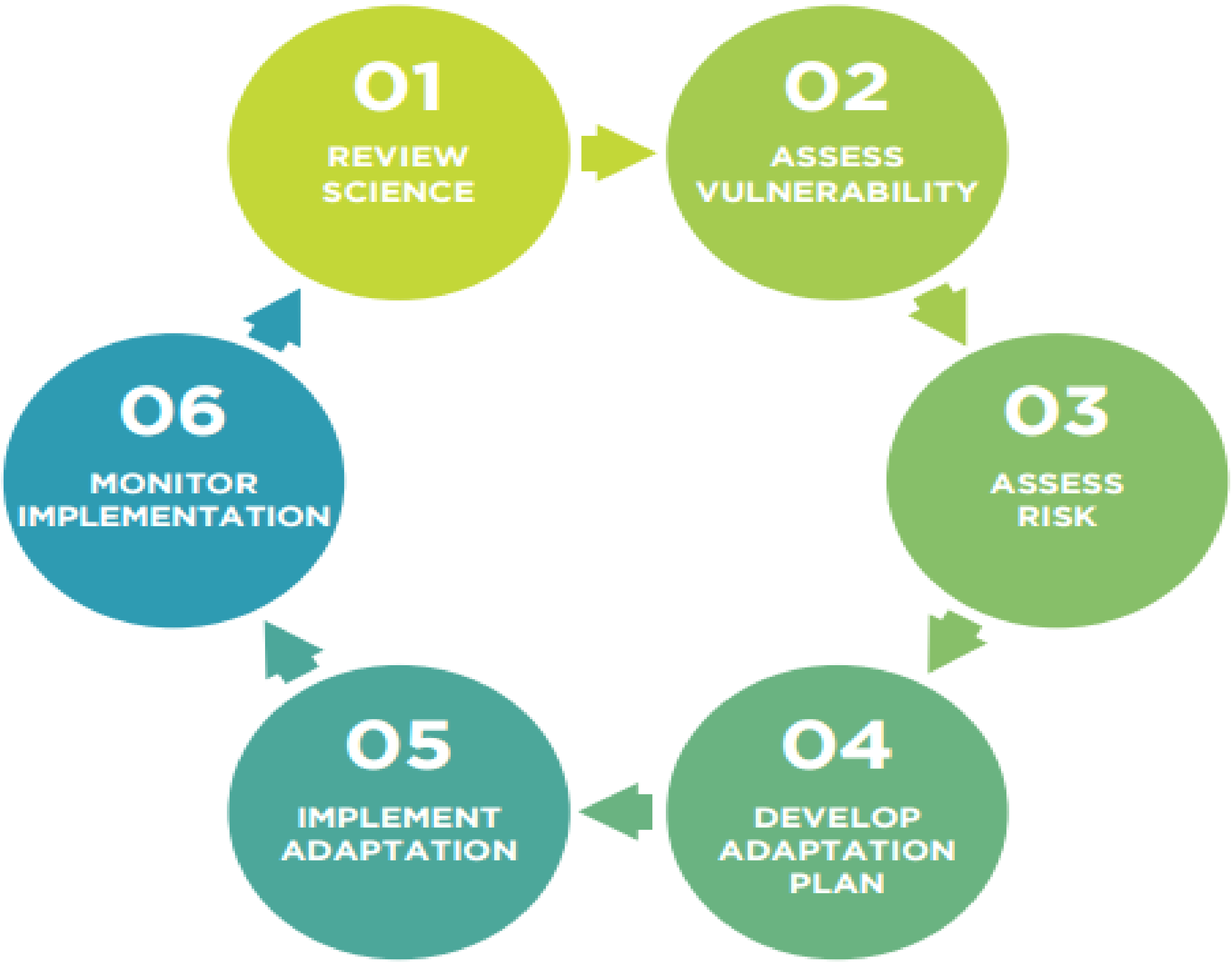


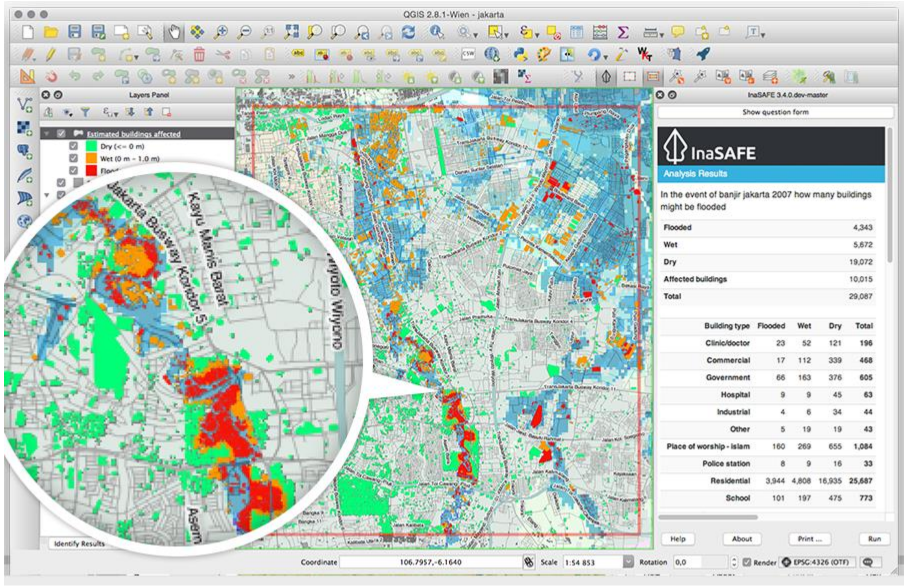
Figure 4. Reduction in modeled losses for alternate levels of protection (RMS, 2015).

A Continuous Process



Model coverage in the region

- Earthquake – well covered
  - AIR, RMS, CoreLogic, Impact Forecasting (in OASIS LMF)
  - ERN, CAPRA, Global Earthquake Model (SARA / OpenQuake)
  - CISMID, IGP
- Flood – less covered
  - Ambiental / Willis
  - Global models now high resolution, can be applied to Peru: JBA, SSBN
- Landslide
  - Global landslide susceptibility
  - Academic or engineering (non-industry) models on local scales



- Other perils and sub-perils to cover – coastal flood, tsunami, liquefaction, drought, windstorm, volcano

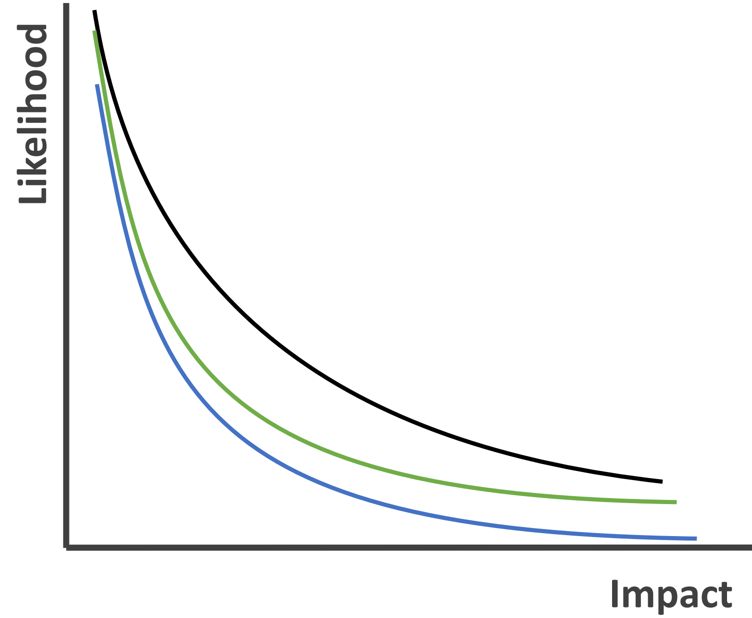
- *Various level of 'model': can assess risk using other means (not only catastrophe models)*
  - *Analyse of exposure / risk by overlay*
    - *probabilistic hazard map or scenario map - e.g., satellite image of past floods*
  - *Other tools*
    - *Copernicus, Flood observatories, Storm track providers – data as input to models*
    - *More basic risk models – e.g., InaSAFE*

Which model to use?

- Influenced by risk strategy and required outputs
  - Scenario loss (‘worst-case’)
    - knowledge of impact from extreme events
      - Education, evacuation planning (be sure not to rely on biggest experienced)
  - Probabilistic
    - Annual average and return period loss over different timescales
      - Risk transfer, land-use planning, construction design

- What does strategy focus on?
  - Economic loss, uninsured or insured assets (how is financial model applied?
  - Particular asset types – e.g., niche industrial facilities, or agricultural crops
  - Population affected and casualties

Which model to use?



- Benefits from multiple model views of risk
- No single model has the ‘correct’ answer
- All have uncertainties, different methods, built on different data
- Different focus / components: sub-perils, asset types, loss outputs
- Combining model views
  - provides a ‘range of estimates’
  - limits on what might actually happen
  - To inform decisions, not give the ‘correct’ number

Pros and Cons of Models

Proprietary

+ Targeted investment, staff resource in development, extensive experience

+ International market acceptance of models - (re)insurance, capital markets

+ User oriented interfaces, client support, clear documentation aids evaluation

+ Program of model updates model

+ Often large suite of models, advance in one can benefit others (faster advances?)

- Licence costs

- Somewhat restricted data sharing, limited direct user access

Open (different levels)

+ Methods accessible to review, validate (if data available), share, adapt, build on

+ Wide scope for innovation by risk community (direct science advances from research/academia)

+ If interoperable, data or components can be combined / shared

+ Common data standards enable data to be used in multiple models

- May be good in one aspect (specialism of research group) but not others

- Ad-hoc UI / updates (esp. academic models) – less user friendly

IDF Risk Modelling and Mapping Group (RMMG)

- One of eight IDF work streams – developing and transferring knowledge around risk data and modelling to risk community

- Understand risk data and model availability
- Inform efforts focus to fill gaps in provision
- Improve efficiency, reduce duplication
- Open risk information

- Online catalogues of risk modelling/data questions and expert guidance

- Coordinate advances in interoperability, data standards, improvements in vulnerability modelling and validation of models

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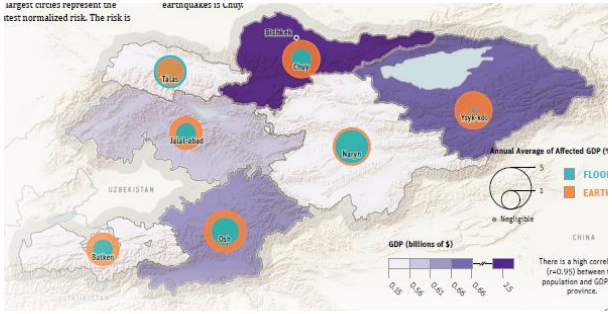
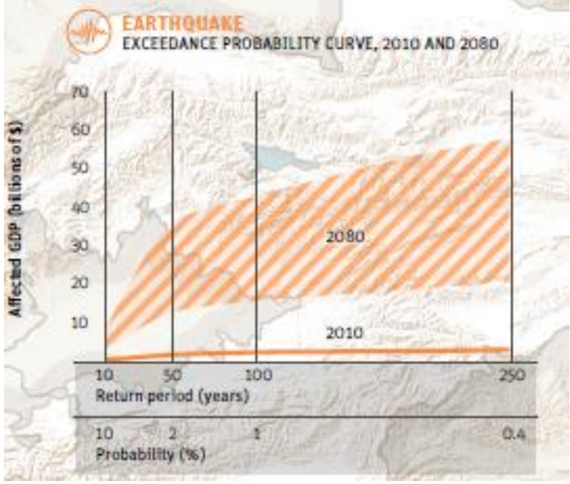
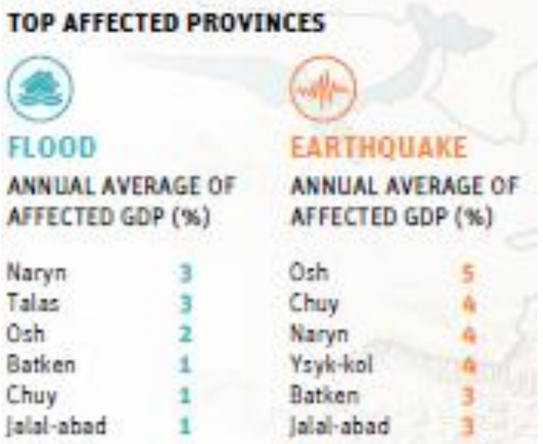
Communicating risk outputs

- Communicating risk
    - Absolute / relative losses, multiple scales
    - Dynamic risk – exposure change (urbanisation, population growth), climate change
    - Loss drivers by sector, region, peril
        - Residential or commercial?, Flood or earthquake?
        - Ranking cities, provinces
    - To prioritise and target risk management / financing strategies
        - By location, asset type, and/or peril
        - Retrofit commercial building stock, Homeowners' insurance market, develop flood protection

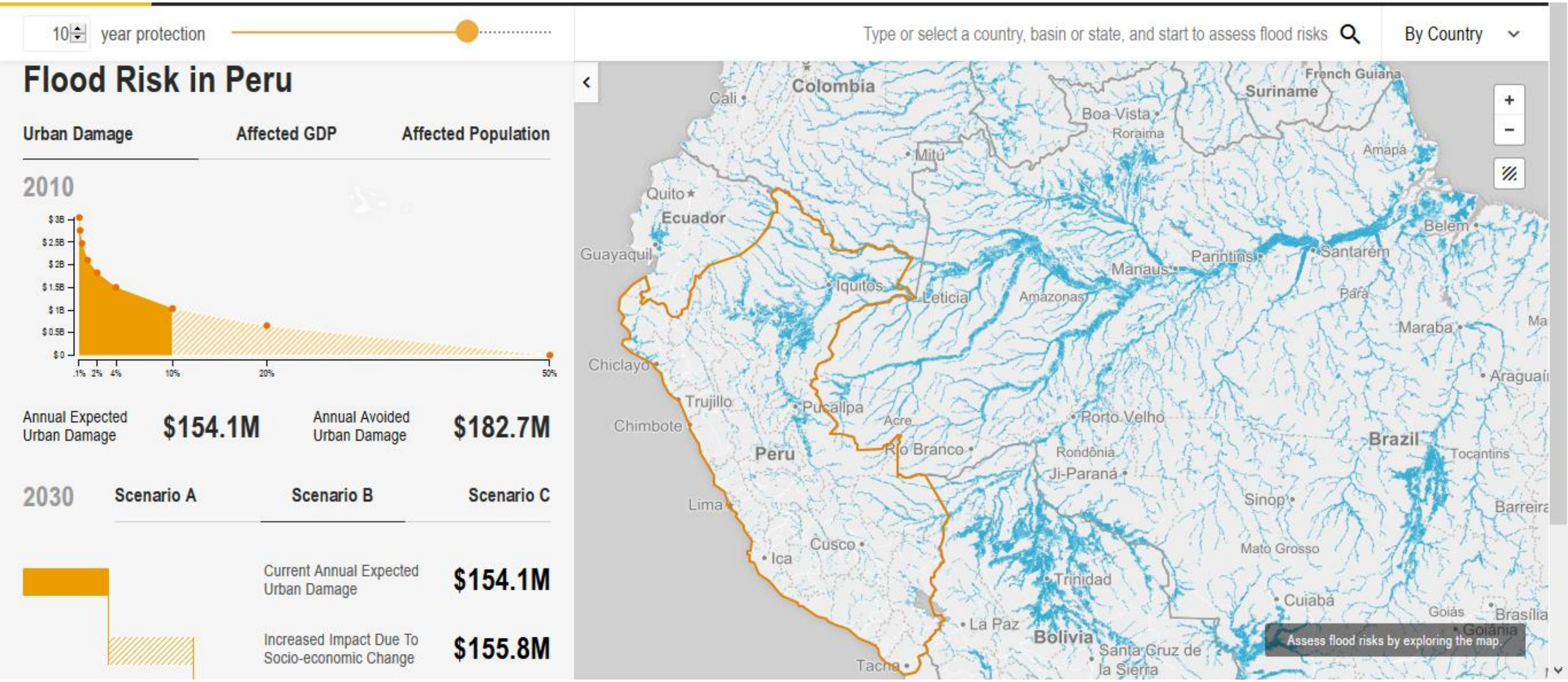






Communicating risk outputs

- Interactive portals, 'Disaster risk profiles'
  - Maps, charts, tables, historical comparison



Summary

- Purpose of risk modelling, structure and components, model differences, and range of outputs of risk assessment
- Final takeaway: modelling process is a collaborative effort
  - Common understanding of user requirements from project start
  - Understanding of outcomes, limitations from the beginning
  - Local knowledge, access to data are important to build robust models