Using Insurance Catastrophe Models to Investigate the Economics of Climate Change Impacts and Adaptation

Dr Nicola Patmore

Senior Research Analyst

Risk Management Solutions (RMS)

Bringing Science to the Art of Underwriting™

RMS®

Risk Management Solutions, Inc.

- The leading catastrophe risk modelling firm
  - Independent, objective focus on providing the best quantification of cat risk to all stakeholders
  - Client base: insureds, insurers, and reinsurers
  - Over 1,000 professionals worldwide (> 60 PhDs in research and development) and annual R&D investment ~$50 million
- Produce models that inform catastrophe risk management along the entire risk transfer chain:

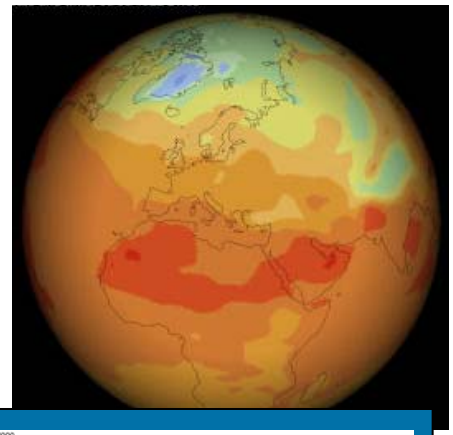
Risk Holders **Brokers** **Insurers** **Reinsurance Brokers** **Reinsurers**

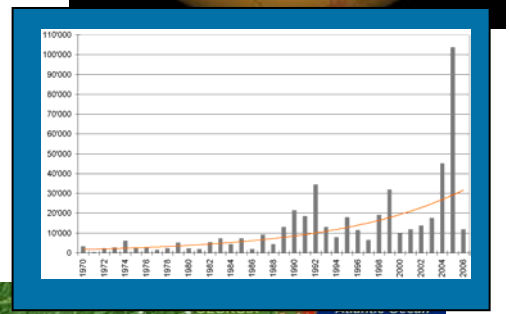
  - Understanding and managing risk across the (re)insurance portfolio
  - Maximise efficient use of capital and optimise reinsurance ((re)insurer)
  - Securitisation – analytical support in transfers of risk to the capital markets

© 2008 Risk Management Solutions, Inc.

RMS Climate Change Practice

- Climate change practice set up in January 2007 to investigate:
  - The implications of climate change for the insurance and the catastrophe modelling industries.
  - How RMS' catastrophe risk expertise can be used to help decision-makers manage the risks from climate change.





© 2008 Risk Management Solutions, Inc.

Contents

- Introduction to the tool: catastrophe models
- Using catastrophe models for climate change
- Examples of research to date

© 2008 Risk Management Solutions, Inc.

Introduction to Catastrophe Modelling

- **Focus on losses from extremes today:** provide a view of the present-day financial risks associated with catastrophes (natural and manmade) for a specific location or aggregated area/portfolio.
- Range of climate-related perils covered by RMS models:

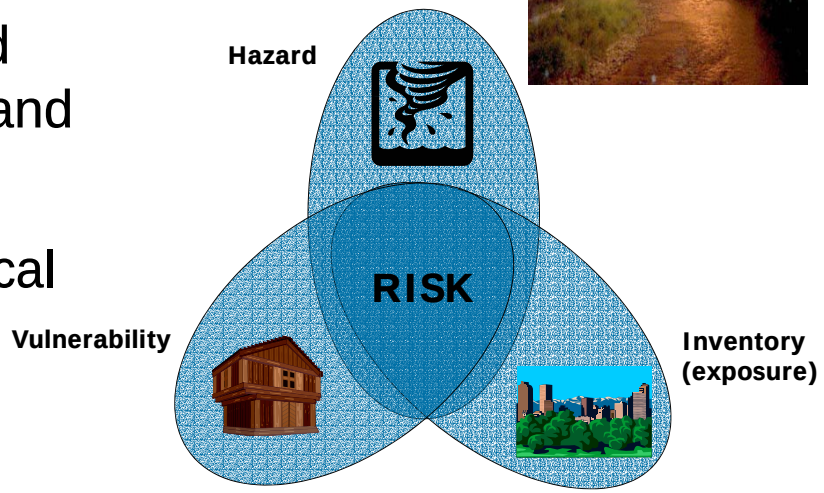
Inland Flood **Storm Surge Flood**

Winterstorm **Wildfire**

Tornado / Hail

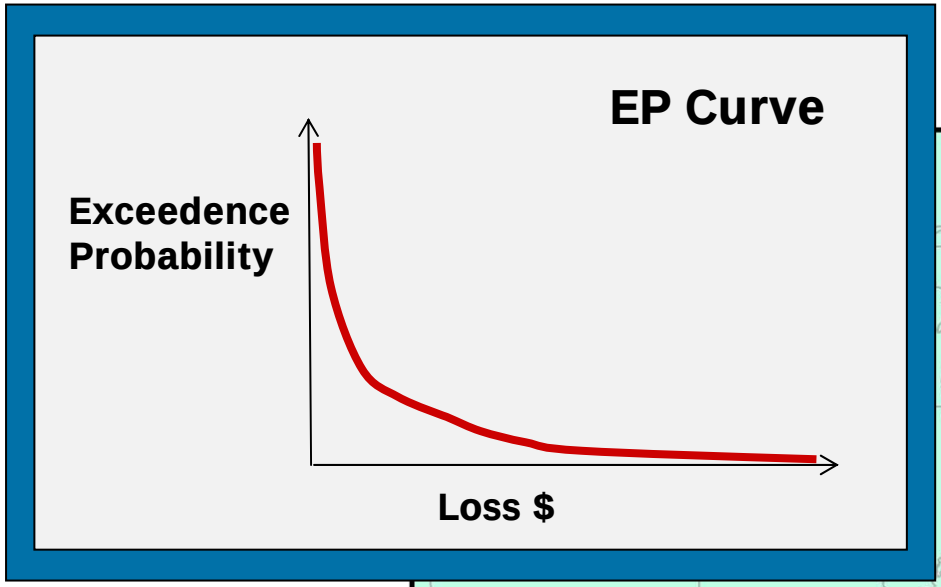
Hurricane / typhoon

- Foundation: statistical models based on a combination of historical data and physical modelling
- **Multi-disciplinary**: combine physical sciences, mathematics/statistics, engineering and financial modelling

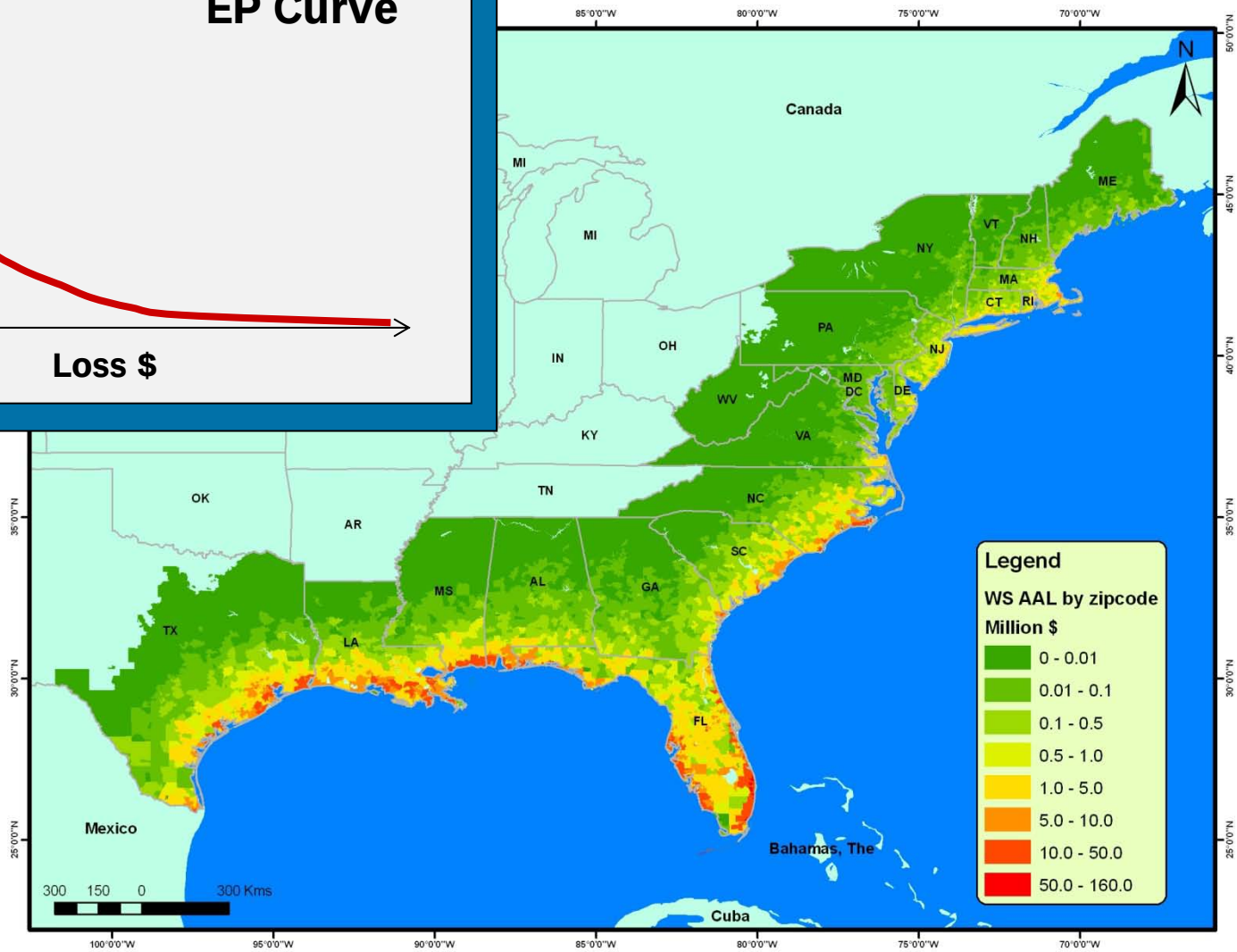


© 2008 Risk Management Solutions, Inc.

Examples of Cat Model Outputs



Landscape of US Hurricane Risk: Average Annual Loss, RL7.0



© 2008 Risk Management Solutions, Inc.

RMS

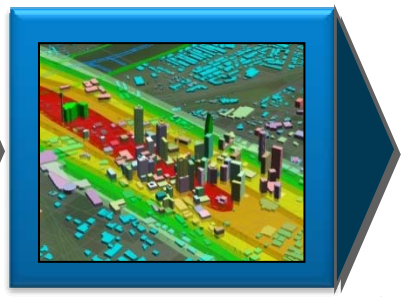
Anatomy of RMS Catastrophe Models

e.g. US Hurricane

Stochastic Event Set

Define Hurricane

Hazard



Assess Wind Speed

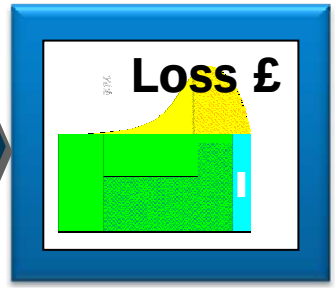
Vulnerability

Calculate Damage

Indirect effects

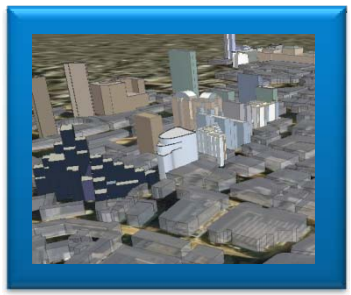
Quantify Loss Amplification

Financial Module



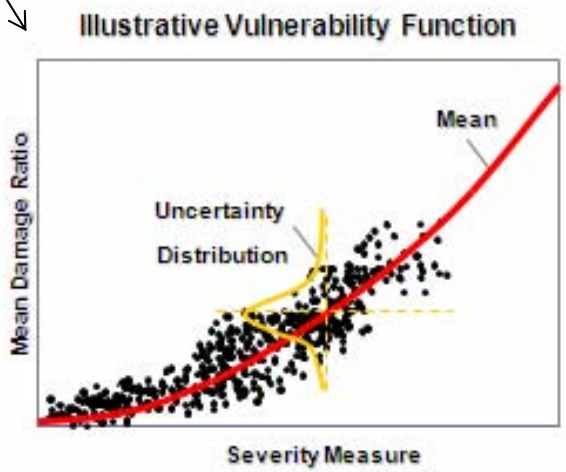
Calculate Financial Losses

Input Exposure



Inventory

High-resolution, high quality exposure data. Insurers estimate their losses by inputting their portfolio; or can estimate market-wide losses using ***RMS industry exposure databases***



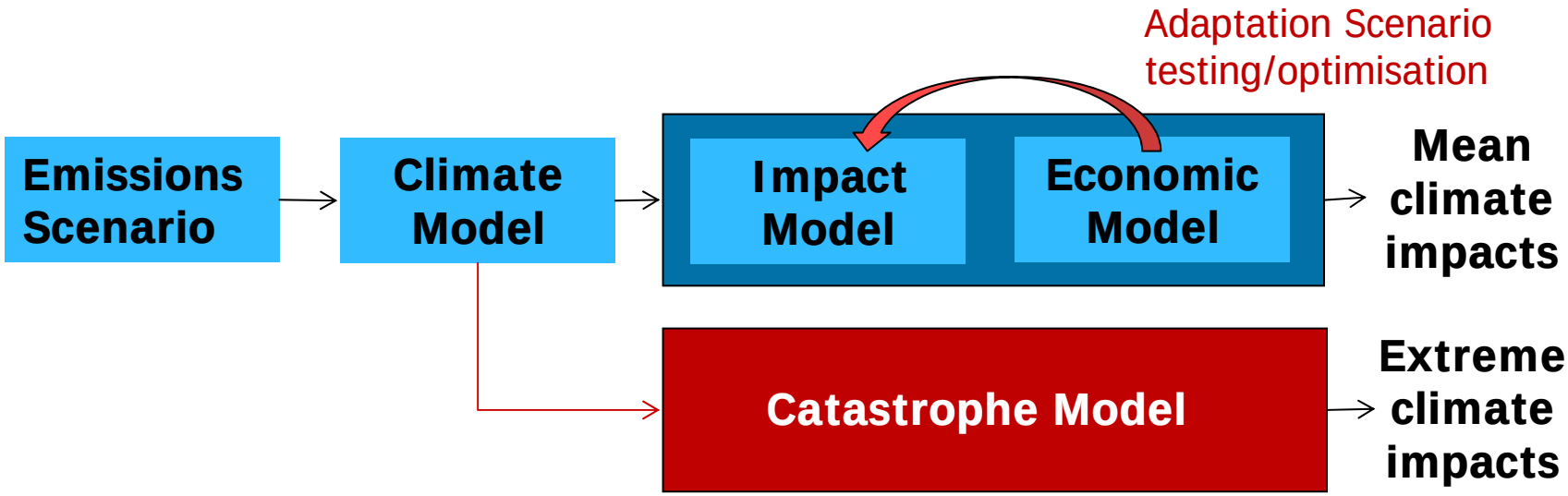
© 2008 Risk Management Solutions, Inc.

Catastrophe Modelling for Climate Change

© 2008 Risk Management Solutions, Inc.

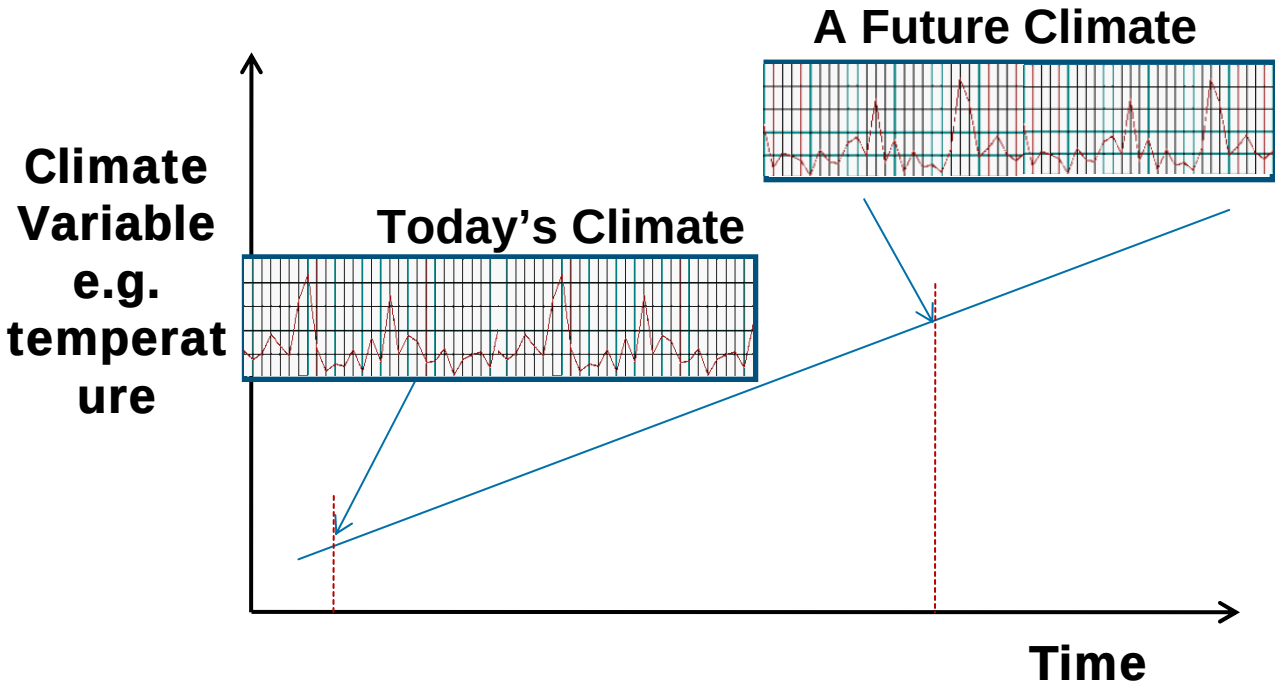
‘Traditional’ Climate Change Impacts Modelling: Integrated Assessment Models (IAMS)

- Impact-specific IAMs used extensively in impacts and adaptation assessments. Tend to be used for **mean climate.**
- IPCC 2007 shows us that some of the first and most severe impacts of climate change will come from **extremes**.
- **RMS exploring how catastrophe models can be used to understand future impacts from extremes, particularly to infrastructure, populations and the economy.**



© 2008 Risk Management Solutions, Inc.

Modelling Climate Change Impacts from Extremes



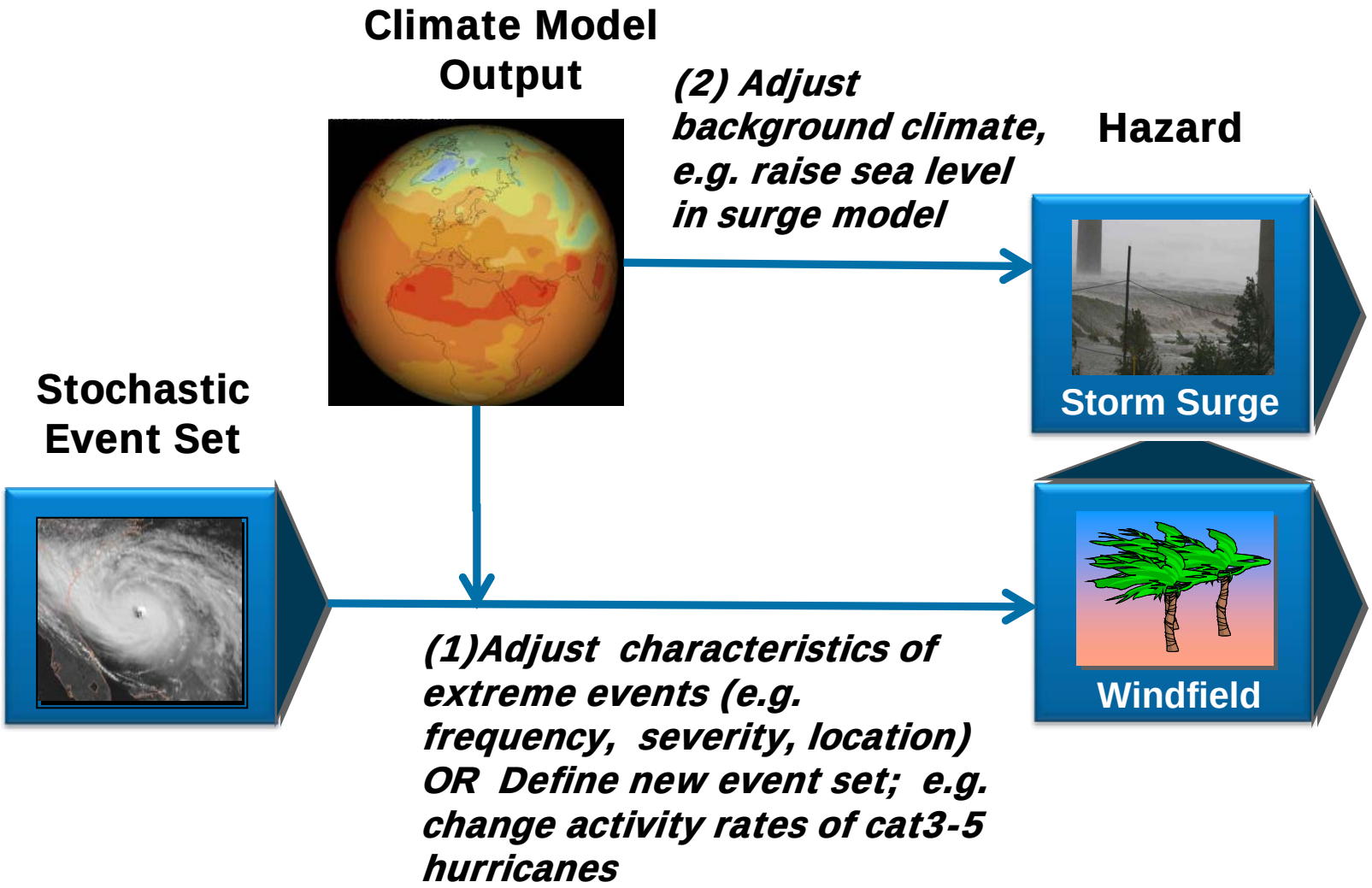
Constraints

- Impacts projections from catastrophe models are only as good as the climate change scenarios used to drive them.
- Climate models do not represent extreme events well – need high resolution and large ensembles of simulations to model trends in extreme events.
- Currently, use climate model output to scale present-day climate in cat models rather than replace it – test a range of scenarios – interpret as indicative of the scale of the impact.

© 2008 Risk Management Solutions, Inc.

Modelling Impacts of Climate Change: Hazards

e.g. US Hurricane

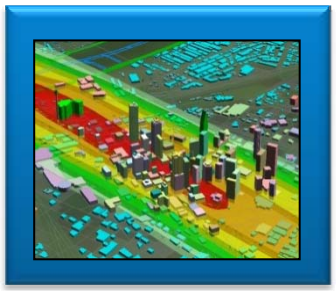


© 2008 Risk Management Solutions, Inc.

Modelling Benefits (£) of Adaptation to Climate Change

Model Changes to Hazard

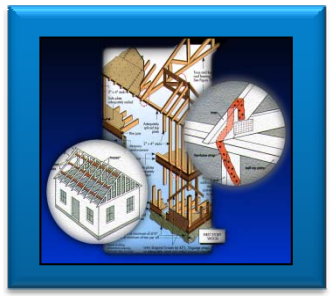
Hazard



e.g. Flood Defences

Model Changes to the Vulnerability of Buildings

Vulnerability



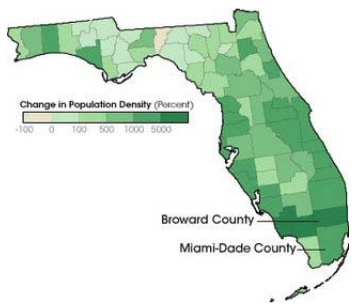
e.g. Flood Resistance & Resilience Measures

(changes to primary and secondary modifiers)

Model Changes to Inventory

Inventory

e.g. Risk Averse Land Planning



© 2008 Risk Management Solutions, Inc.

What is unique about the catastrophe modelling approach for climate change?

1. Probabilistic Hazard Assessment
2. Identification of Correlated Risks
3. Climate peril-Level Resolution
4. Financial Impacts Assessment
5. Integrated Adaptation Modelling Approach

Hazard Component

Exposure / Vulnerability Components

Also: incorporates real hazard data, detailed geospatial exposure information and building specific vulnerability data

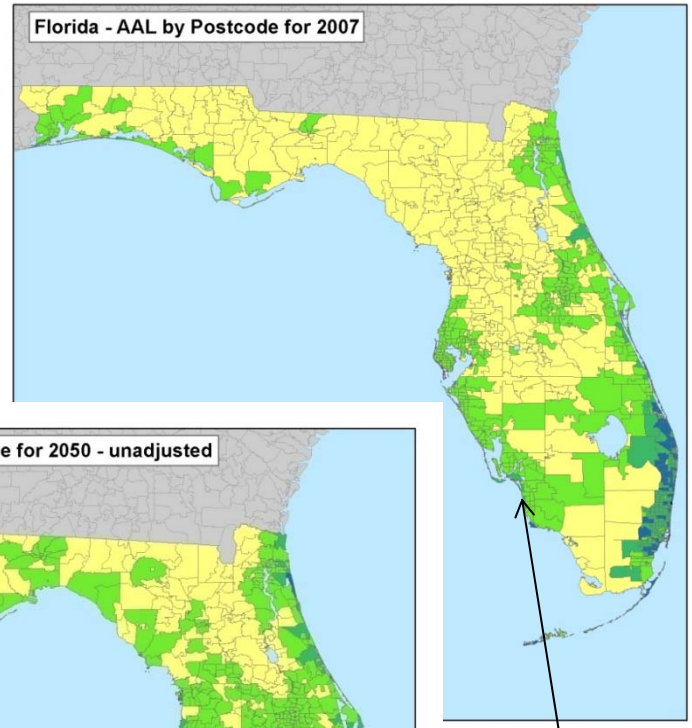
© 2008 Risk Management Solutions, Inc.

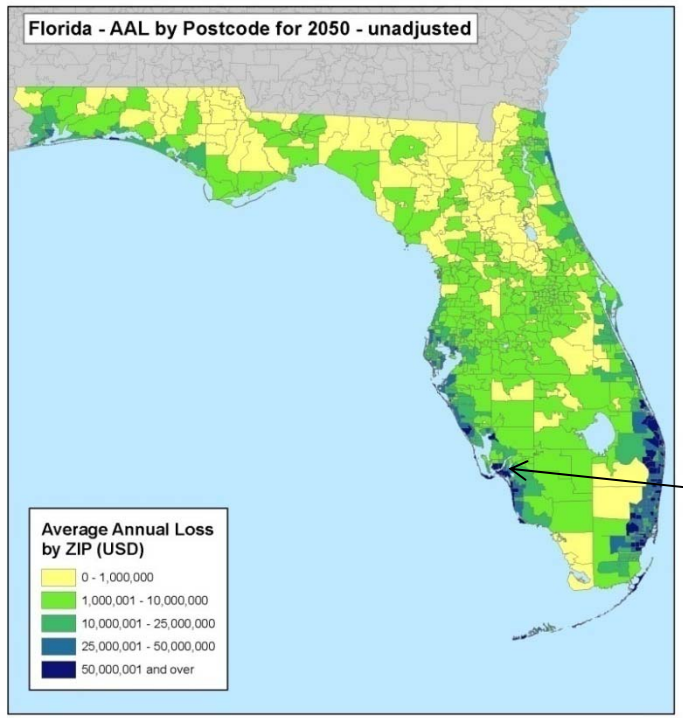
Examples

© 2008 Risk Management Solutions, Inc.

Example: Potential Future Hurricane + Surge Losses in Florida in 2050

- INPUT: sea level rise; scenarios of altered hurricane activity rates; scenarios of exposure growth
- Can investigate:
  - Future losses due to exposure growth projections versus climate change?
  - Which adaptation measures work best, and where?:
    1. **Land use policy**
    2. **Individual adaptation**
    3. **Hard defenses (sea walls, dikes)**



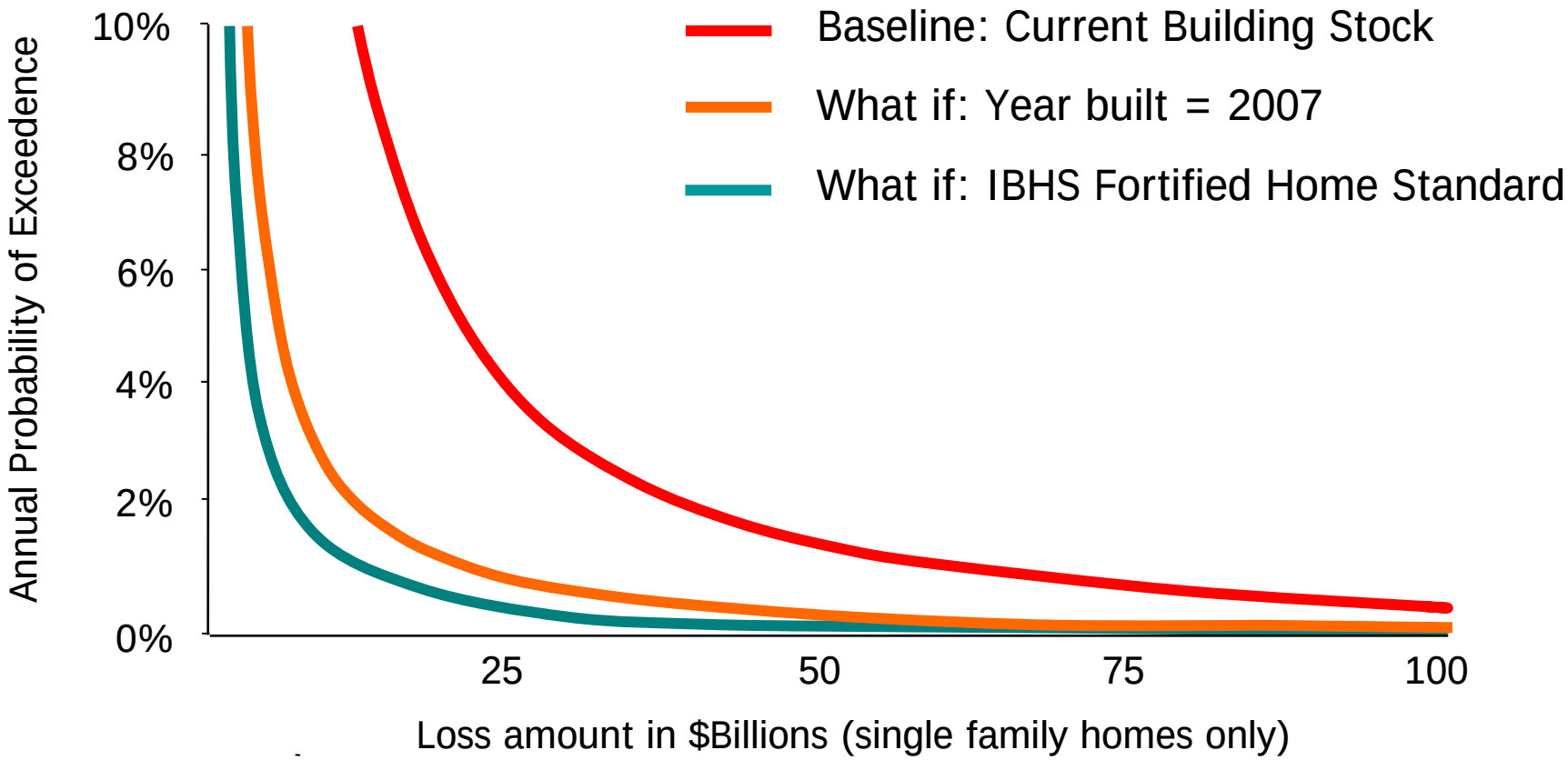


Under high scenario, annual losses more than double

[Work in Progress]

© 2008 Risk Management Solutions, Inc.

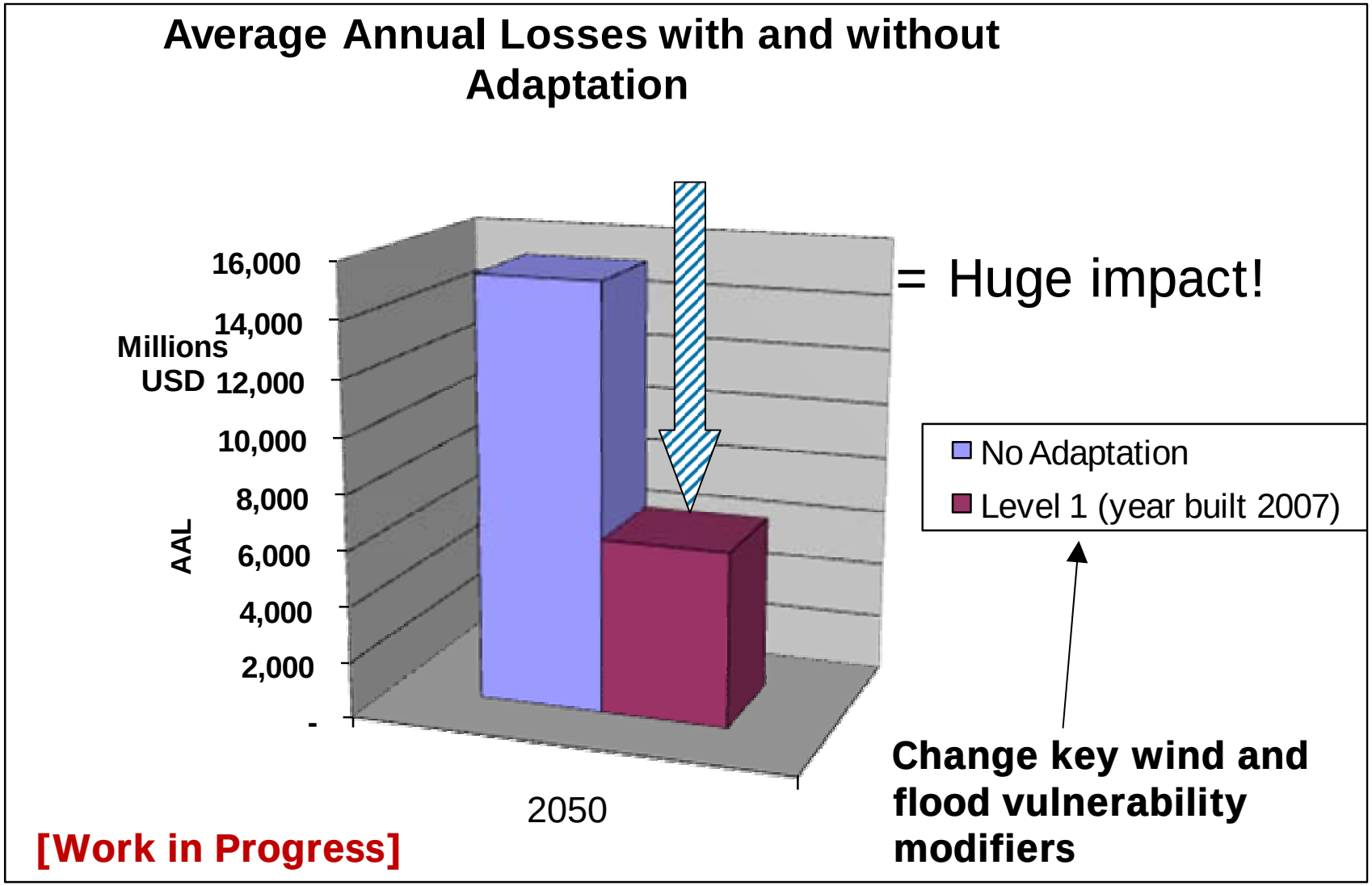
Example: Benefits of hardening the Florida building stock (today)



[Work in Progress]

© 2008 Risk Management Solutions, Inc.

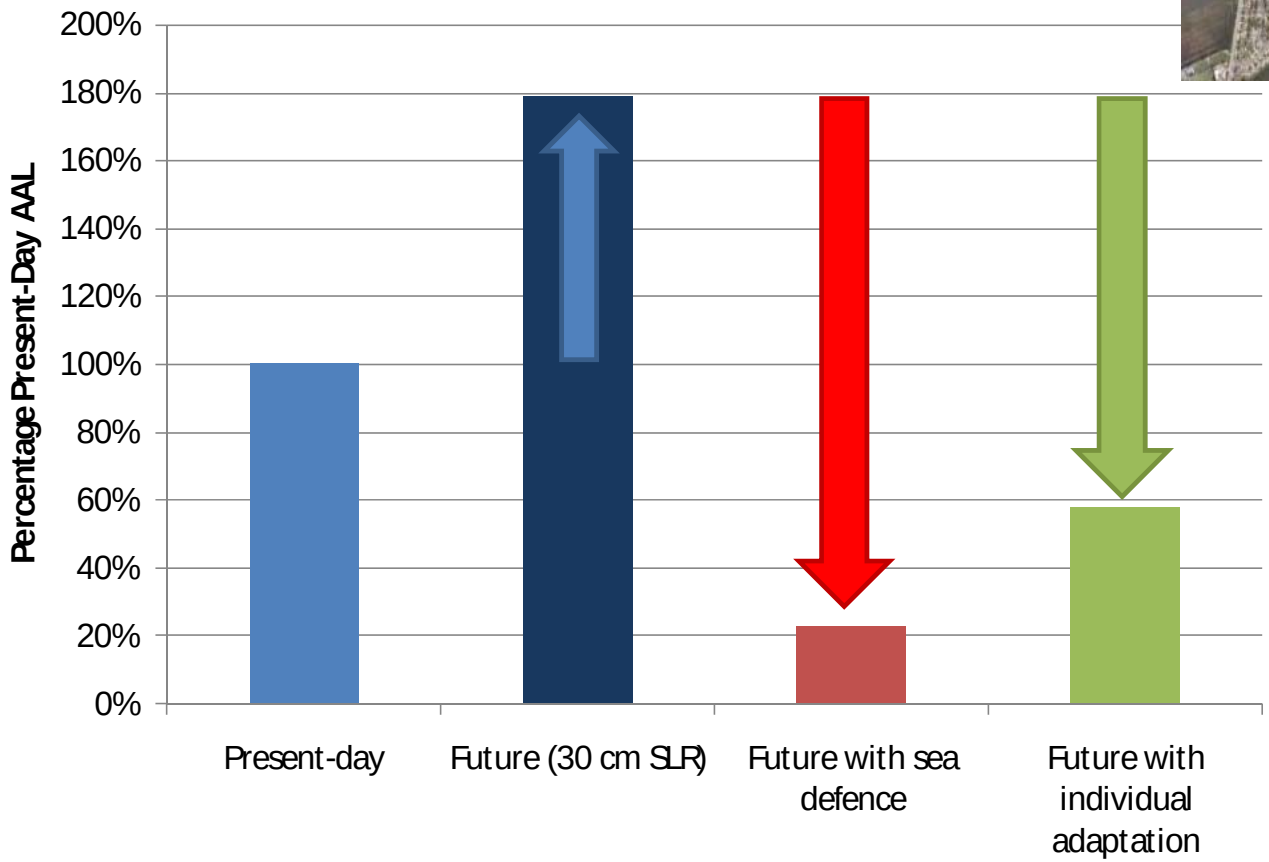
Example: Value of Improved Building Codes in 2050



© 2008 Risk Management Solutions, Inc.

Example: Benefits of Adaptation on the UK East Coast (undefended property)

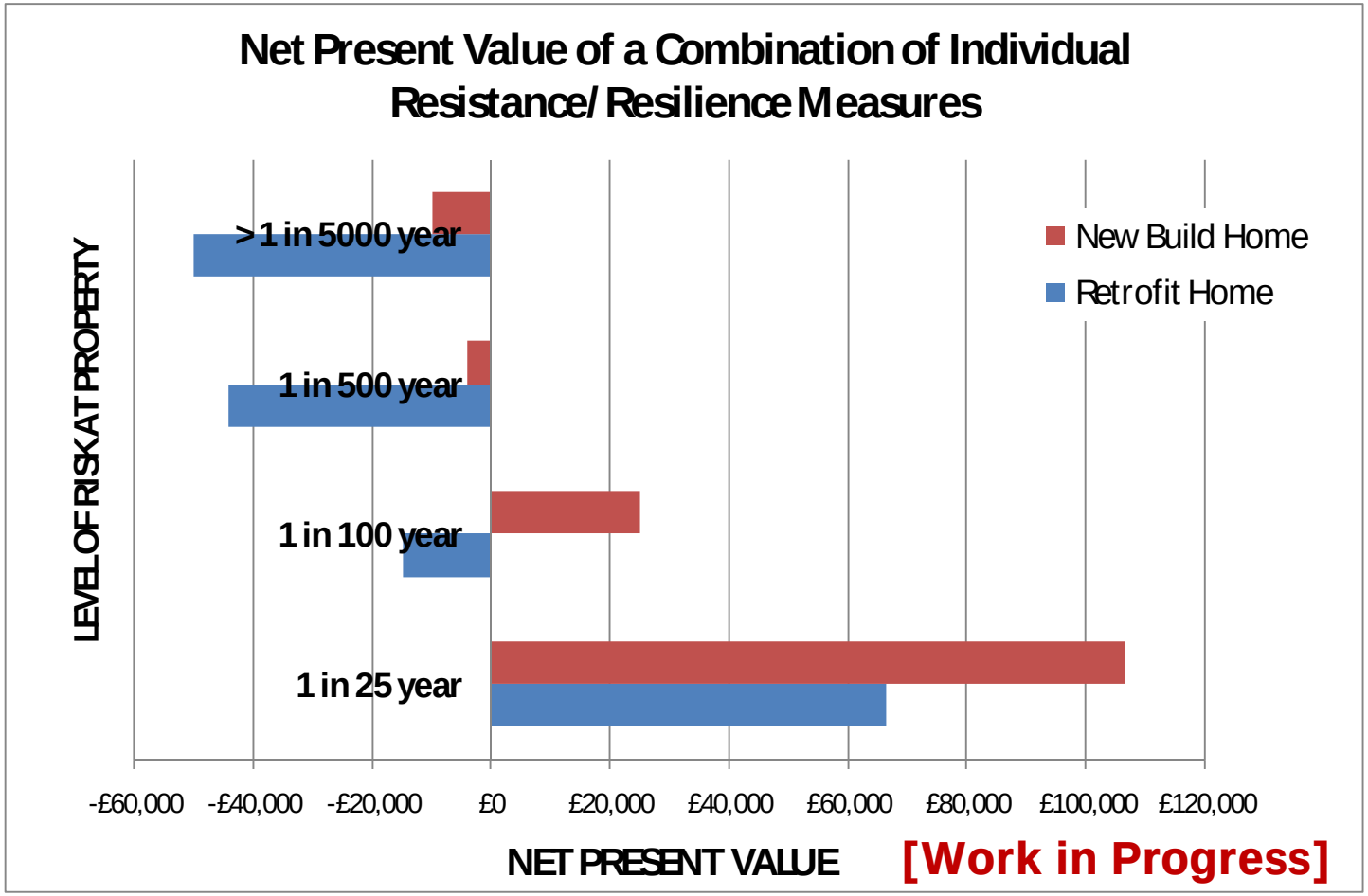
[Work in Progress]



© 2008 Risk Management Solutions, Inc.

Understanding the Economics of Adaptation

- When combined with estimates of the costs of adaptation, RMS models can be used as a tool for cost-benefit analysis.



Example of cost-benefit analysis of individual adaptation for UK flood; comparing benefits for a retrofit and new build home and on homes at different levels of risk

© 2008 Risk Management Solutions, Inc.

Summary

- Catastrophe models are a potentially powerful tool for quantifying the impacts of climate change and the benefits of adaptation.
  - Focus on extremes
  - Probabilistic approach
  - High resolution – location specific
  - Ability to identify correlated risks
  - Financial outputs
  - Integrated adaptation modelling

For more information, contact the RMS Climate Change research team:

Nicola Patmore (nicola.patmore@rms.com)
Celine Herweijer (celine.herweijer@rms.com)

© 2008 Risk Management Solutions, Inc.