Introduction of the day's program
"Loss Modelling and Insurance Pricing Regarding Earthquake Risk"

Mustafa Erdik

Building sustainable and resilient communities against earthquakes is a critical effort in active seismic regions. A catastrophic earthquake and its cascading events have substantia economic impact across various sectors.

Earthquake insurance is important in this effort because it functions as a pre-disaster funding tool limits the economic impact of post-disaster recovery to individuals, businesses and government by transferring the risk of earthquake damage and funding the recovery efforts.

In this connection the technology of earthquake loss modeling (CAT Modeling) emerged as a powerful tool for the insurance industry with applications in many areas.

Earthquake CAT modeling is an integrated process of conducting numerical simulations of earthquake occurrence, ground motion prediction, damage assessment, and seismic loss calculation.
It typically involves: (1) inventory/exposure database, (2) hazard characterization, (3) structural vulnerability assessment, (4) loss estimation and (5) insurance portfolio analysis.

Insurance pricing is one of the outcomes of CAT modeling. The pure premium is derived by outputs of cat models but is routinely inflated to account for several items, including running costs, profit, unmodeled hazard, and unknowns.

Components of a Catastrophe Model

- Events (Hazard) *Stochastic event set, Intensity Measure calculation, Geospatial hazard data*
- Damage (Vulnerability) *Structural damage estimation*
- Loss (Financial Model) *Insurance and reinsurance loss calculation*

Types of Losses Modeled

- Direct *Physical damage to buildings and contents, Casualties*
- Indirect *Loss of use, Business Interruption*
- Loss Amplification / Demand Surge

Primary Metrics

- Exceedance Probability (EP)
- Average Annual Loss (AAL)
- Probable Maximum Loss (PML)

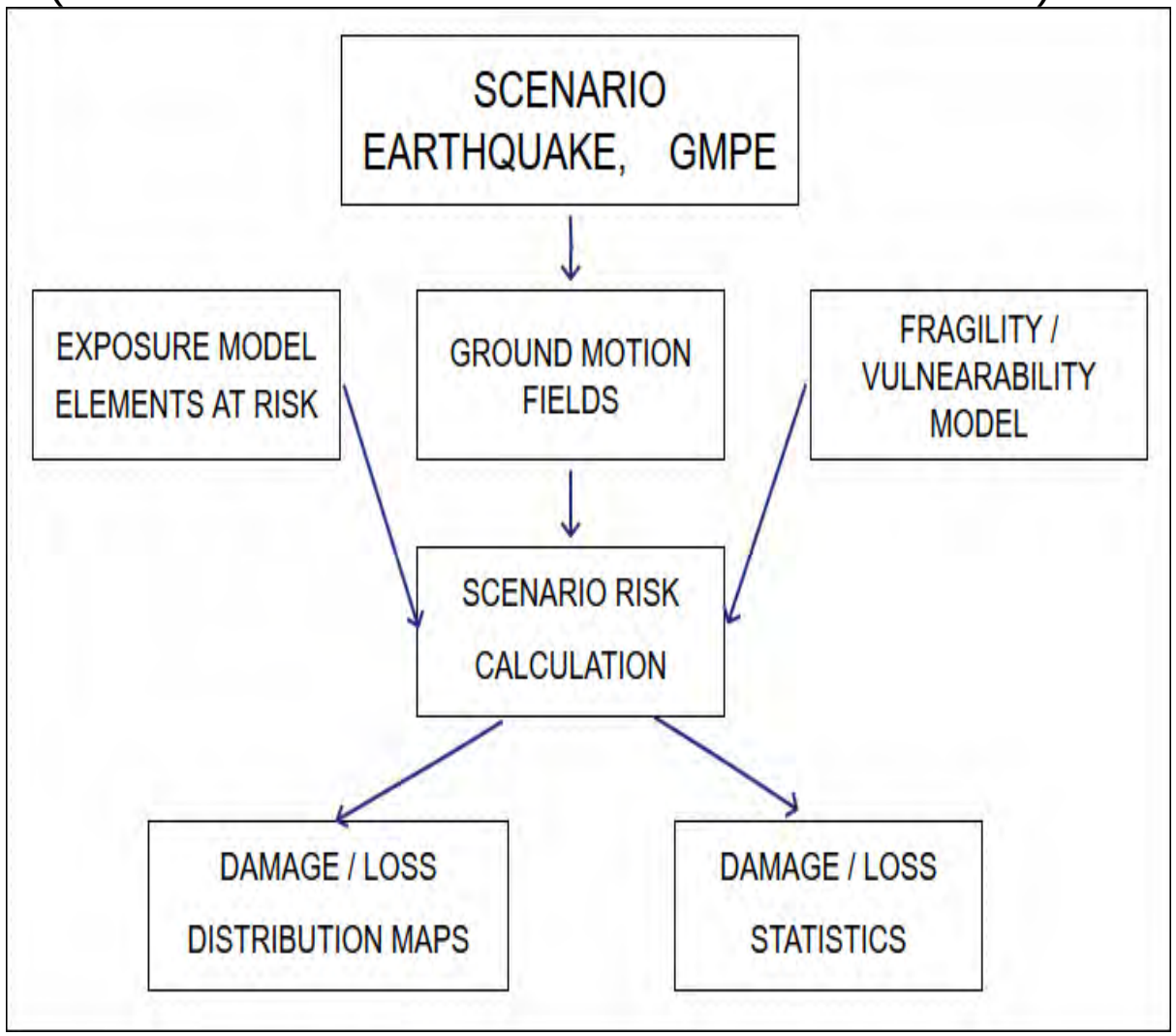
Potential Uses

- Insurance Pricing / Ratemaking
- Underwriting/risk selection
- Management of Exposures
- Loss mitigation strategies
- Reinsurance/risk transfer analysis
- Financial adequacy analysis / Solvency

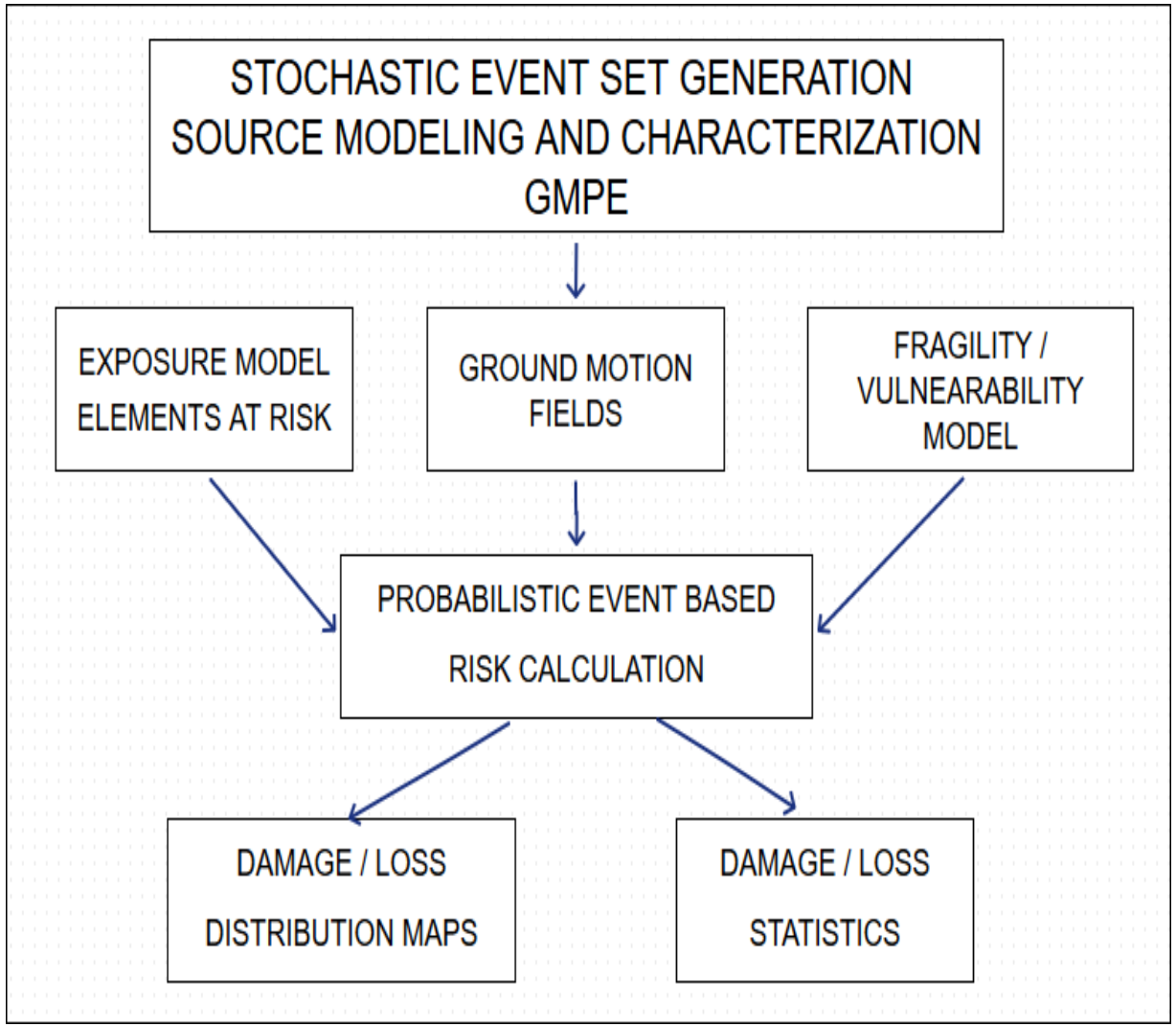
Earthquake Risk / Loss Estimation Methodology

(*Silva et al., 2014; OpenQuake, 2015*)

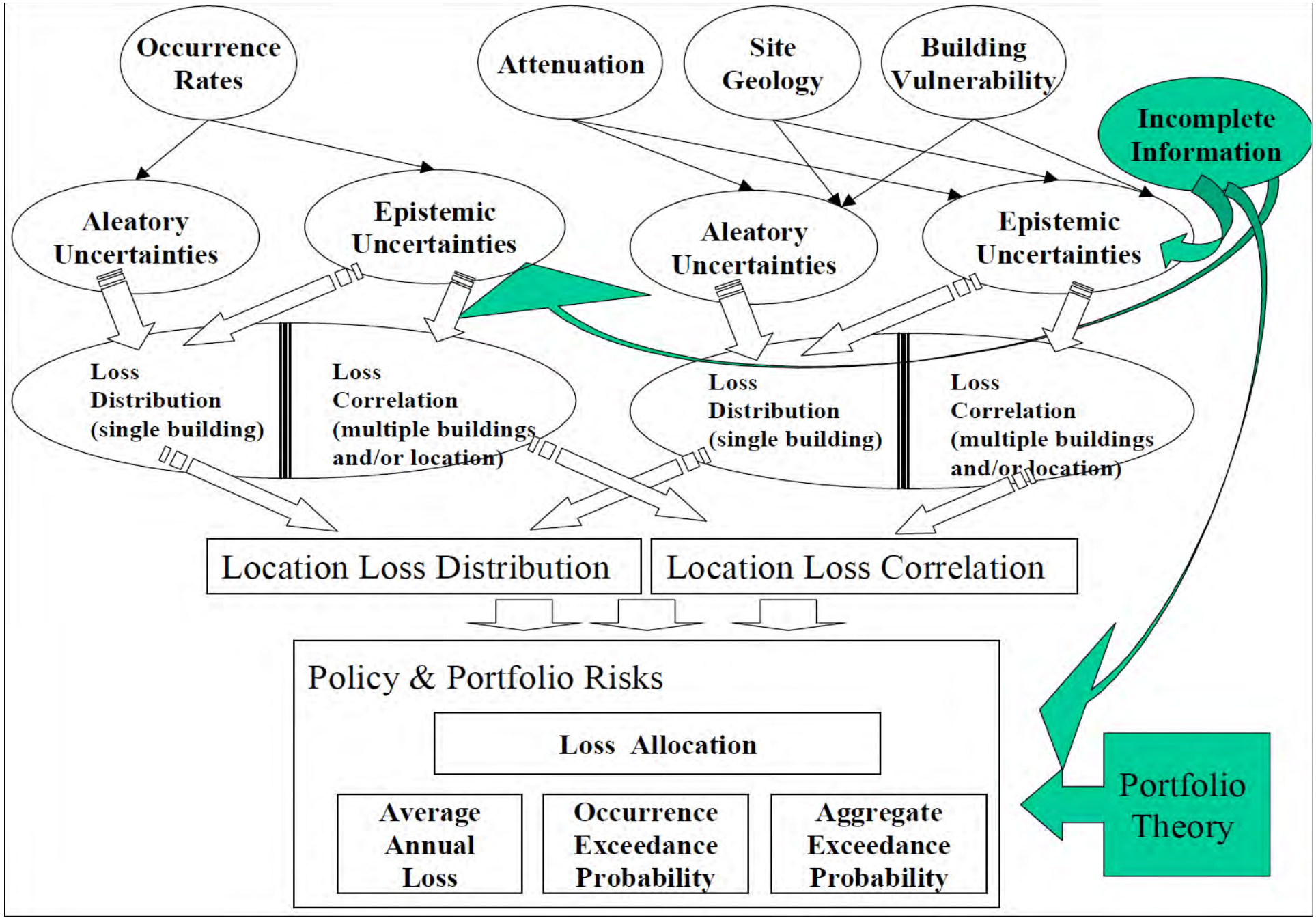
Due to single earthquake scenario
(**Deterministic Event-Based Loss Calculation**)

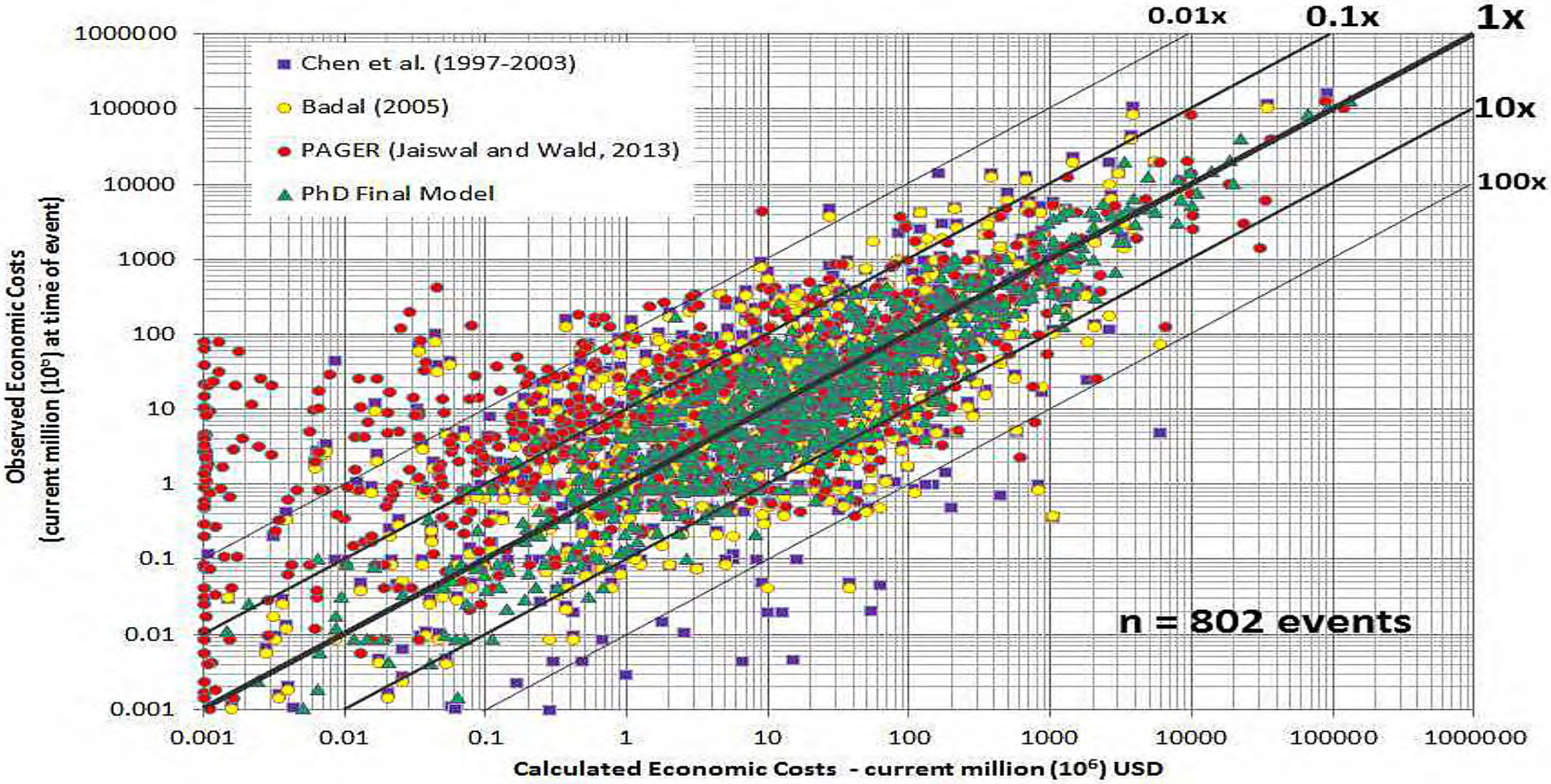


Considering a probabilistic description of the events and associated ground motions
(**Probabilistic Event-Based Loss Calculation**)



Effect of Uncertainties on Loss Estimation *(Wong et al, 2000)*





Observed vs. calculated costs for 4 different studies (Daniell and Wenzel, 2014) versus Chen et al. (1997-2003), Badal (2005) and PAGER (Jaiswal and Wald, 2013). (*After Daniell and Wenzel, 2014*)

Uncertainties in Loss Estimation

Uncertainties arise in part from incomplete scientific knowledge concerning earthquake ground motion and their effects upon buildings and facilities. Incomplete inventories of the built environment add to the uncertainty.

Epistemic uncertainties include model and parameter variation/incompleteness and can widen the loss distributions. The losses at different sites/cells may be correlated (loss/vulnerability correlation) essentially due epistemic uncertainties.

Aleatory uncertainties affects loss distributions and exceedance curves.

Epistemic uncertainty and aleatory variability in IM distribution maps.

The mean damage ratio (MDR) is highly sensitive to the cost ratios assigned to each damage state.

Loss correlation can also have an influence on the aggregate portfolio risk.

These factors can result in a range of uncertainty in loss estimates, at best, a factor of two.

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Earthquake Loss Modelling and Pricing Chairperson*: Sinan Akkar*
Risk Oriented Earthquake Hazard Assessment *Peter Stafford*
Empirical fragility and vulnerability of regional building stock in Europe *Sergio Lagomarsino*
Elements at Risk, Fragilities, Consequence Functions and Vulnerabilities *Helen Crowley*
Earthquake Physical Risk/Loss Assessment Models and Example Applications *Sinan Akkar*
Cat Modelling, Application to Insurance Industry: Unknowns and Possible Sources of Bias in Pricing *Paolo Bazzuro*
Role of Earthquake Insurance in Earthquake Risk and Resiliency Management *Fouad Bendimerad*
Turkish Catastrophe Insurance Pool *İsmet Güngör*
Fire Following Earthquake Models and Insurance *Charles Scawthorn*

Panel Session: What we have learnt? What is the future?
Moderator: *Mustafa Erdik*
Panelists : *Luis Sousa*, AIR
Matthew Eagle, Guy Carpenter
Martin Käser, Munich Re
Joe Melly, RMS
Nicolas Georgy, Swiss Re

Panel Session

Earthquake Loss Modelling: What we have learnt? What is the future?

Mustafa Erdik

Choices of Cat Models
Main Vendors (RMS, AIR, EQE)
Reassurance Company Models
Broker Models
Insurance Company Models
Open Source Models – *GEM OpenQuake*

Although earthquake loss modelling is now an established area of research, with many groups in research institutes and universities engaged in, the needs of the insurance and reinsurance industries have been met mainly by a few well-known companies specializing in catastrophe (CAT) modelling.

The ability of the user community to ‘own’ the code enables much more rapid development, the spotting and removal of bugs, and ultimately produces better software.
The main benefits associated with open-source loss models are; (i) advancing the state-of-the-art of catastrophe risk modelling and (ii) improved information sharing, such as the case with OpenQuake.

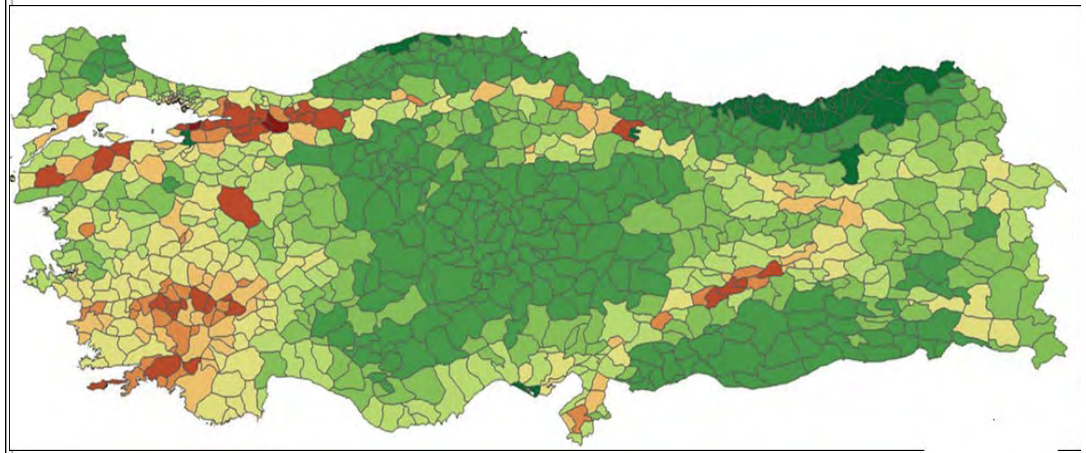
COMPARISON OF VENDOR AND LOCAL MODELS

COMPARISON OF THE DISTRICT (*İLÇE*) BASED AAL ASSESSMENTS

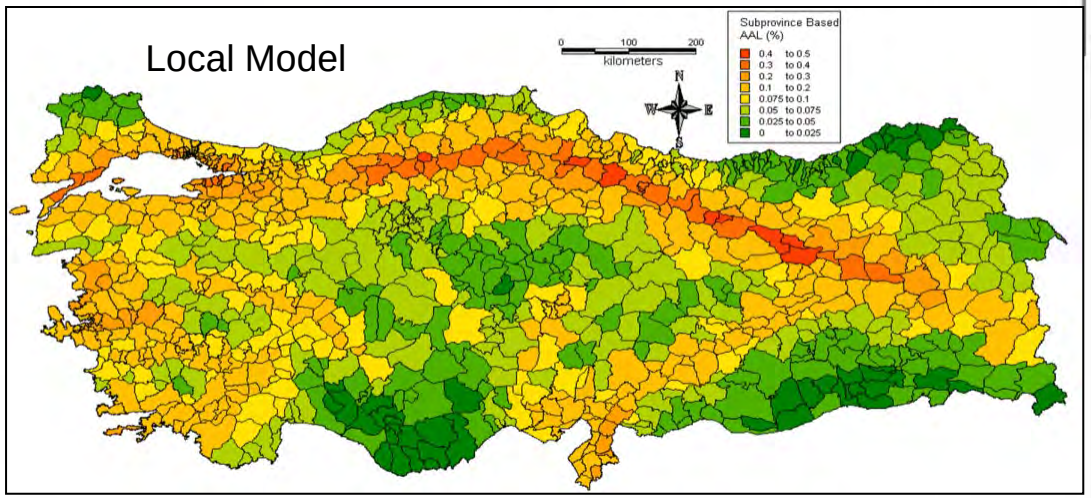
Vendor Model 1

Vendorl Model 2

Vendor Model 3

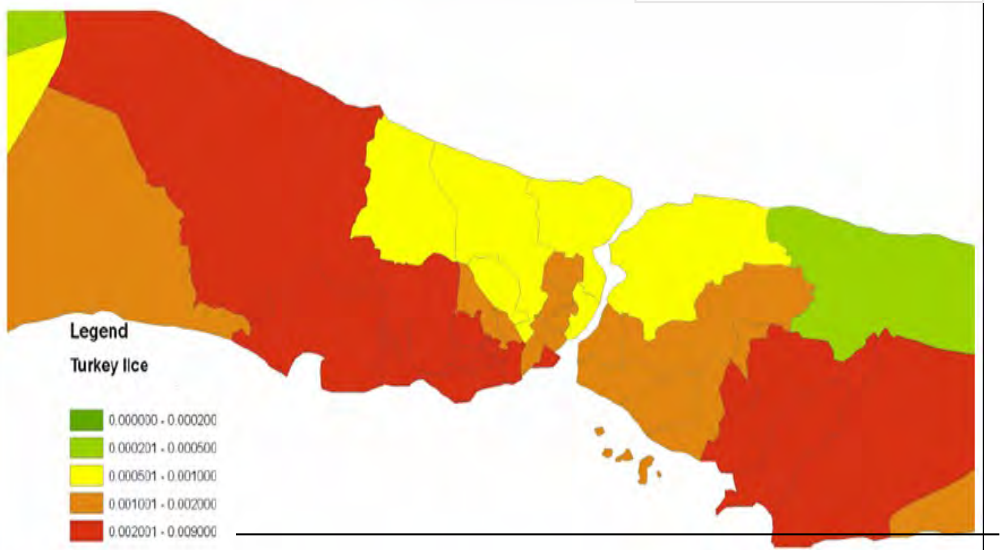


Local Model

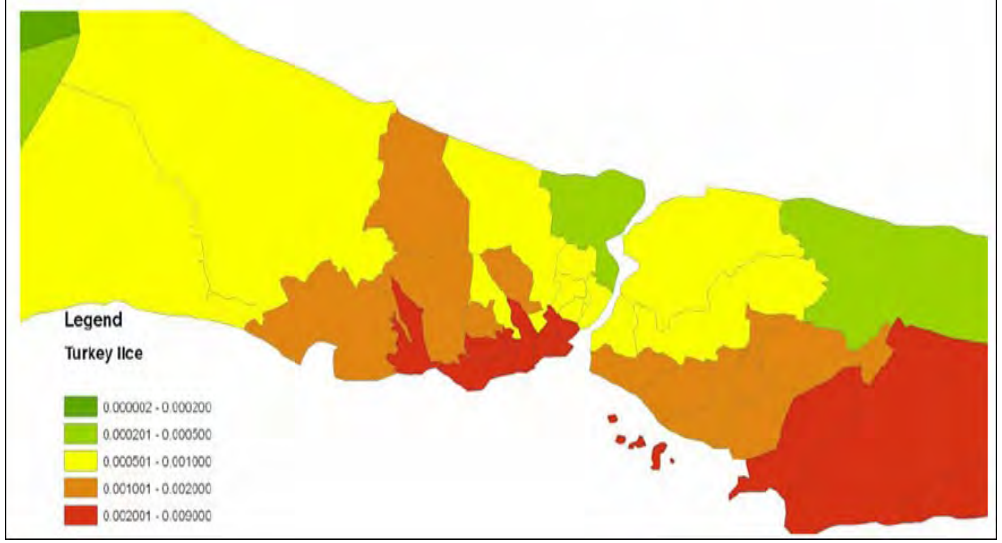


COMPARISON OF MARMARA REGION / ISTANBUL AAL ASSESSMENTS

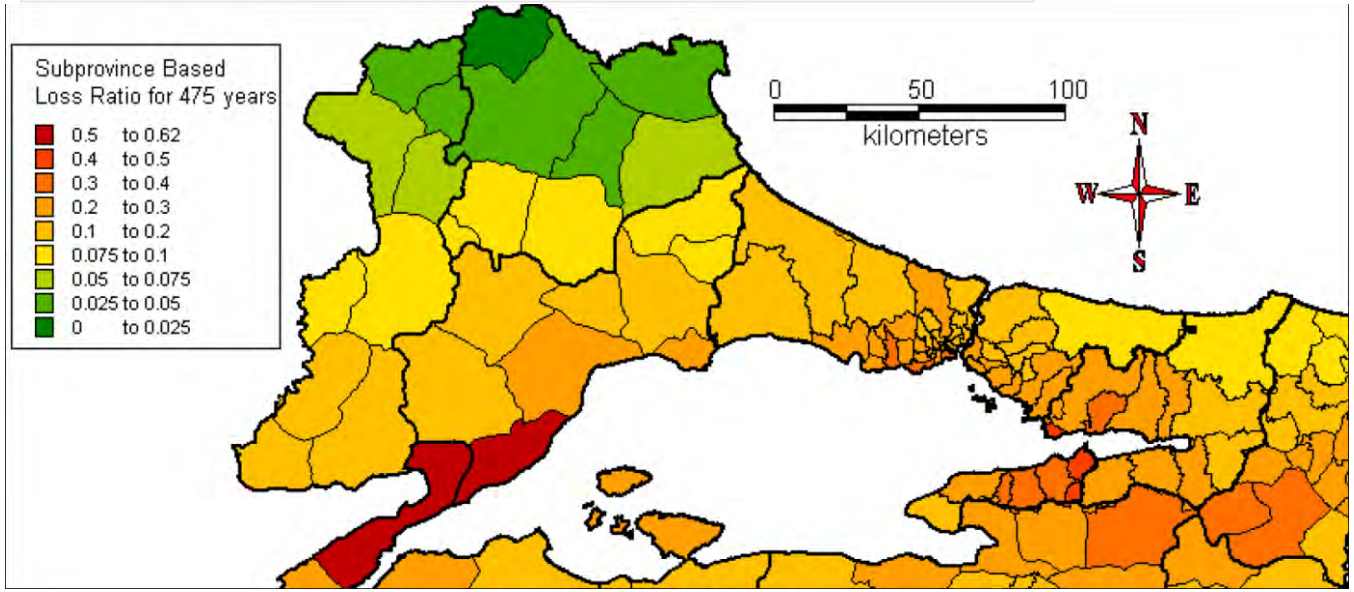
Vendor Model 1

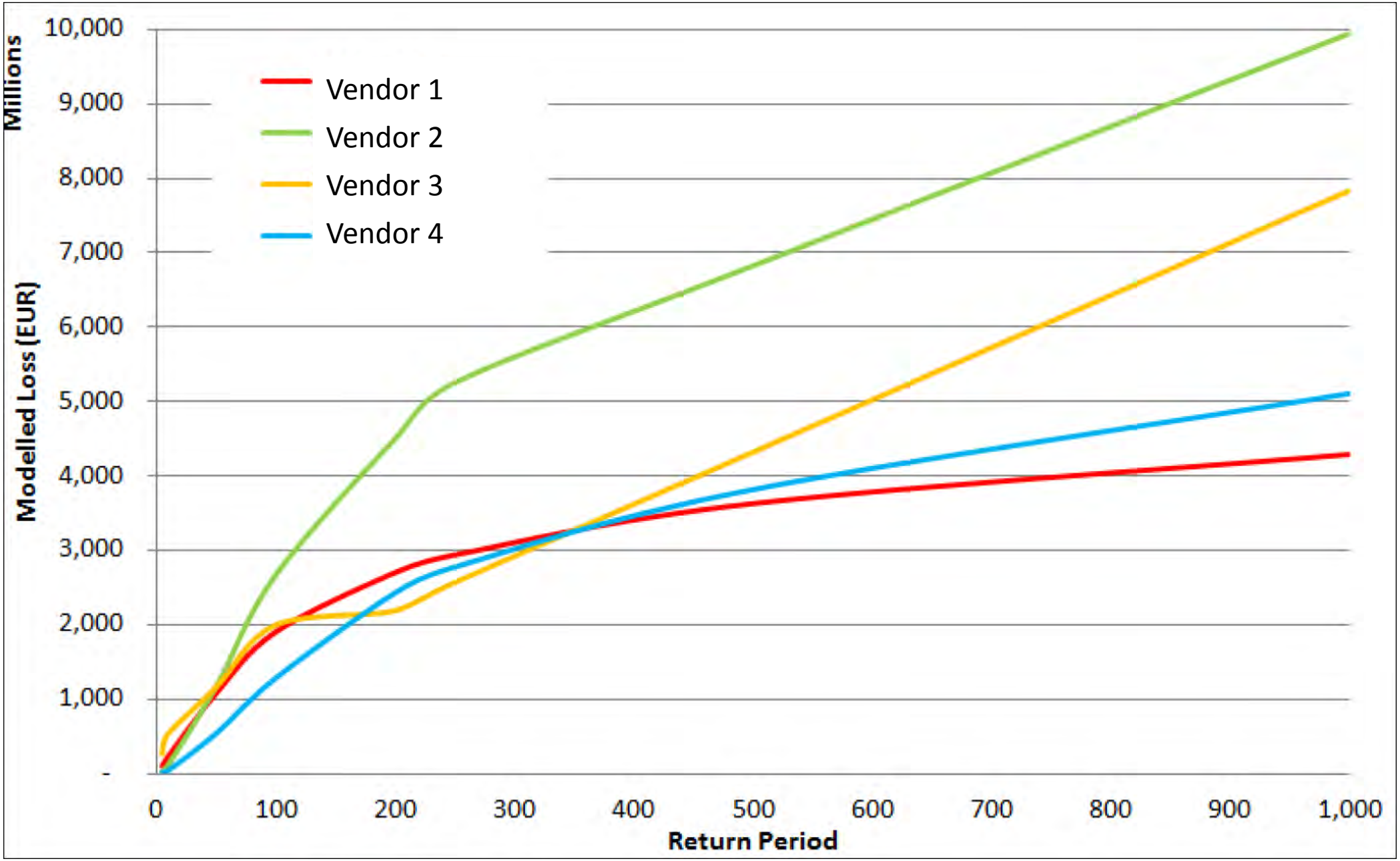


Vendor Model 2



Local Model - İlçe Based 475 Year Mean Loss Ratio (Share Project)




Millions
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
-
Modelled Loss (EUR)
Vendor 1
Vendor 2
Vendor 3
Vendor 4
0
100
200
300
400
500
600
700
800
900
1,000
Return Period

Demand surge/Loss amplification – Post event inflation.
– Shortages of labor and materials cause prices to rise.
– Supply/demand imbalance.
–Insurers are pressured to settle claims generously

Demand surge is understood to be a socio-economic phenomenon of large-scale natural disasters: repair costs rise, locally and temporarily, through any of several possible demand- or supply-related mechanisms. Increased repair costs after past large-scale natural disasters have been reported in the range of 20 to 50%.

Institutions that indemnify properties exposed to natural disasters, such as insurers, reinsurers, and governments, pay billions of U.S. dollars in claims after large-scale natural disasters; these payments can be even larger as a result of demand surge.

Indemnity insurance payments can be larger as a result of demand surge.