Flood and Earthquake Risk Models and Their Pricing and Risk Management Applications

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12-14 October 2011
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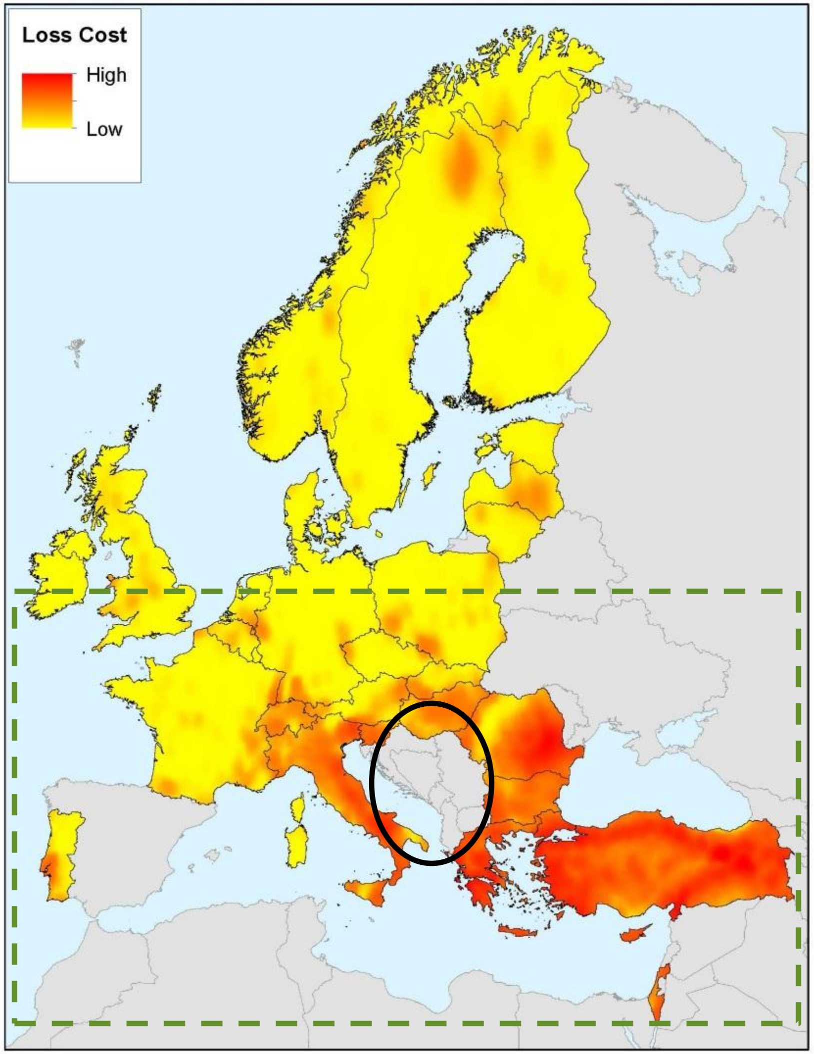
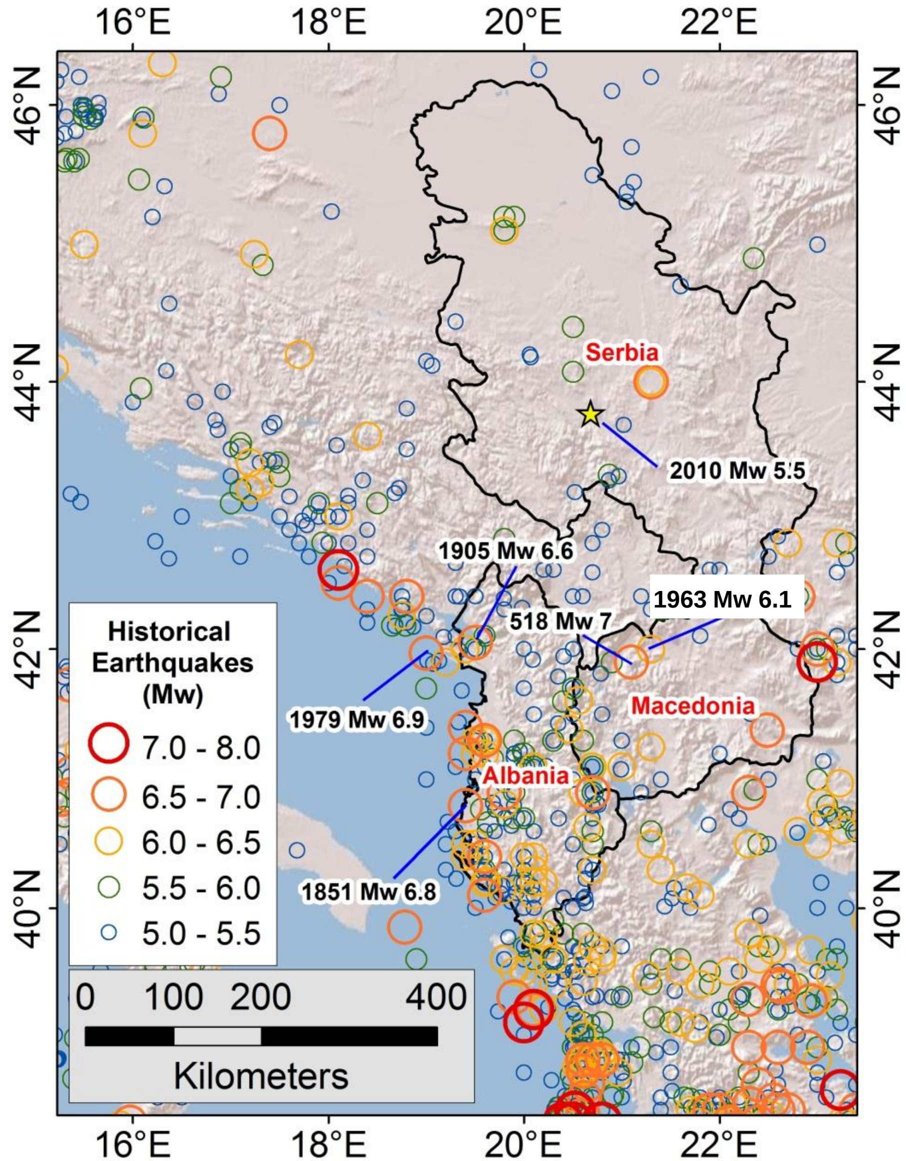
Highest Earthquake Risk is Concentrated Around the Mediterranean and Black Sea



Large Earthquakes Occurred in the Region from 58 BC to present



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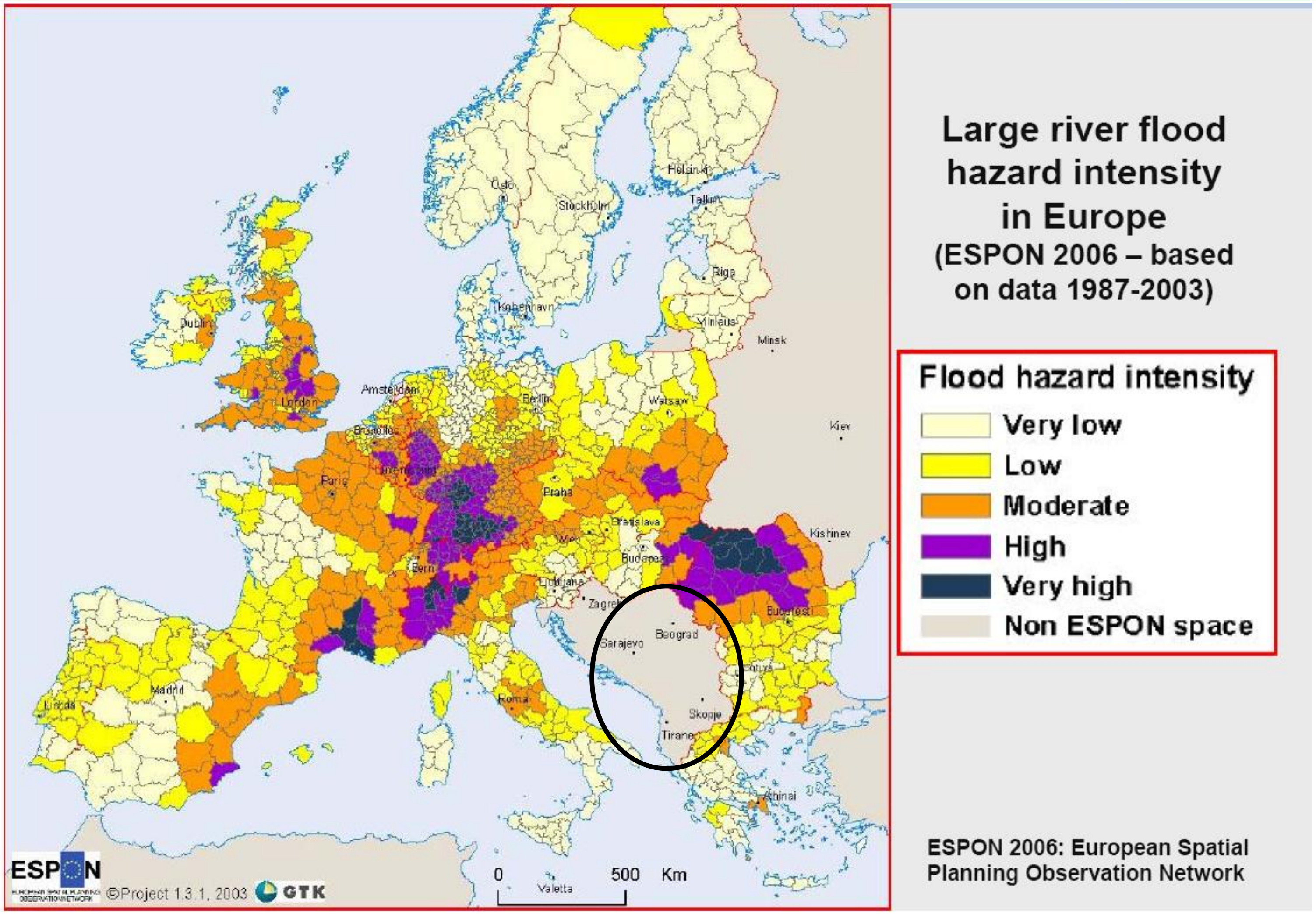
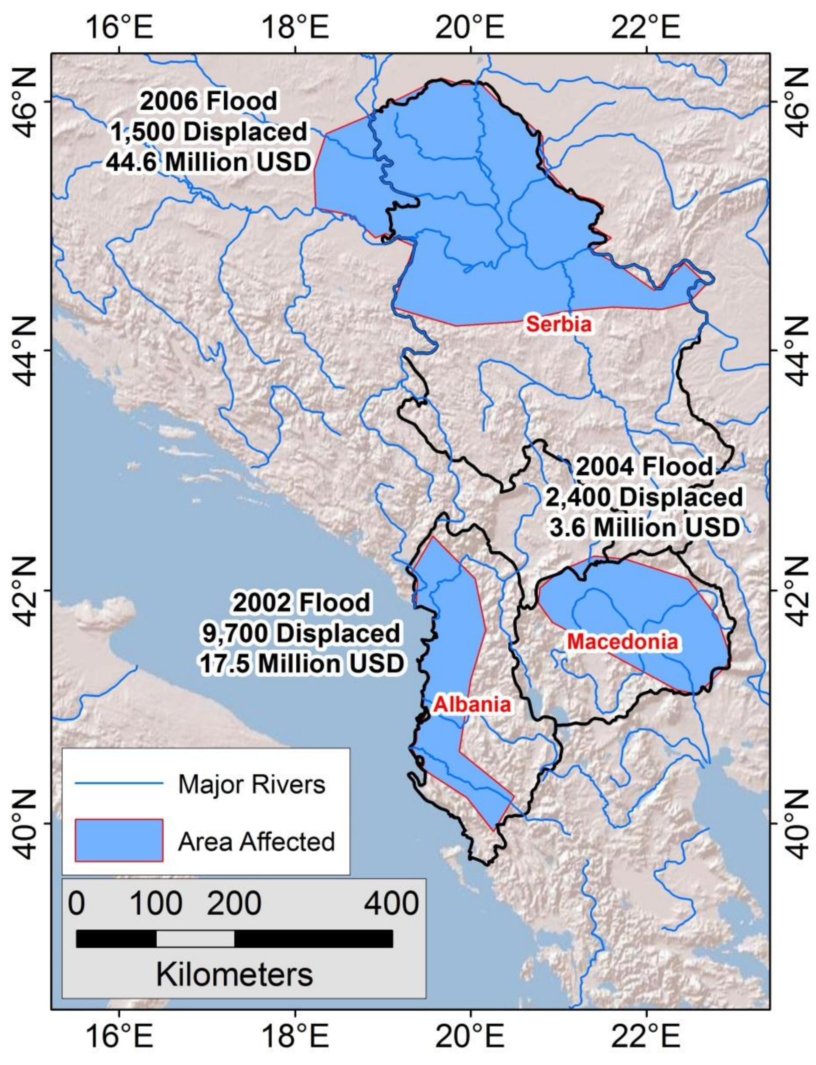
Areas of Large River Flood Hazard Intensity Exist Throughout Europe

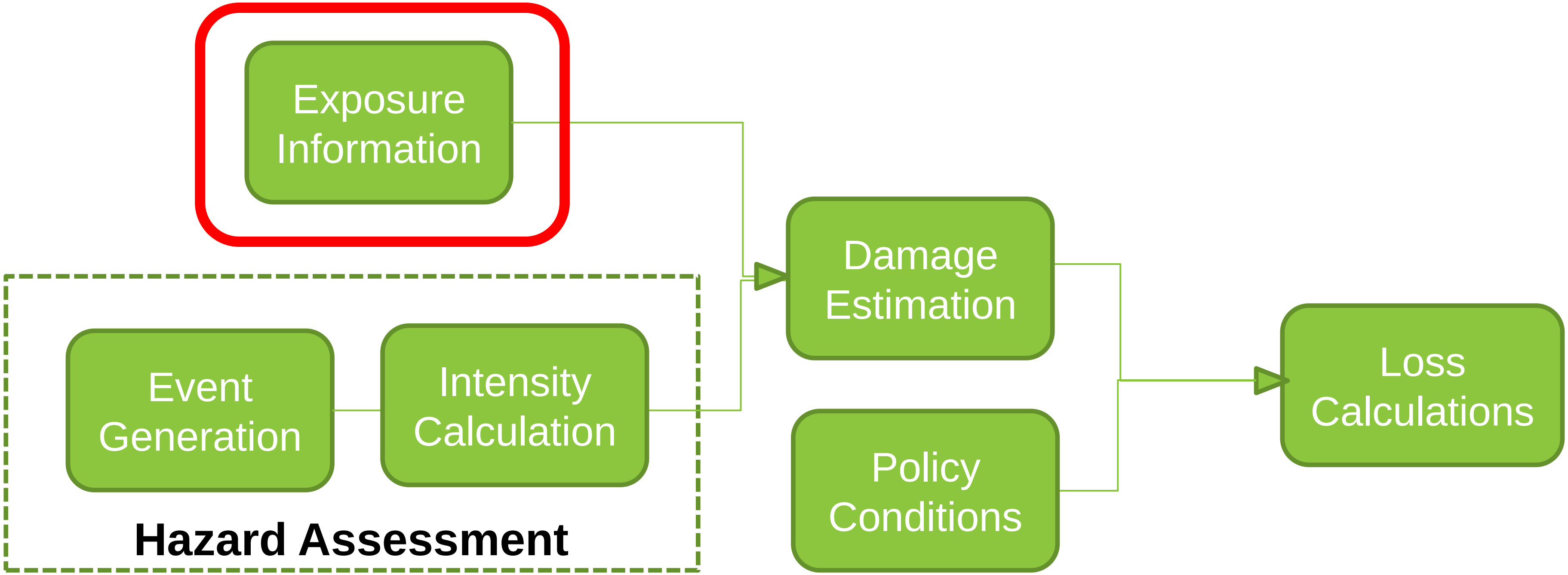


Severe Floods Have Occurred in the Region in Recent Times

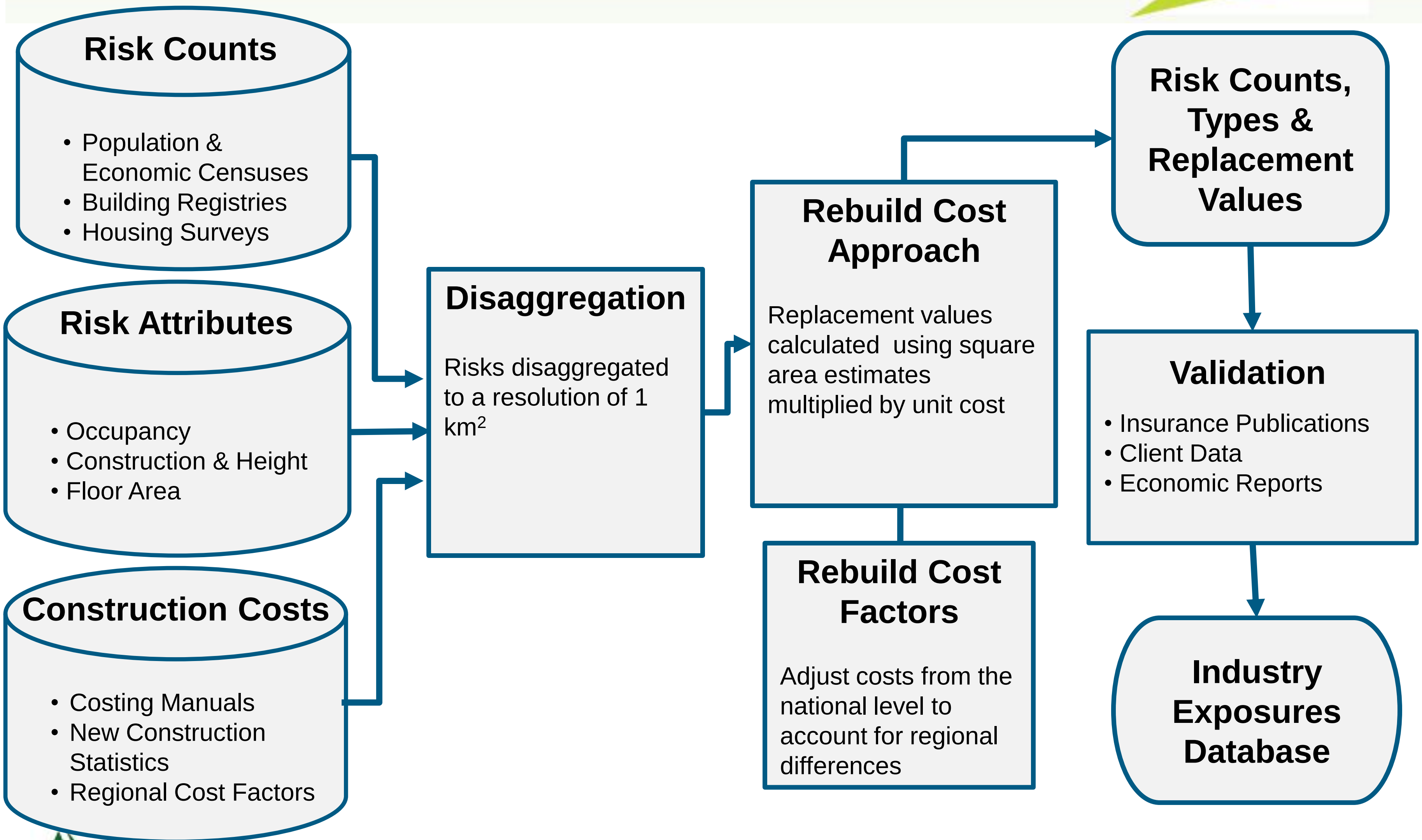


Objective: Develop Earthquake and Flood Risk Models for Albania, FYR of Macedonia, and Serbia

Risk Assessment Methodology

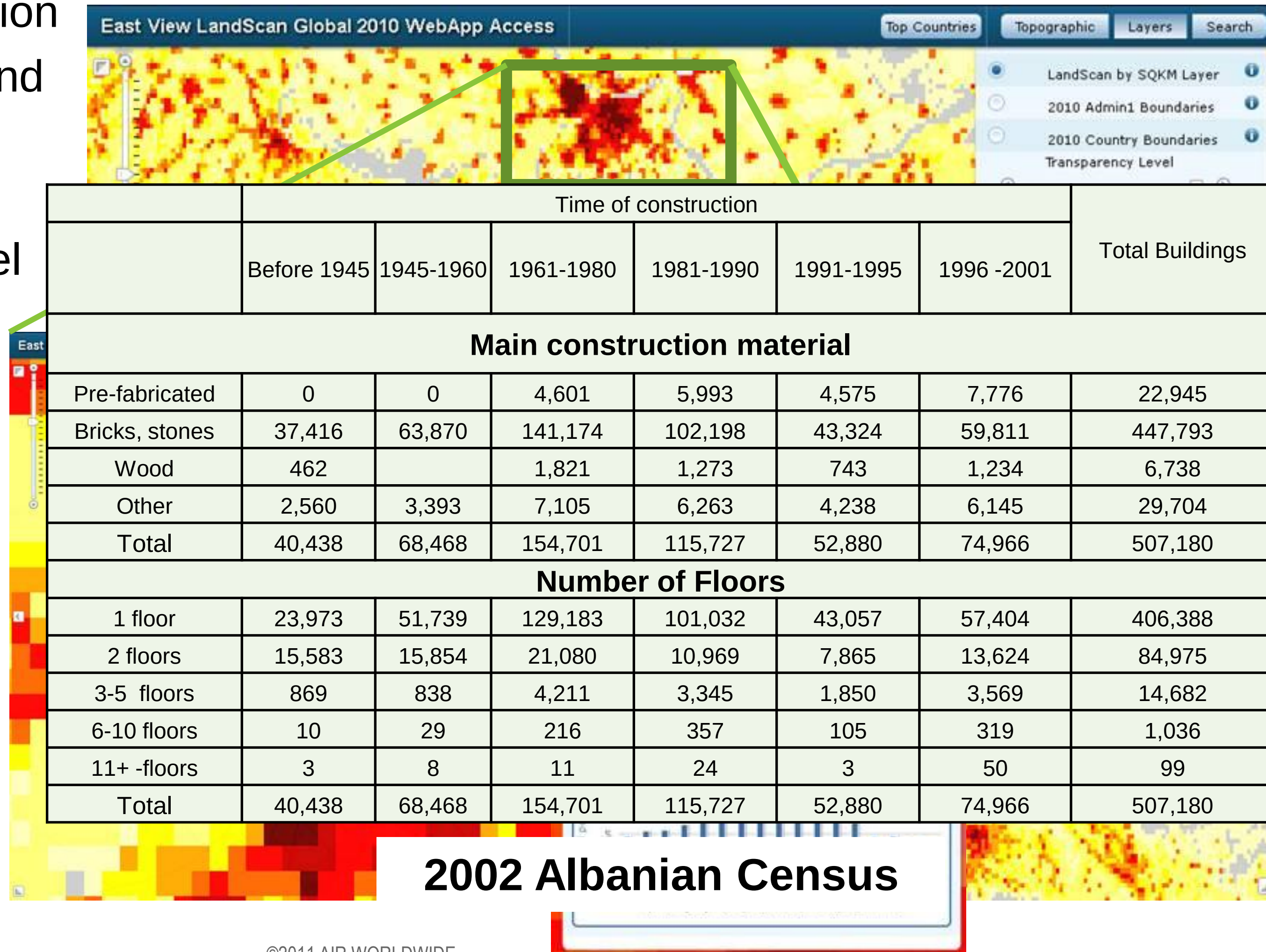


AIR Constructs Industry Exposure Databases from the Bottom Up



Examples of Data for the Countries under Study

- **Available Public and Proprietary Data (infer buildings from population)**
  - Gridded Population
  - Land Cover / Land Use Maps
  - Urban Extents
  - District/City Level Census



	Time of construction						Total Buildings
	Before 1945	1945-1960	1961-1980	1981-1990	1991-1995	1996 -2001	
Main construction material							
Pre-fabricated	0	0	4,601	5,993	4,575	7,776	22,945
Bricks, stones	37,416	63,870	141,174	102,198	43,324	59,811	447,793
Wood	462		1,821	1,273	743	1,234	6,738
Other	2,560	3,393	7,105	6,263	4,238	6,145	29,704
Total	40,438	68,468	154,701	115,727	52,880	74,966	507,180
Number of Floors							
1 floor	23,973	51,739	129,183	101,032	43,057	57,404	406,388
2 floors	15,583	15,854	21,080	10,969	7,865	13,624	84,975
3-5 floors	869	838	4,211	3,345	1,850	3,569	14,682
6-10 floors	10	29	216	357	105	319	1,036
11+ -floors	3	8	11	24	3	50	99
Total	40,438	68,468	154,701	115,727	52,880	74,966	507,180

2002 Albanian Census

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Examples of Data for the Countries under Study

- Proprietary Building Data
  - Digitized City Maps (Tirana, Belgrade, Novi Sad)
  - Cadaster

Building Footprint Digitization in Durres, Albania

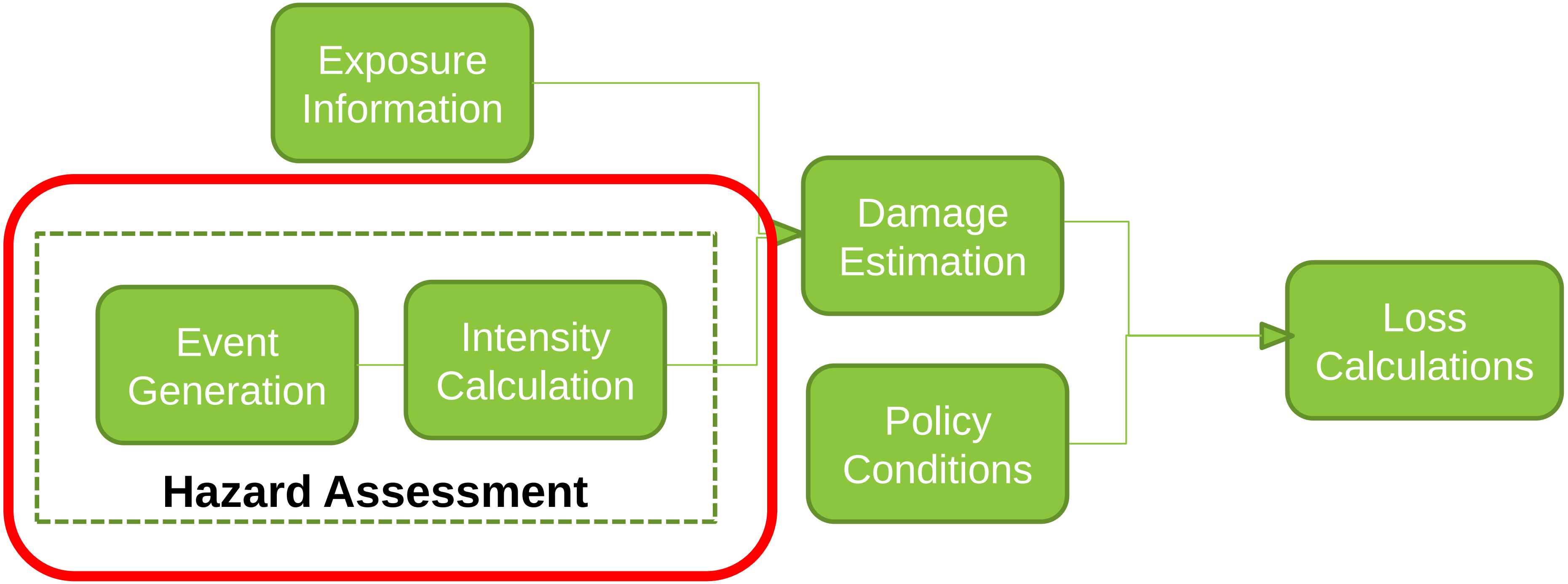
Common Building Types in the Balkans

Unreinforced
Brick/Stone

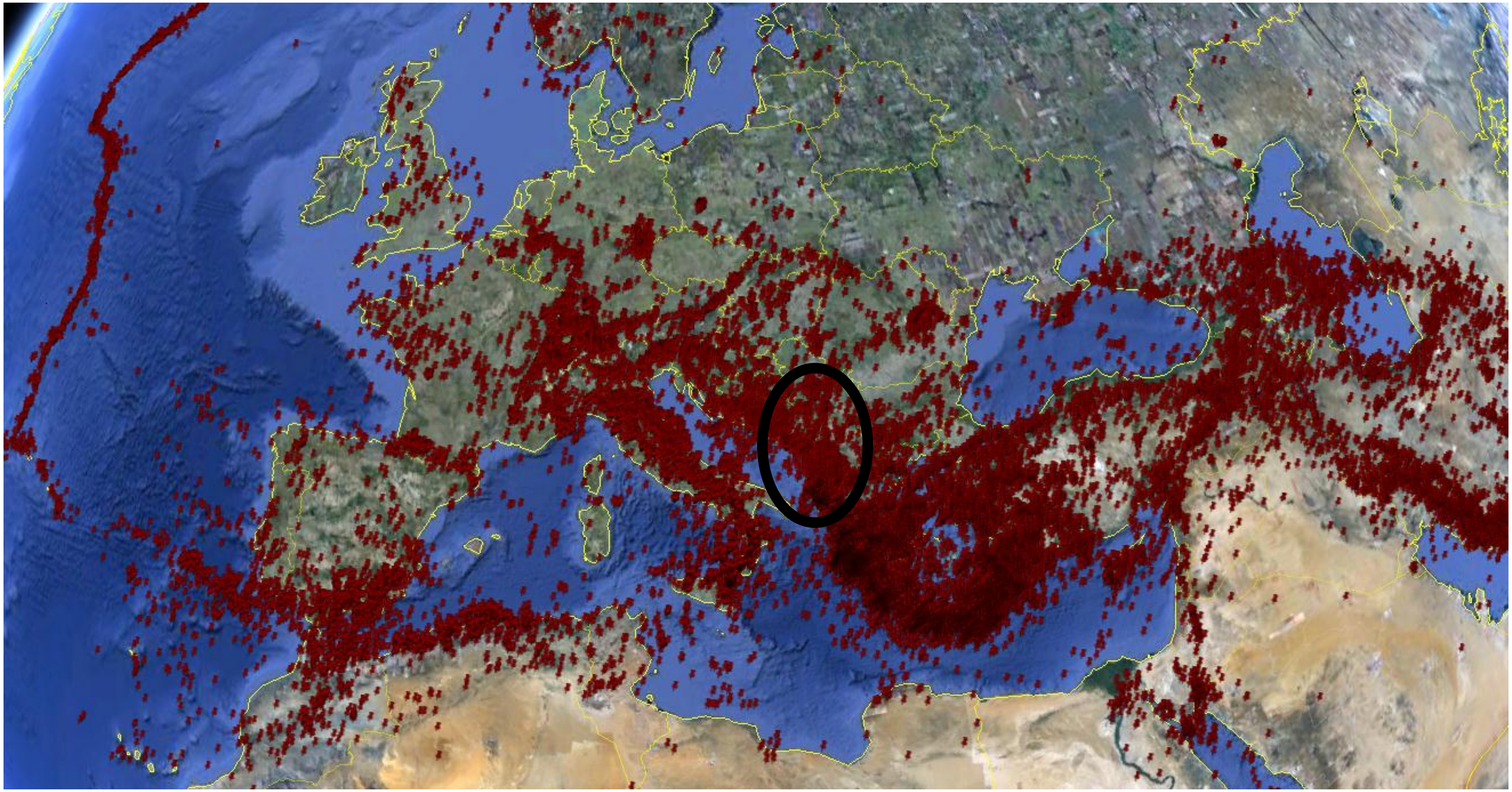
Confined Masonry

Precast Prestressed
Concrete Frame with
Concrete Shear Walls

Risk Assessment Methodology

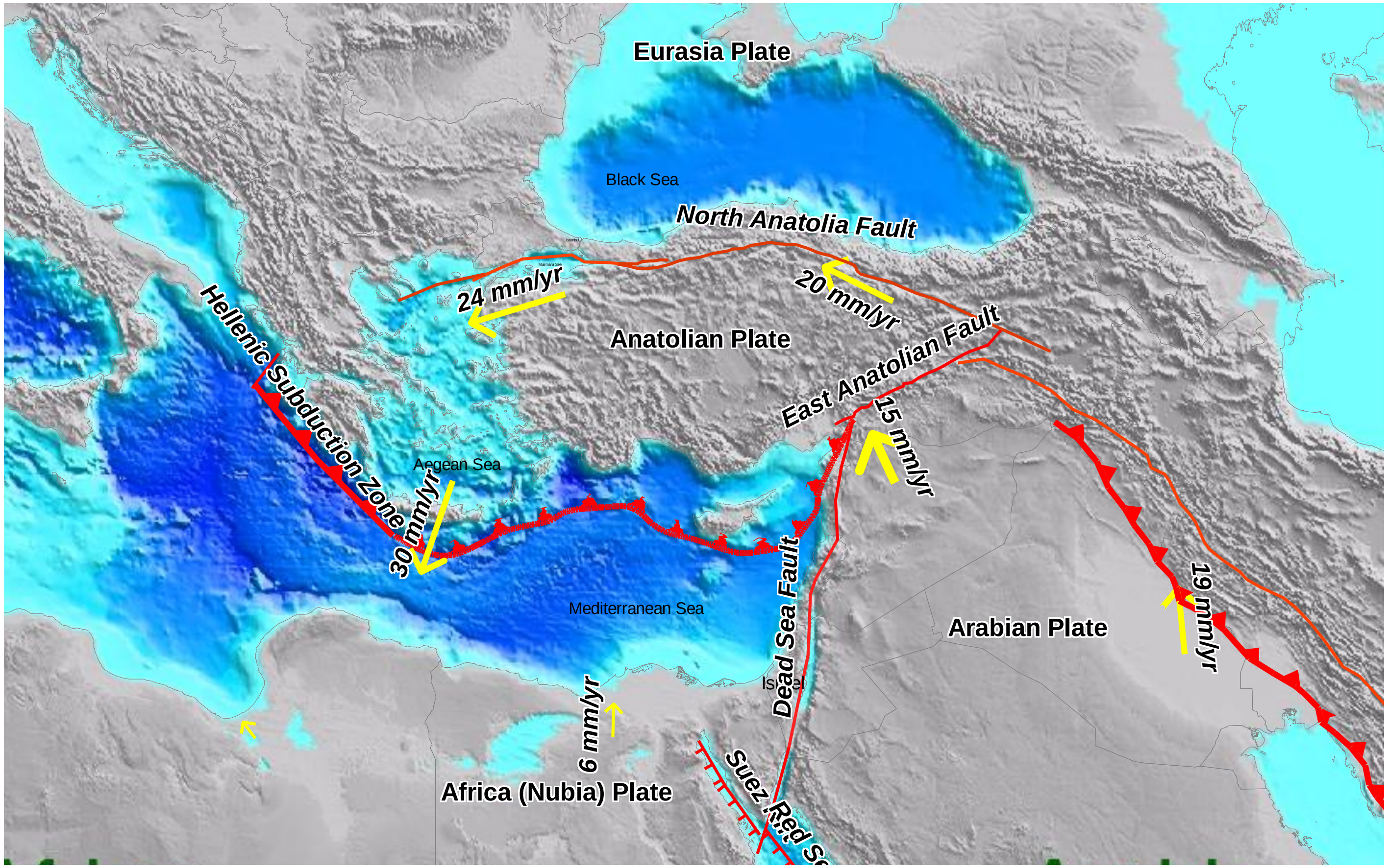


Distribution of M≥ 3.0 Earthquakes in Europe in the Last 2,000 years

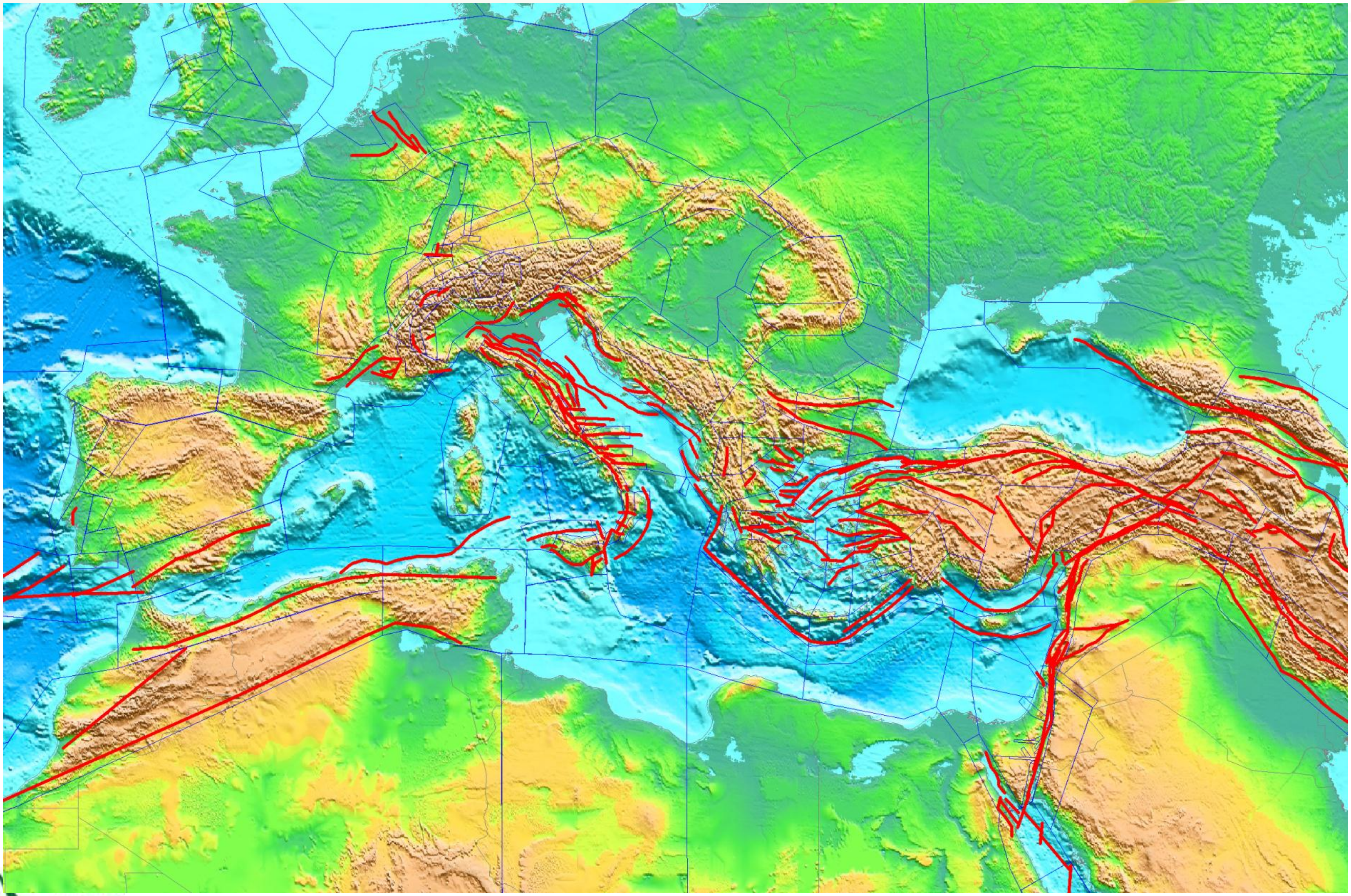


Seismicity of Europe Is Shaped by Complex Interaction Between Seismotectonic Features Consisting of Newer and Older Structures

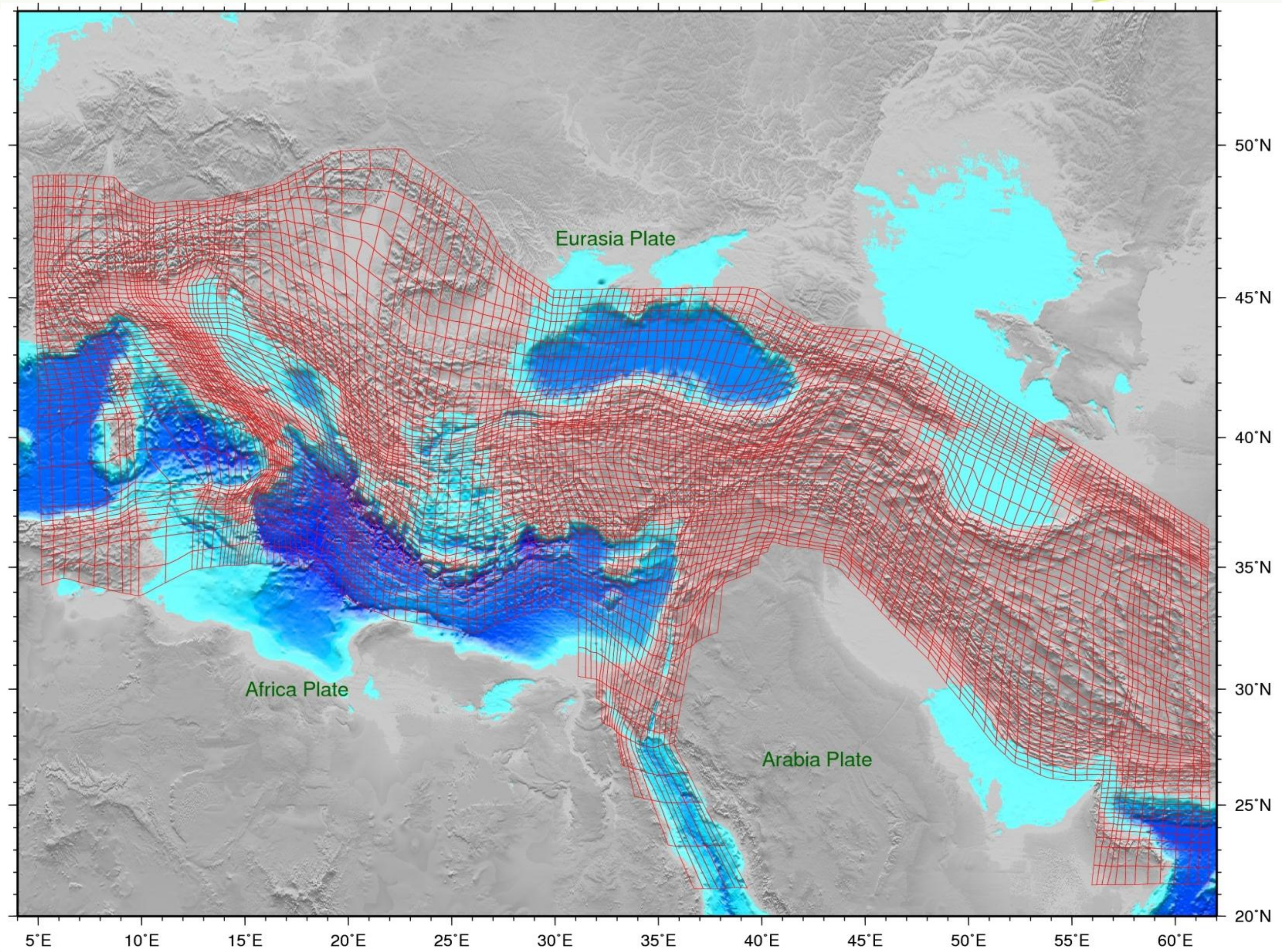
Tectonic Plate Motion Velocities along the Boundaries



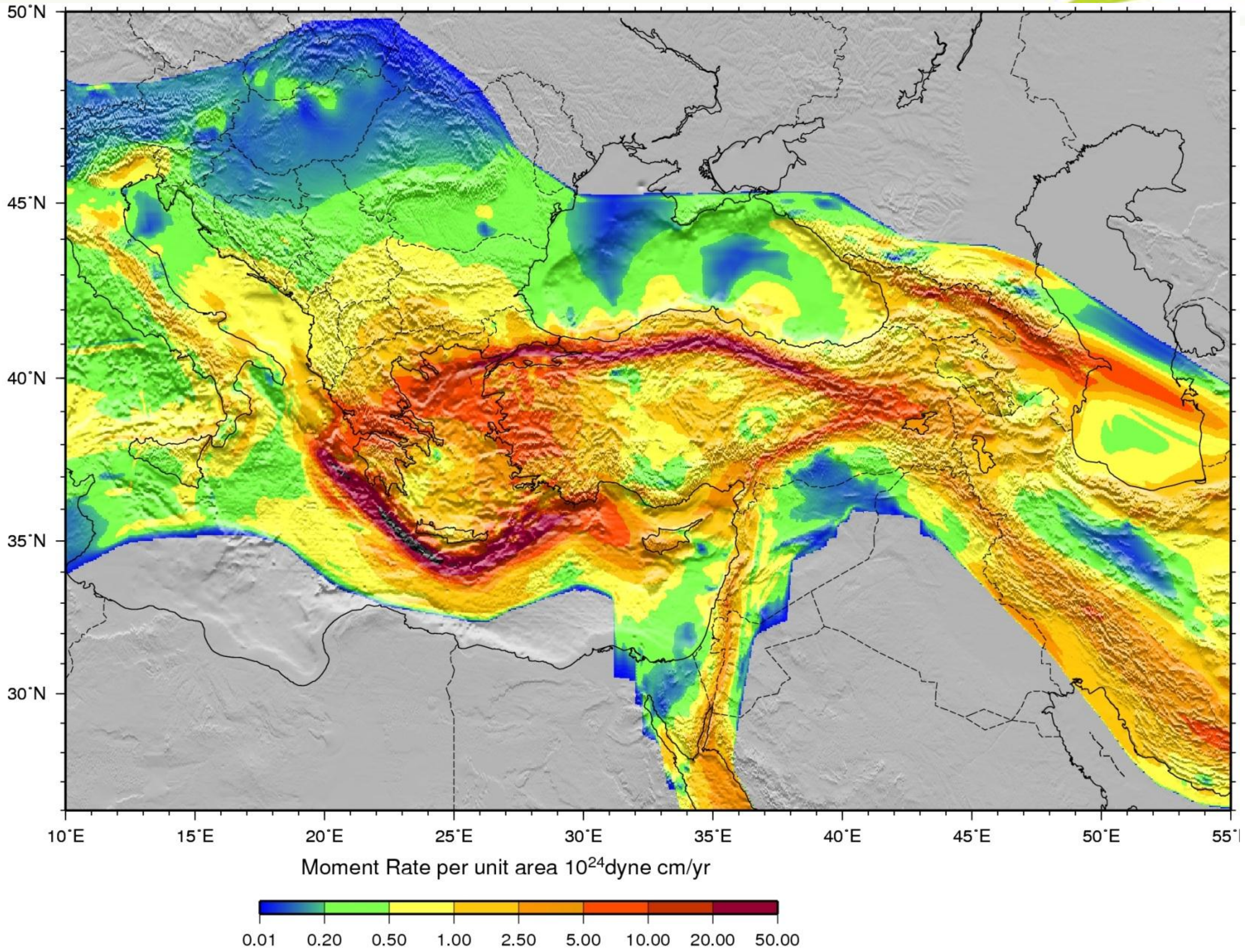
The AIR Pan-European Model Includes 328 Seismic Zones and 445 Major Faults for Large Earthquakes



A Kinematic Model Is Constructed to Estimate the Strain Rate Field within the Actively Deforming Plate Boundary Zone

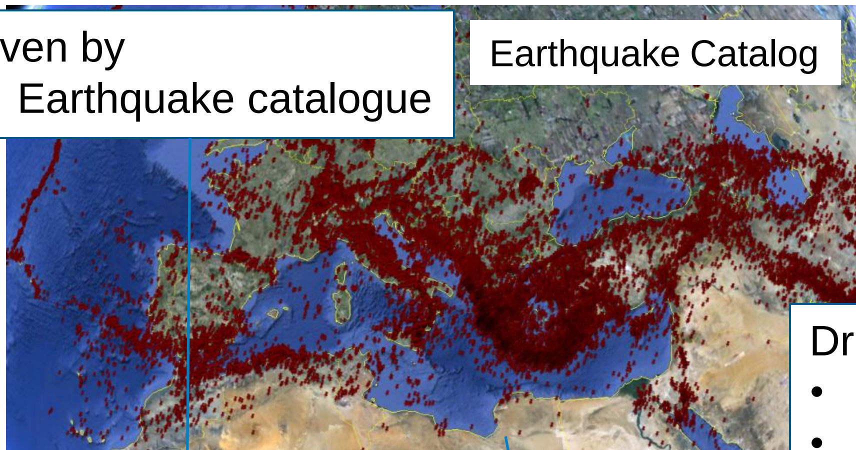


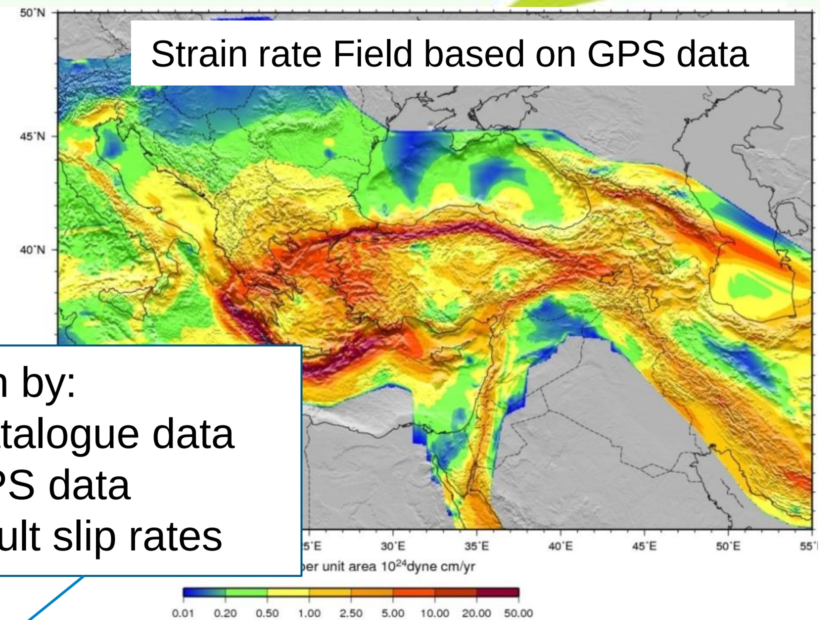
Regional Kinematic Model Provides a Continuous Strain Rate Field across the Region



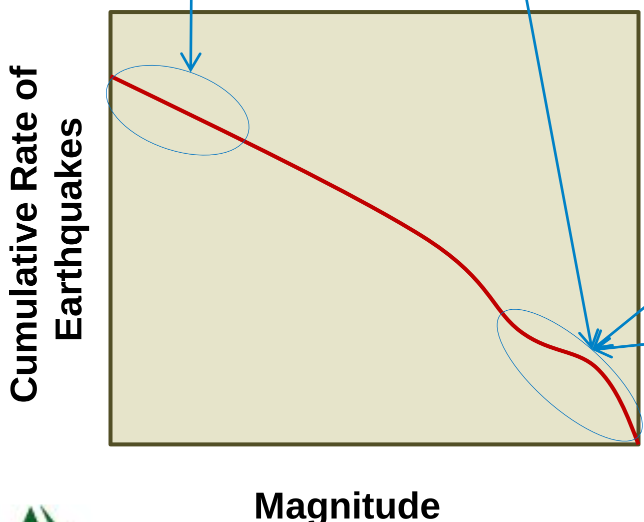
Earthquake Historic Catalogue, Fault Information, and GPS Kinematic Results Are Used to Construct Seismicity Models

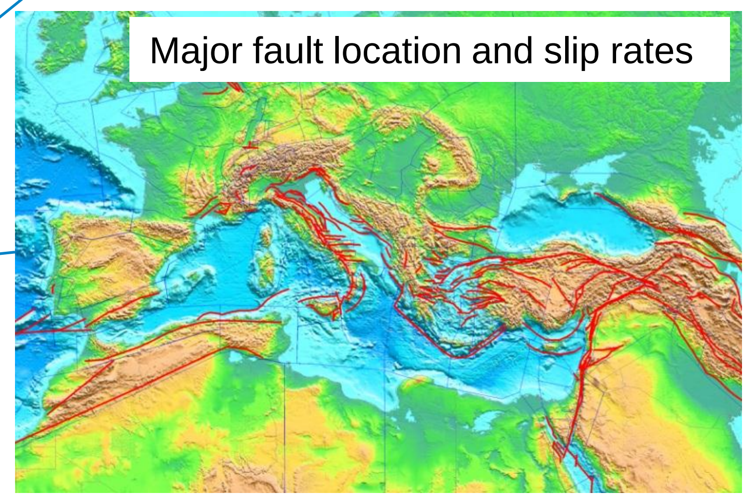
Driven by
- Earthquake catalogue



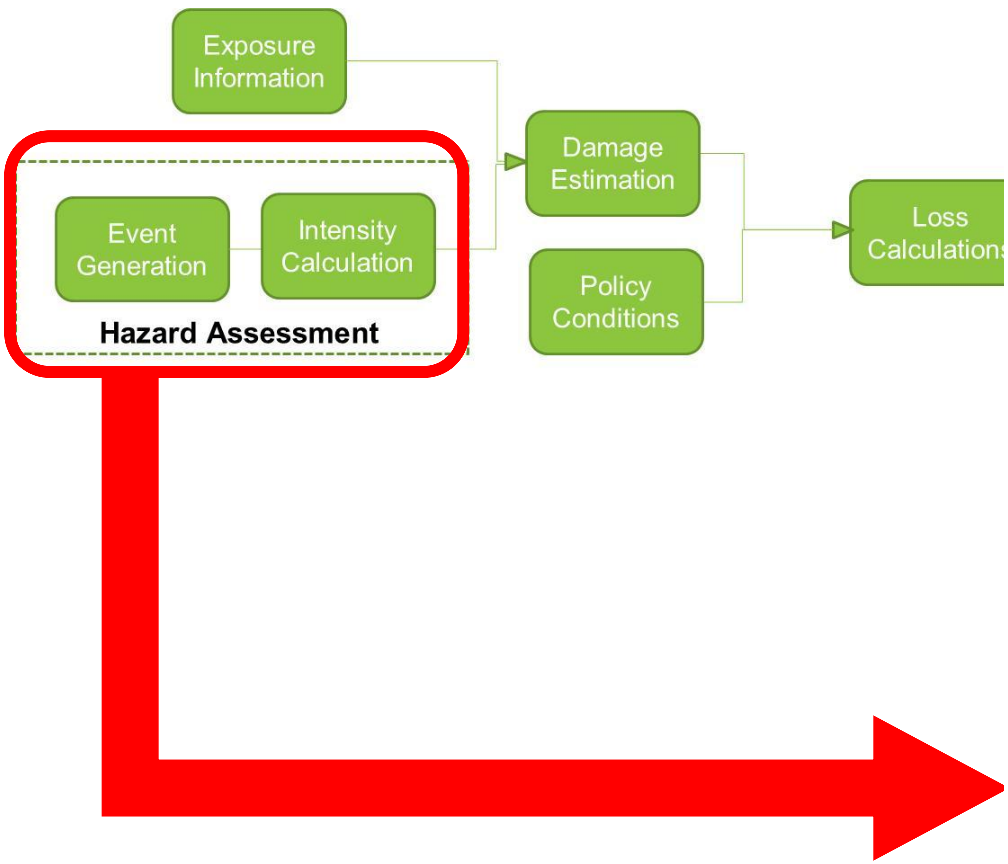


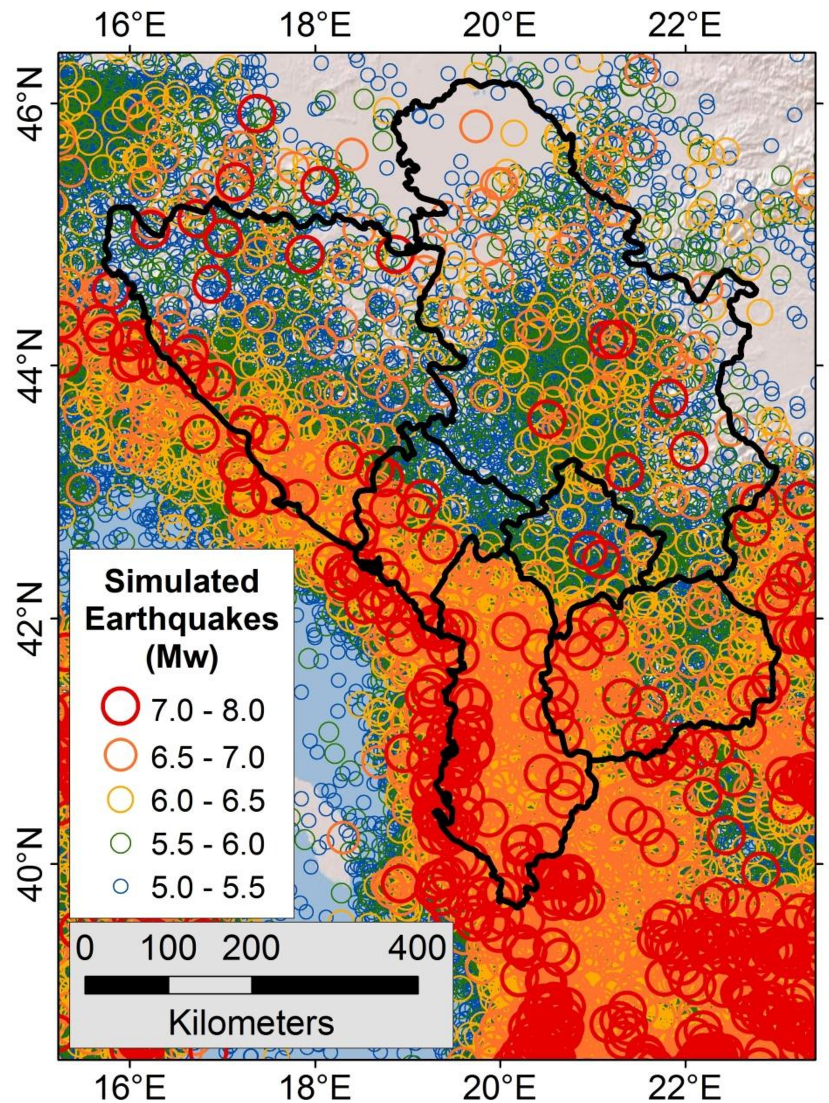
Driven by:
- Catalogue data
- GPS data
- Fault slip rates



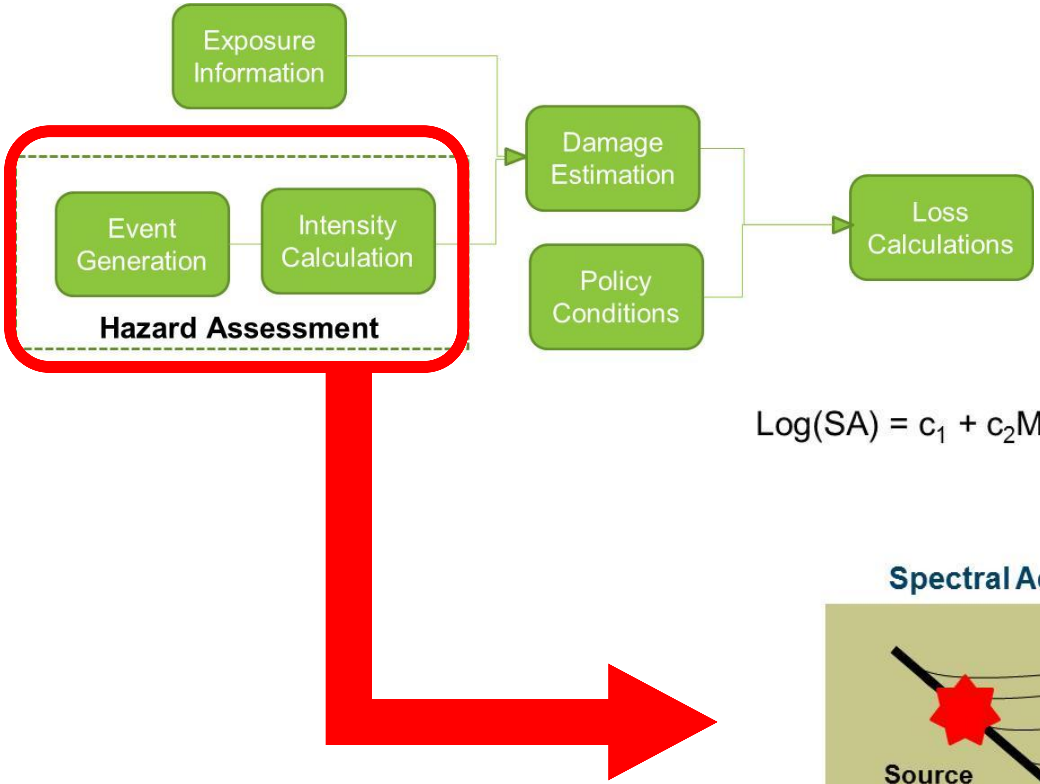


Simulation of Future Earthquakes

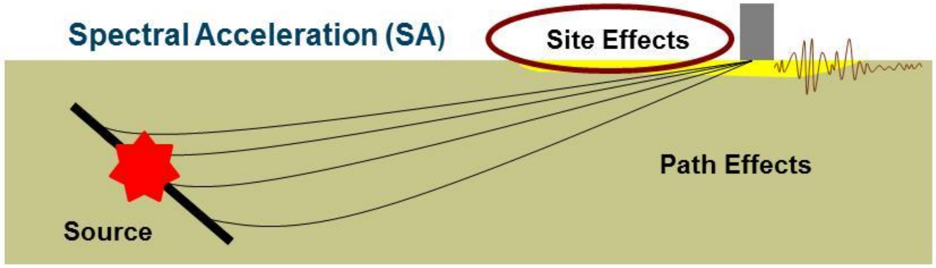




Empirical Equation are Used to Predict Ground Motion in the Region Affected by an Earthquake

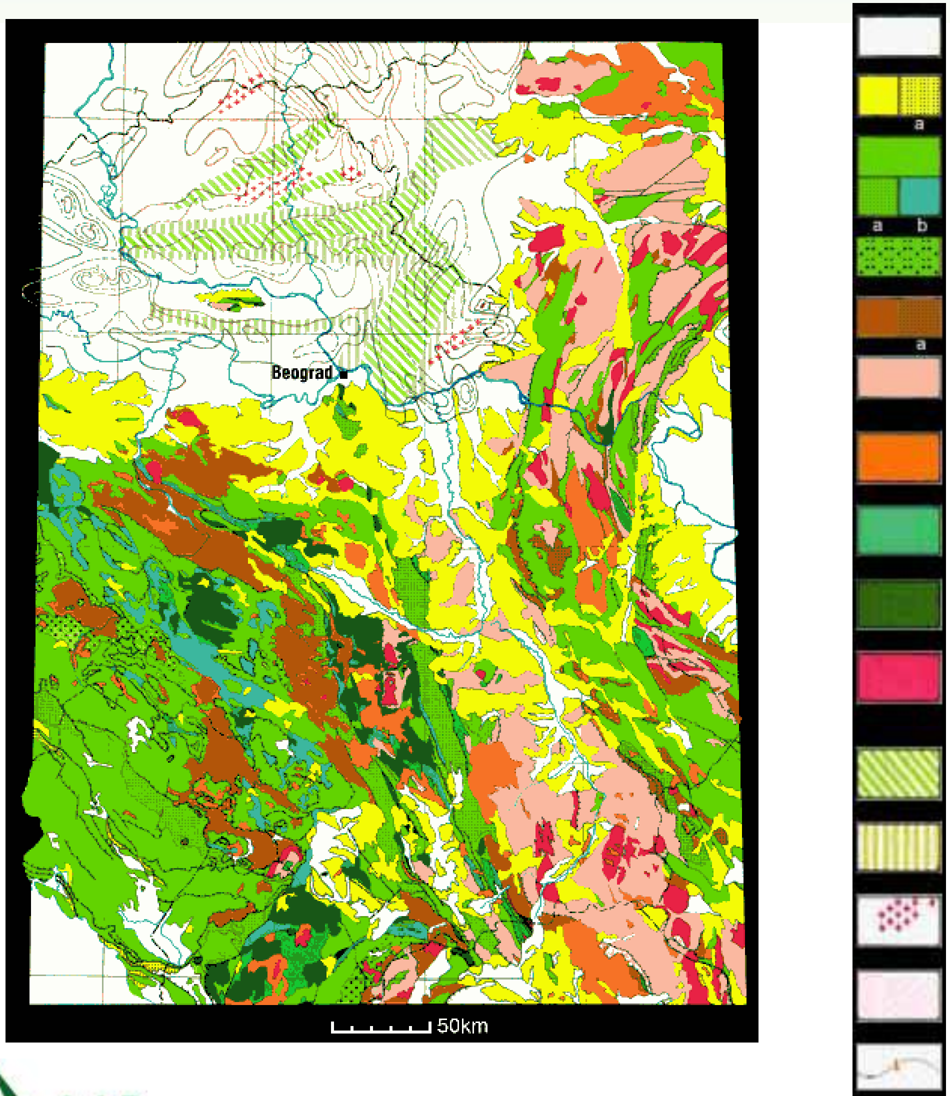


$$\text{Log}(SA) = c_1 + c_2 M + c_3 \log(R + c_4) + c_5 R + F(\text{Site, Mechanisms, …}) + \varepsilon_{inter} + \varepsilon_{intra}$$



SA = Spectral Acceleration
M = Magnitude
R = Distance

Surface Geology and Local Soil Conditions Affect the Earthquake Ground Motion



Quaternary
Tertiary; a - flysch
Mesozoic in general (a - flysch,
b - ophiolitic mélange

Permian-Triassic
Paleozoic; a - flysch
Metamorphites

Volcanites
Basites
Ultramaphites
Granitoids

Mesozoic
Ophiolites
Granitoids
Crystalline schists
Depth to the base

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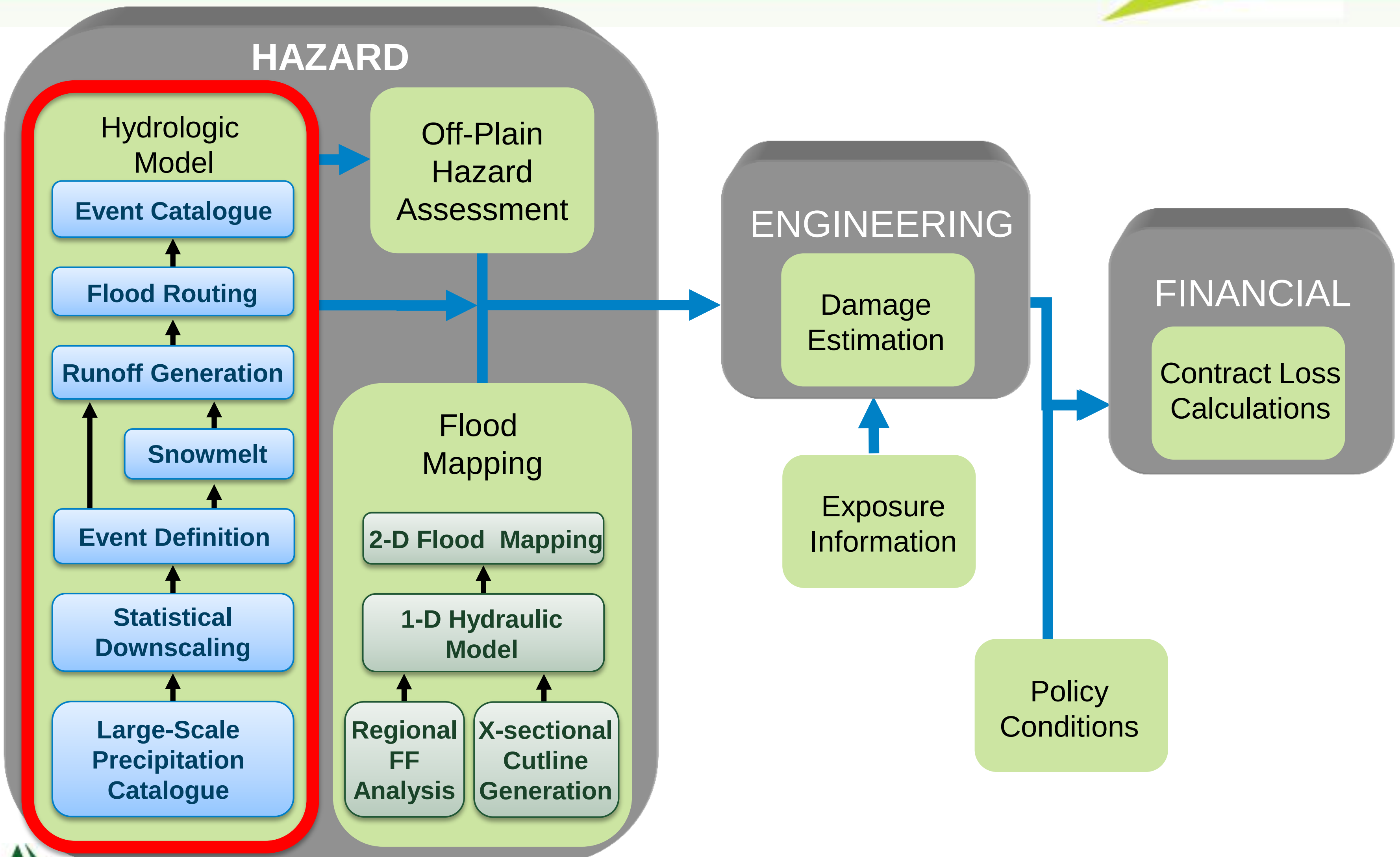
Model Framework Must Incorporate Hydrologic and Hydraulic Components to Realistically Simulate Floods



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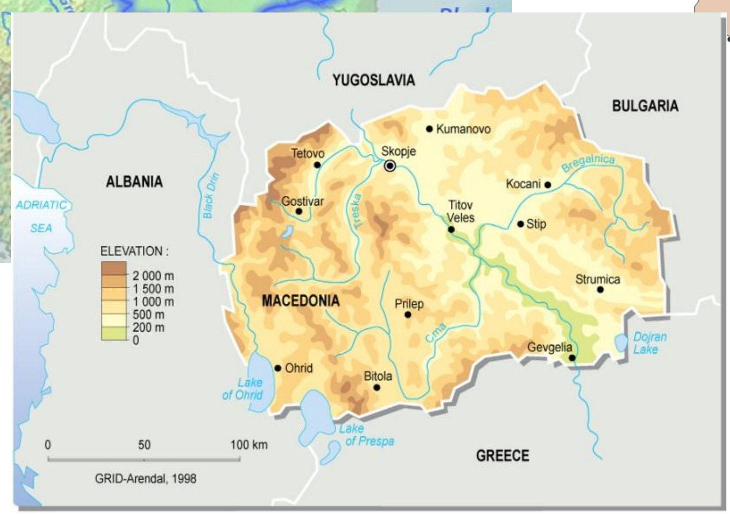
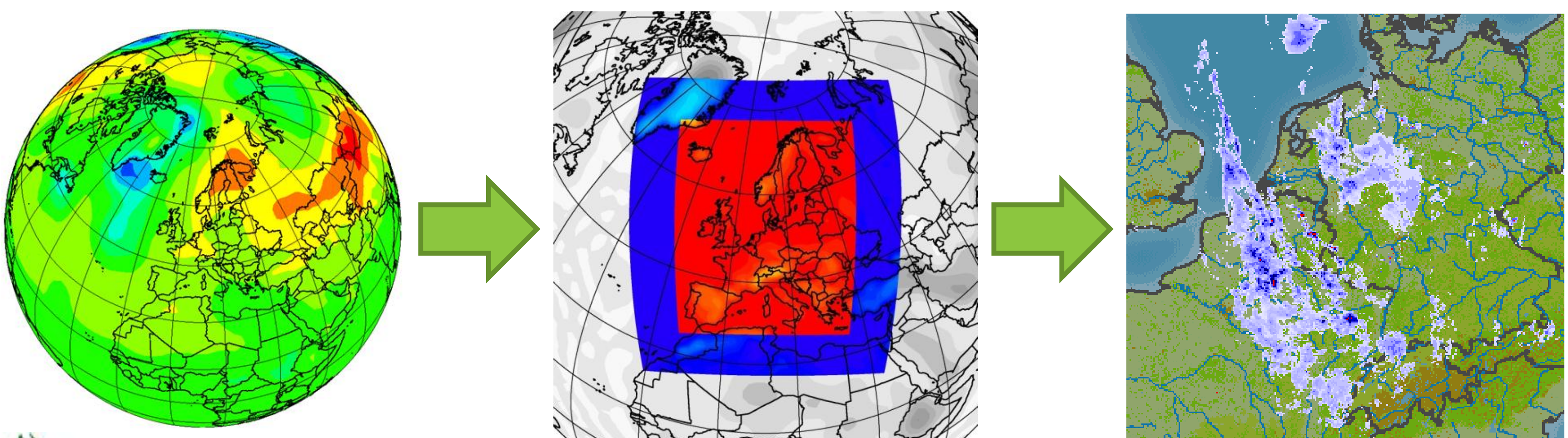
The Flood Model Will Include the Danube River Basin and All Relevant River Basins Draining to the Adriatic and Aegean Seas



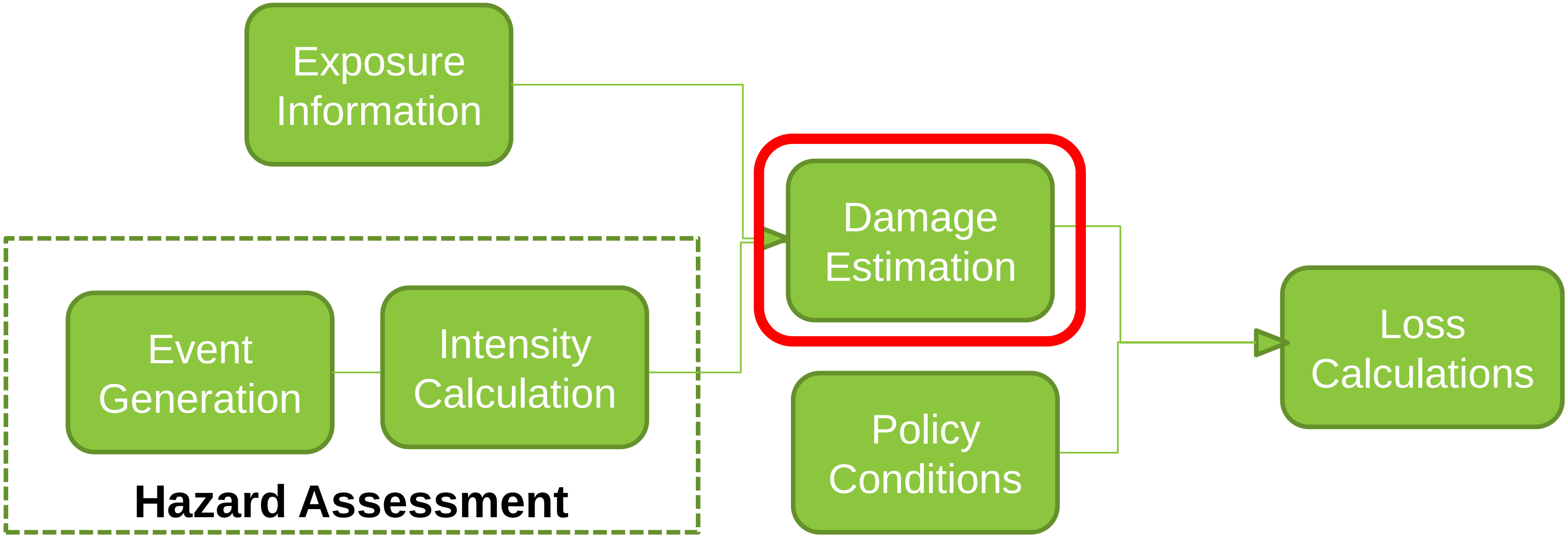
South East Europe Flood Model – Extension of Watersheds

AIR's Innovative Solution to Large-Scale Precipitation Simulation: Coupling GCM and NWP Models

1. Couple Global Circulation Models (GCM) at global scale with a mesoscale Numerical Weather Prediction (NWP) models at regional scale to provide coherent large-scale patterns
2. Employ sophisticated downscaling techniques to realistically simulate small-scale features
3. Technique preserves local rainfall statistics
4. Snowmelt modeling is important for the Alps: critical for both large and small scale



Risk Assessment Methodology



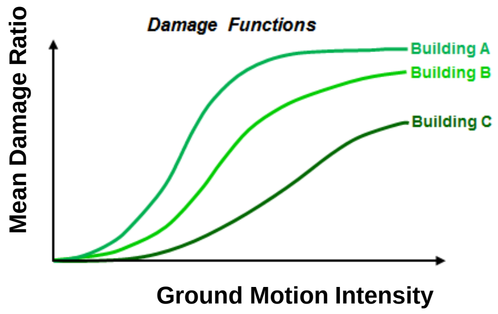
Damage Estimates are Based on Level of Shaking

Building characteristics
- Material
- Height
- Configuration
- Seismic resistance
- Engineering design

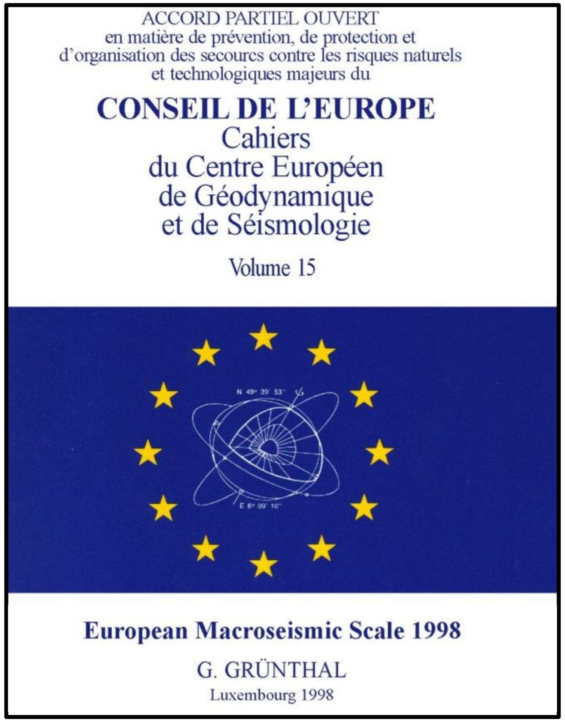
Main vulnerability classification

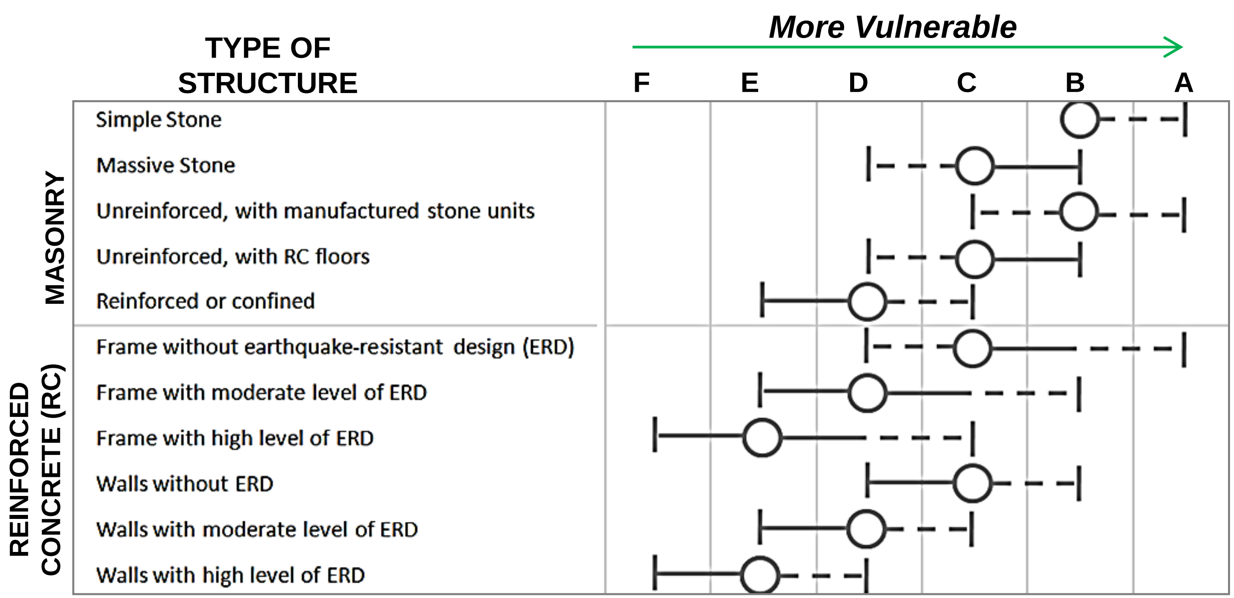
Regional considerations
- Building code
- Code enforcement
- Construction quality

Vulnerability Module By Country



AIR Vulnerability Module Leverages the Risk-UE, EMS98, and LessLoss Projects





Damage Surveys Provide Additional Information for the Design and Validation of the Vulnerability Module

M7.4 Izmit EQ 1999

M6.3 L’Aquila EQ 2009

- Soft stories and pancaking
- Failure of non-structural elements
- Relatively better performance than expected for RC
- URM failures
- Retrofits worked

- Soft stories
- Poor quality
- RC mid-rise generalised failures
- Poor RC connections
- Insufficient rebar
- Poor concrete mixes

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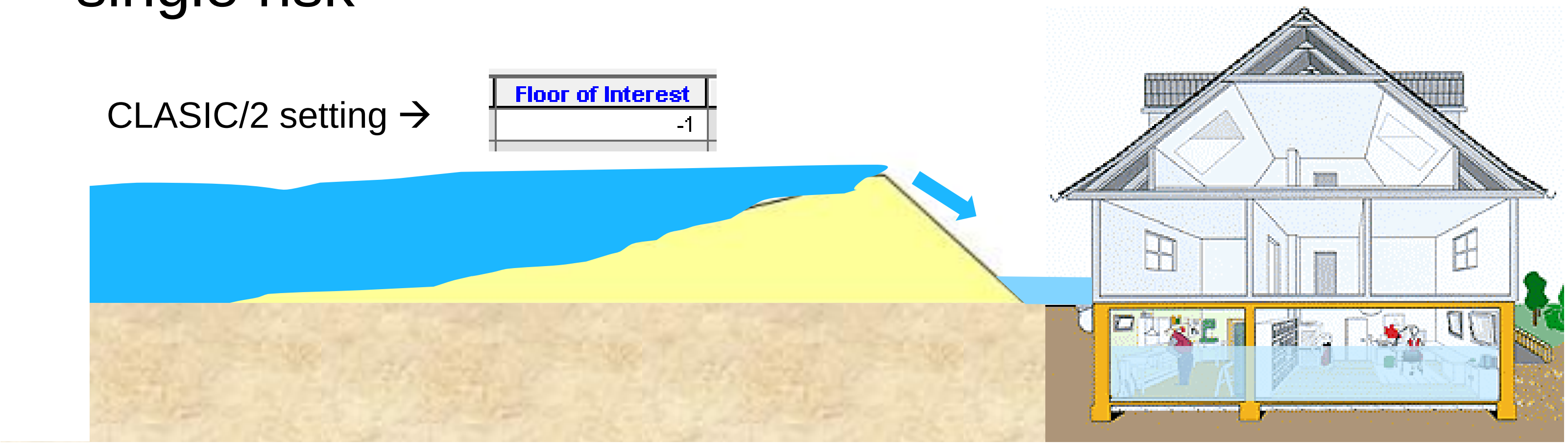
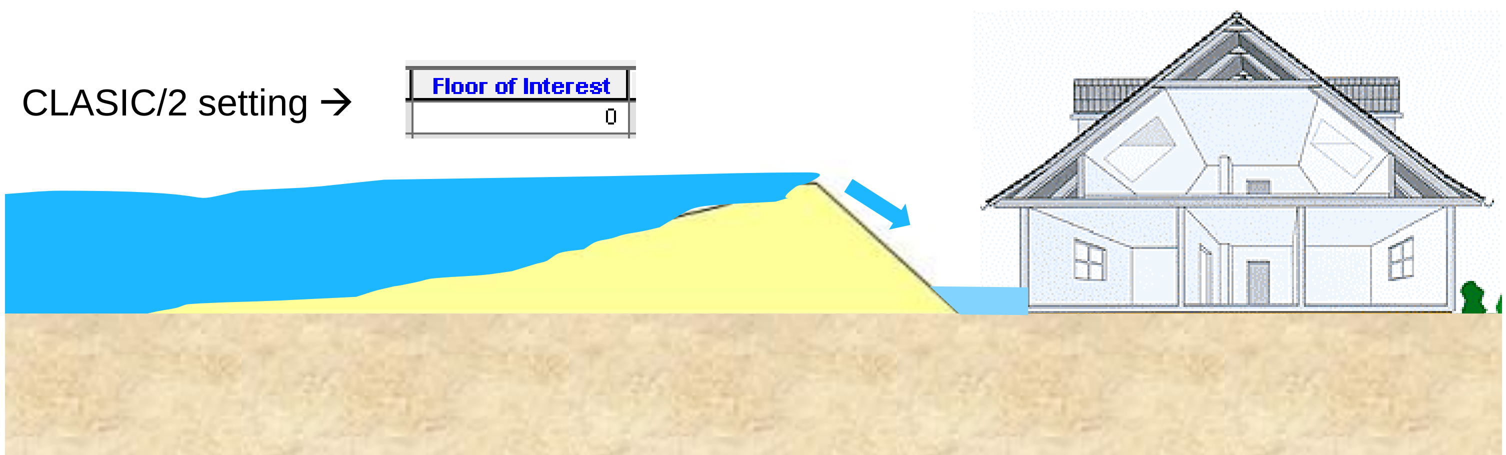
Damage Estimate is Based on Flood Depth

- Damage functions have been developed based on historical data, research publications, engineering analysis, damage surveys and insurance claims data
- Damage functions vary by **occupancy**, **construction**, and **height of the building**
- **Secondary risk modifiers**, such as presence of a basement, are supported to modify the damage functions

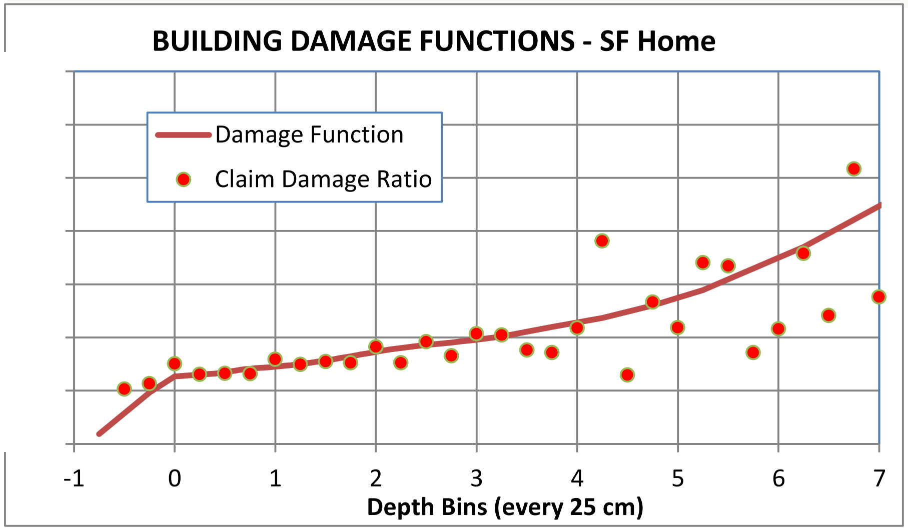
CLASIC/2 Enables Users to Specify Whether a Risk Includes a Basement

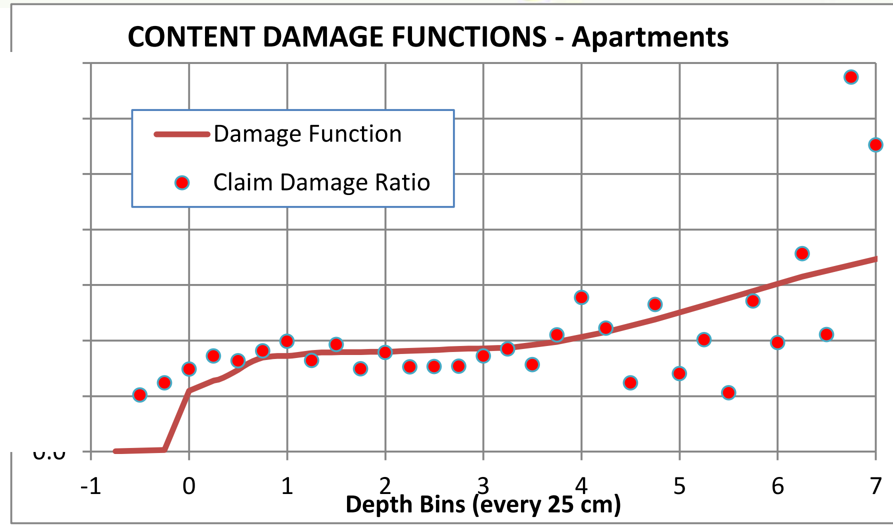
- Secondary Modifier “Floor of Interest” can be edited on single risk

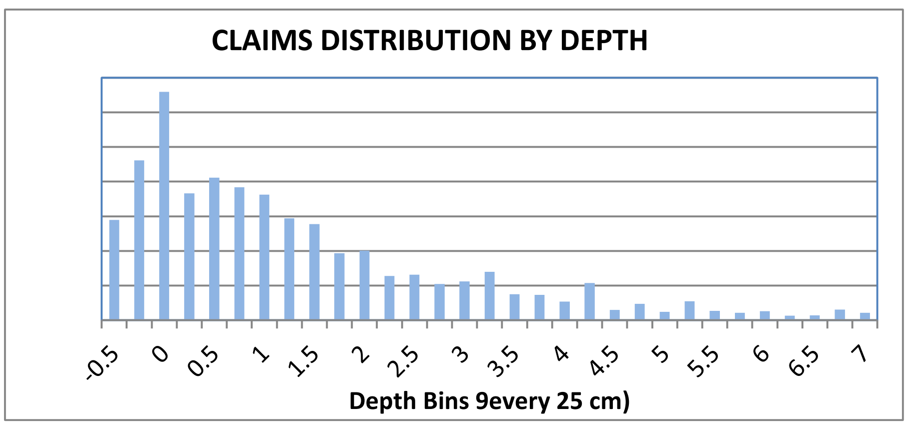


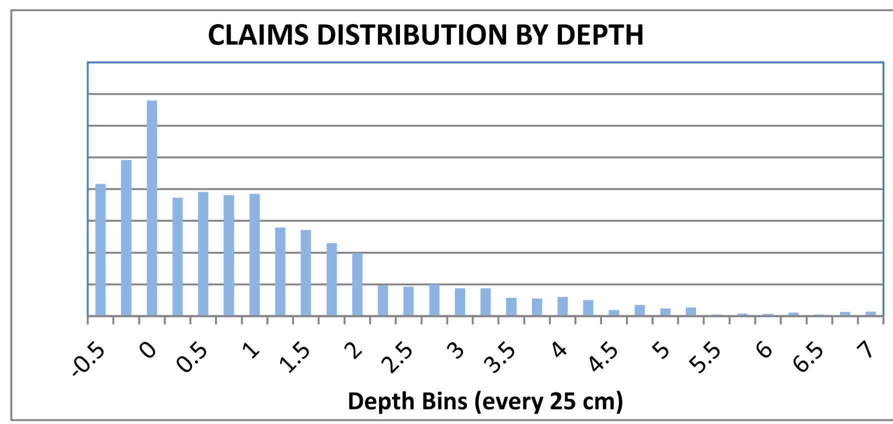


Damage Functions for Germany and U.K. Have Been Validated Using Company Claims Data









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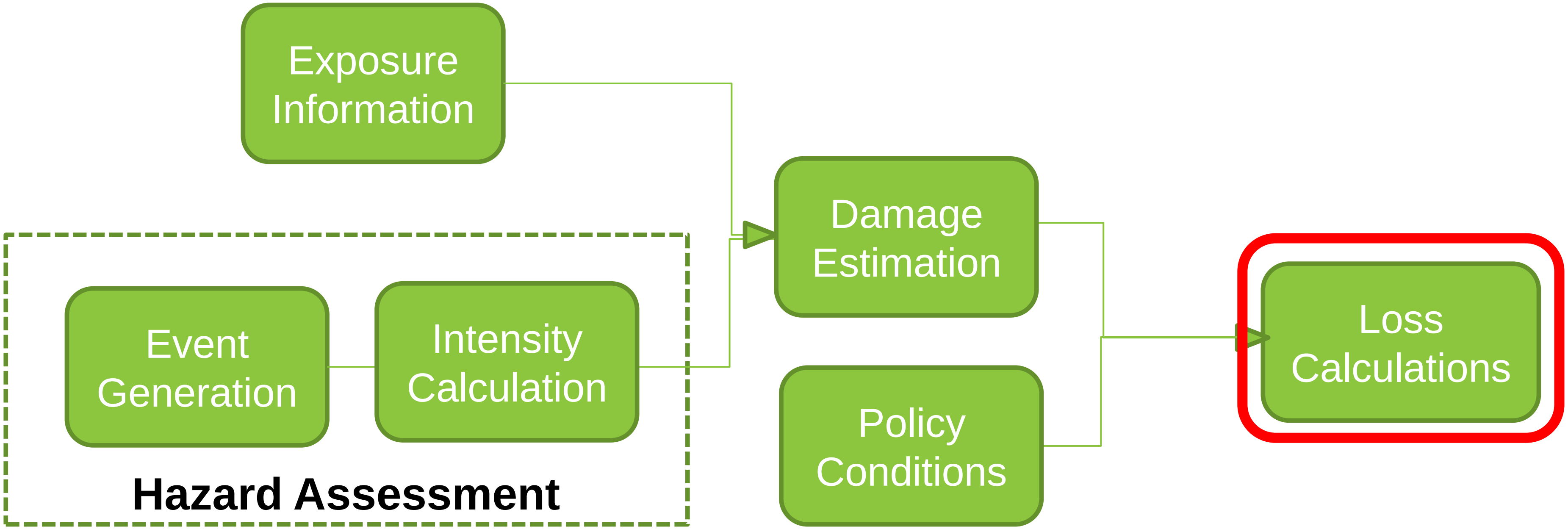
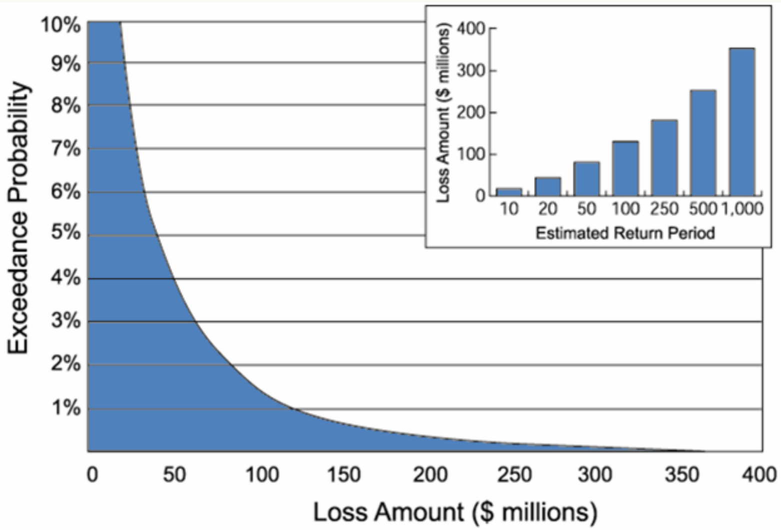
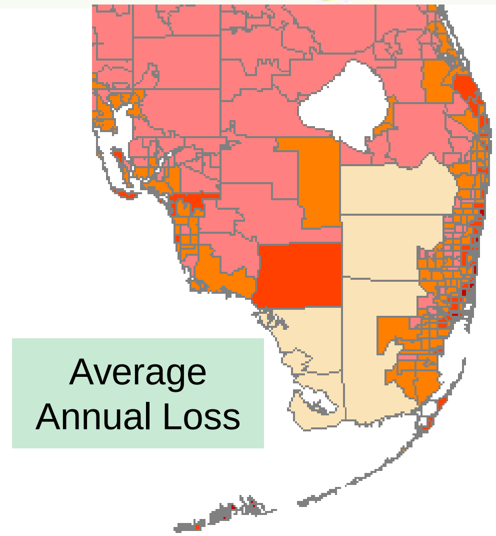
Risk Assessment Methodology

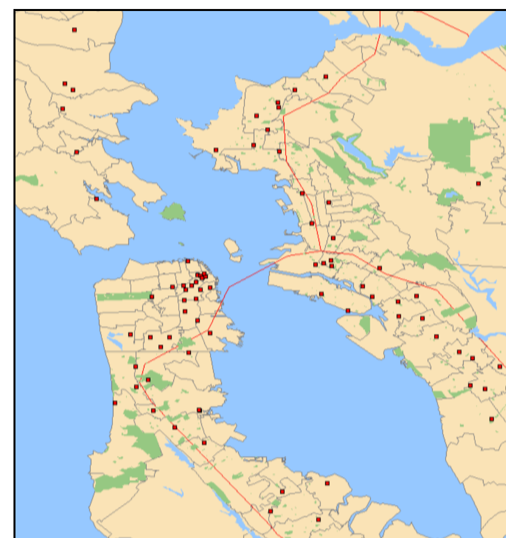


Catastrophe Models Provide a Wide Range of Outputs



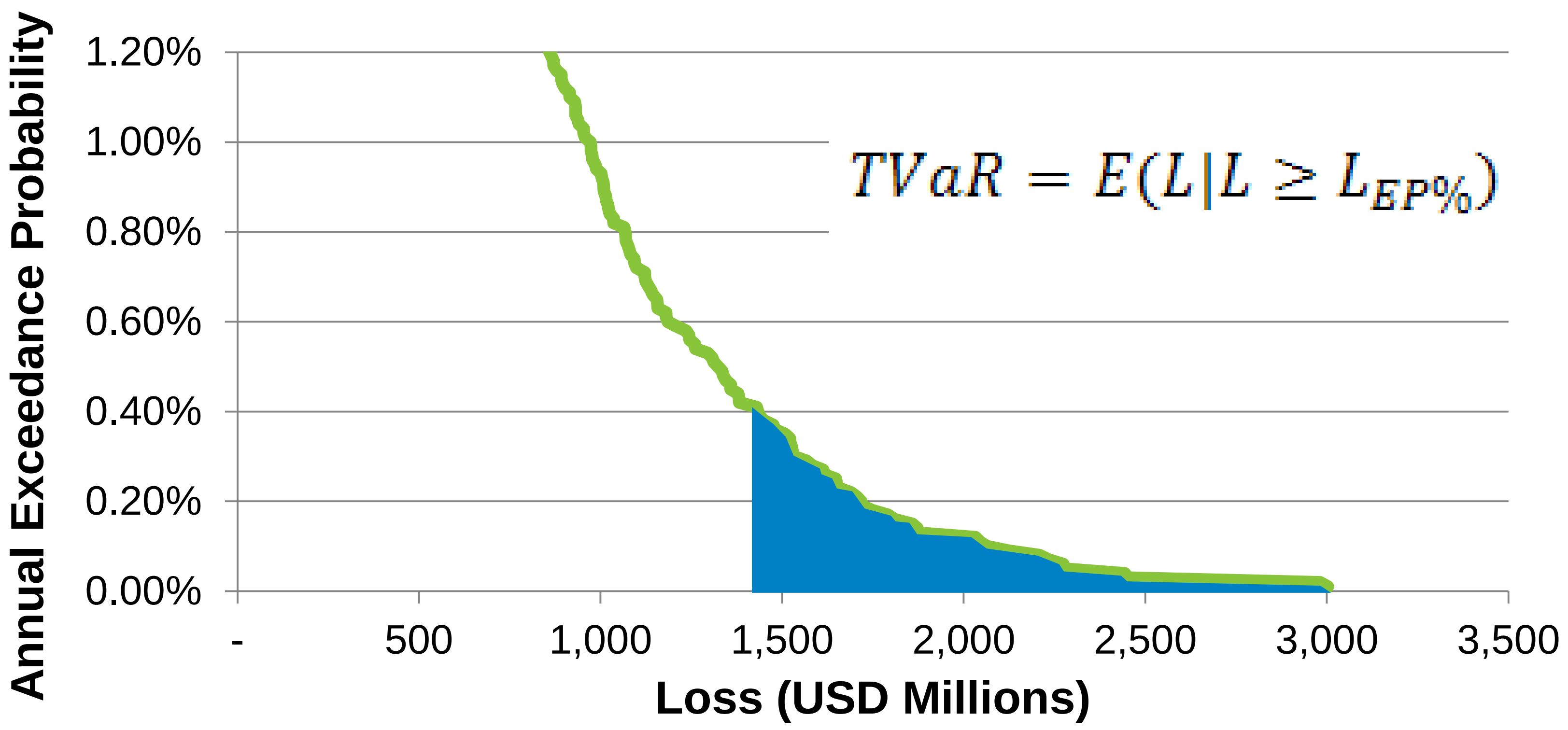


Event	Year	Contract Loss	Event Info
270007942	2353	1,995,714,211	Class 3 Hurr TX GOM
270003822	1143	1,994,490,277	Class 3 Hurr FL GOM GA
110044047	6410	1,993,822,104	MW 7.4 EQ Los Angeles
270021674	6488	1,992,783,613	Class 3 Hurr GOM AL FL GA MS
270018191	5445	1,992,529,830	Class 3 Hurr MA RI ME NY CT
270021539	6447	1,992,239,441	Class 3 Hurr FL BF
110010511	1539	1,991,950,215	MW 6.6 EQ Los Angeles
270014761	4407	1,991,795,632	Class 2 Hurr TX GOM LA
270029332	8763	1,990,905,697	Class 3 Hurr GOM FL AL GA MS
110014872	2164	1,990,461,843	MW 6.5 EQ San Francisco
270006759	1983	1,989,857,449	Class 2 Hurr LA GOM MS AL
270023332	6984	1,989,268,193	Class 3 Hurr SC TN NC KY GA
270008182	2423	1,989,078,459	Class 2 Hurr NC SC VA



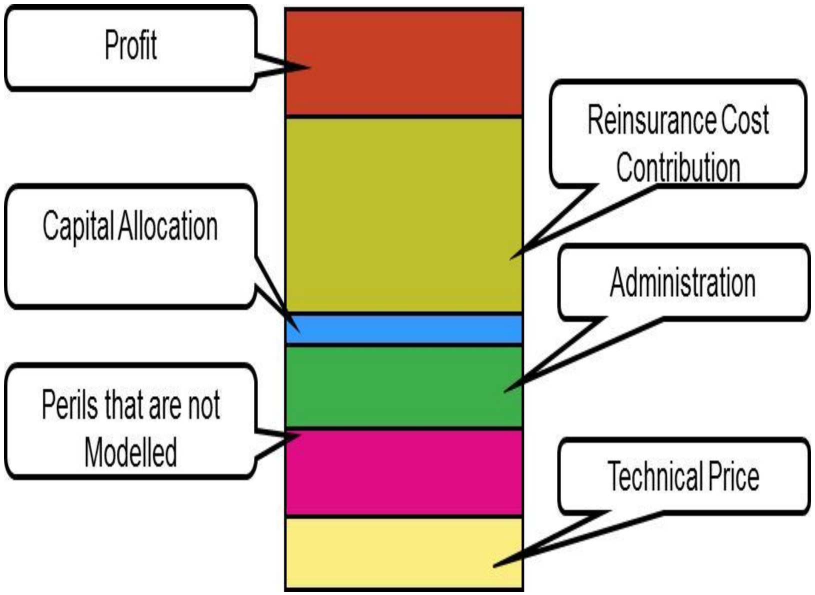
Assessing Risk Beyond 0.4% Exceedance Probability

- Tail value-at-risk (TVaR): average of all simulated event losses beyond specified probability, such as 1% or 0.4%



Applications of Catastrophe Models

- Pricing
  - Insurance
    - Premium = f (AAL, SD, Expenses, Profit Loading, Commission etc.)
    - “Pre risking”- Preview catastrophe losses to a policy before taking on risk
  - Reinsurance
  - Catastrophe Bonds
- Reserving
    - Solvency II capital requirements are dependent on 99.5th percentile of loss distribution over one year
- Marginal impact
    - Effect on portfolio PMLs (probable maximum loss) with and without policy



Summary and Conclusions

- Comprehensive Earthquake and Flood Risk Models for Albania, FYR of Macedonia, and Serbia are under development
- Models to be used for pricing insurance premium for single assets at risk and for assessing EuropaRe total exposure to risk
- The models will be seamlessly linked with an underwriting platform to be developed by Insurance Systems Inc. and with an efficient system for settling claims expeditiously
- Preliminary risk estimates will be available by the end of 2012 and final models and SW will be ready in Fall 2013

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