

# Modelling Earthquake Risk In Israel

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# Agenda

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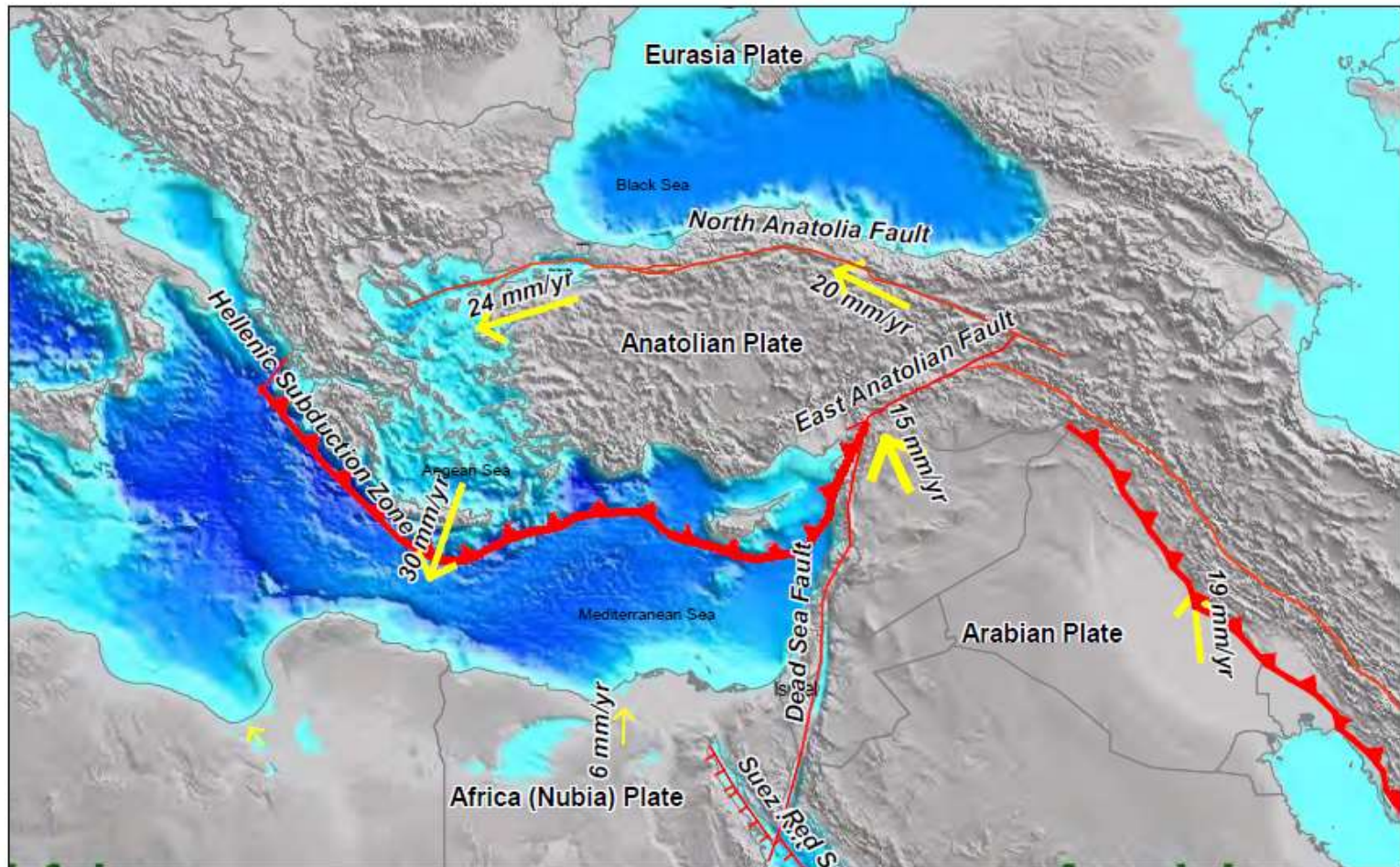
- Overview of AIR's Earthquake Model in Israel
- Managing your Earthquake Risk using AIR's Touchstone
  - Exposure characteristics
  - Accumulation techniques
  - Stochastic model output
  - Comparing AIR's stochastic model losses to Israeli F-factor accumulation
  - Creating your own view of risk

# Overview of AIR's Earthquake Model in Israel





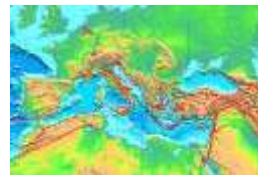
# Plate Tectonics of the Eastern Mediterranean Are Relatively Complex



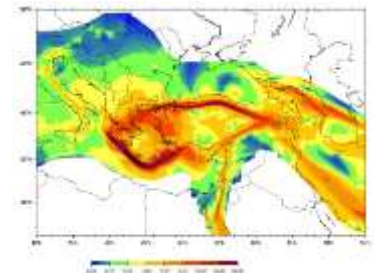


# The Stochastic Catalogue Is Built Using Multiple Data Sources

- Historical and instrumentally recorded earthquakes
- Paleo-seismic data
- Active fault data
- Geodetic data – GPS

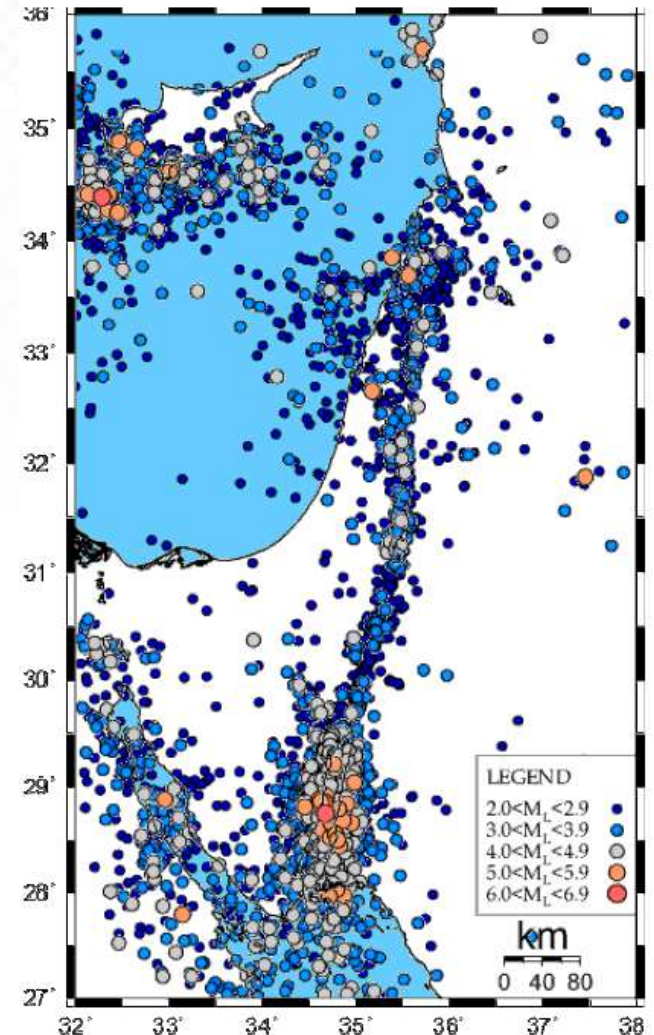


Kinematic model



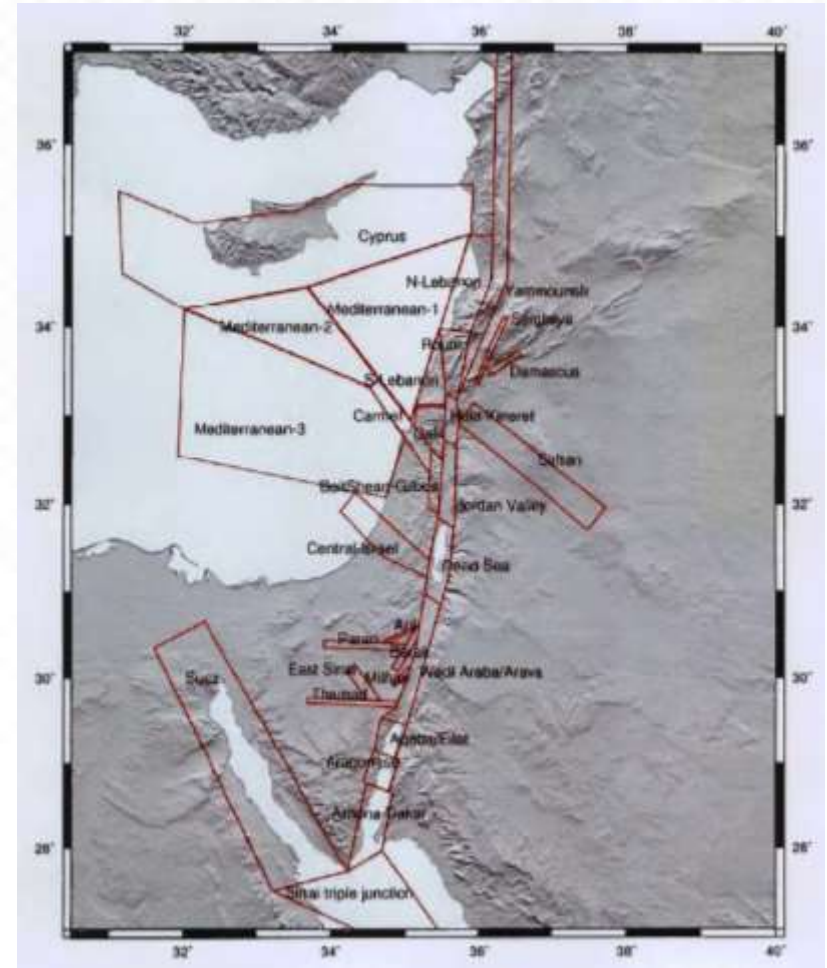
# Historical Seismicity Shows Main Fault Systems Are the Dead Sea Fault Zone and the Carmel Fault

- Earthquake epicenter locations indicate the main faults in Israel
- The majority of historical seismicity in Israel is concentrated along the Dead Sea Fault
- Many other strike/slip faults (e.g. Carmel)
- Large ( $>7$  Mw) historical events include the Mw 7.1 1837 Safed earthquake and the Mw 7.3 1995 Gulf of Aqaba earthquake



# AIR Source Zones in Israel Are Based on the Seismic Zonation Established by Shapira et al., (2007)

- The zonation considers:
  - Unified historical earthquake catalogue
  - Catalogue of young faults in Israel
  - Active faults
- Seismicity parameters include:
  - The parameters of the frequency-magnitude relationship
  - Maximum magnitude
  - Recurrence period

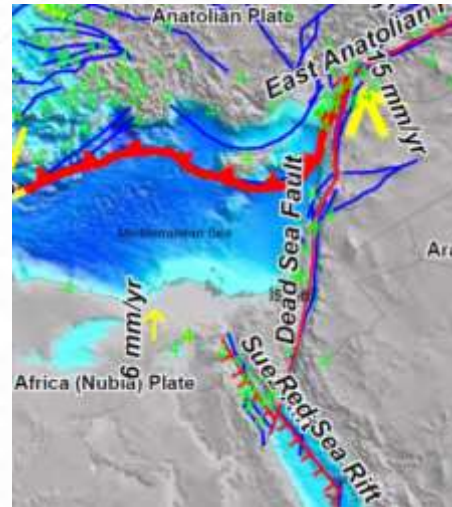


*Earthquake Hazard Assessments for Building Codes Final Report, Shapira et al., 2007*

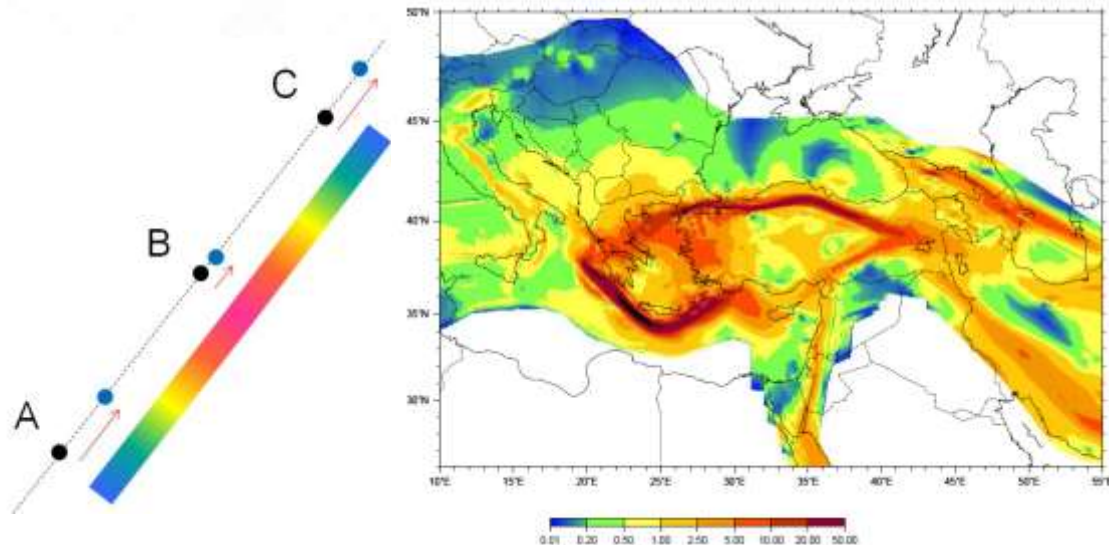


# Advances in Geodetic Data (GPS Measurements)

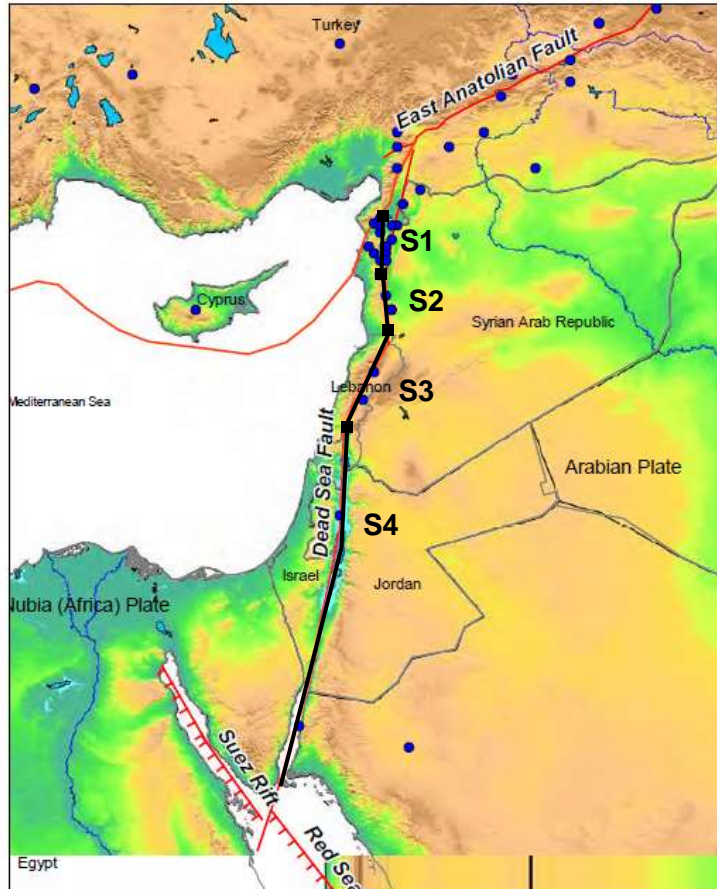
## Detect Small Land Displacements



GPS Recording Stations



# Modelling Time Dependency Is Important for Capturing the Risk in Israel



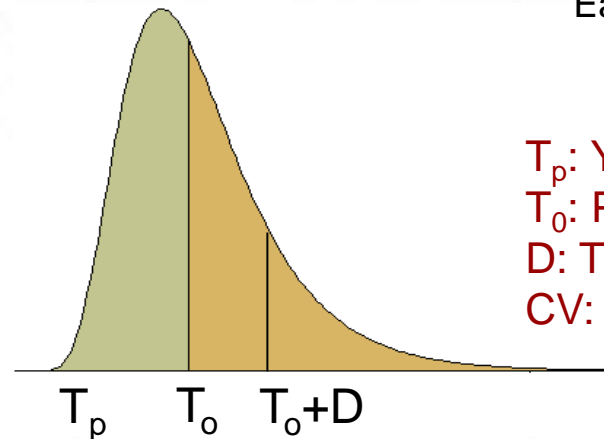
The Dead Sea Fault Zone is divided into 4 segments:

S1: Ghab Valley segment

S2: Missyf Graben segment

S3: Lebanon Bend segment

**S4: Jordan & Araba Valley segment**



Earthquake Chronology

$T_p$ : Year of Past Occurrence

$T_o$ : Present Year

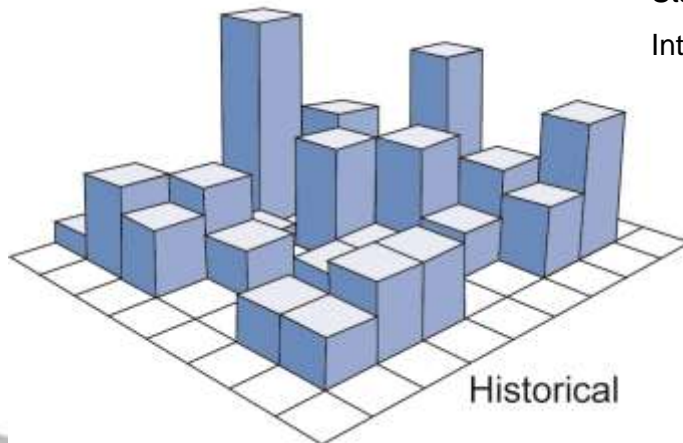
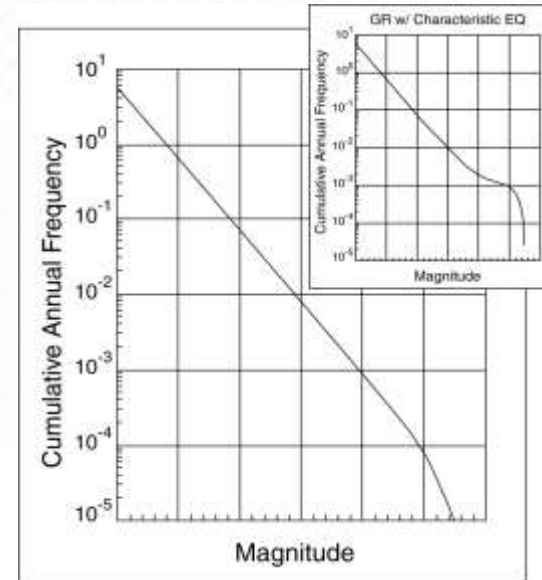
$D$ : Time Duration

$CV$ : Coefficient of Variance

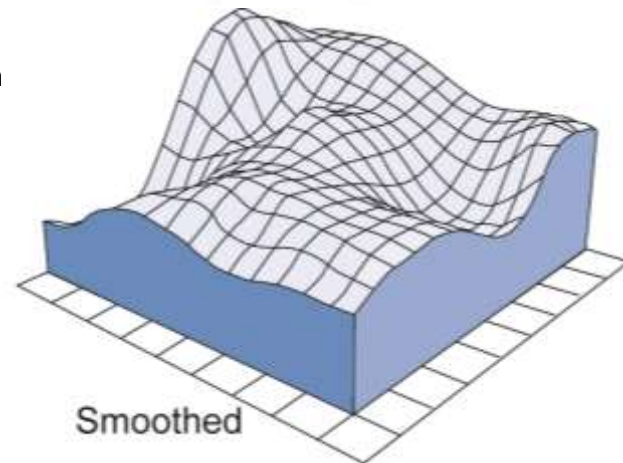
$$P(\text{Occurrence} | T_p, T_o, D)$$

$$= B / (1 - A)$$

# Gridded Background Seismicity Is Capable of Capturing Seismicity on Unmapped Faults

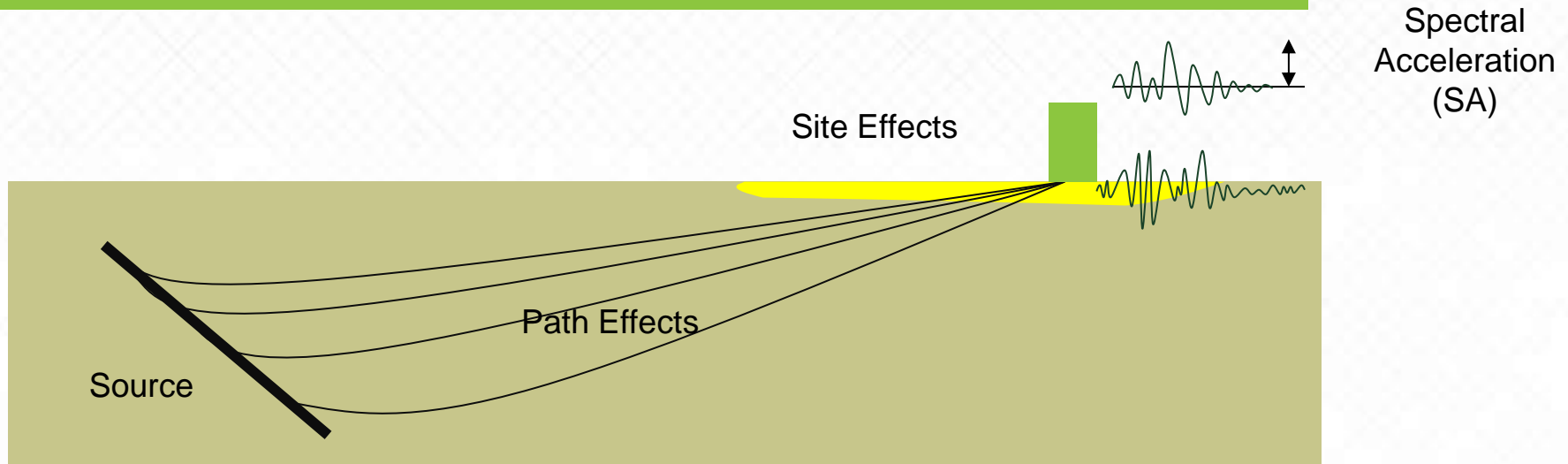


Statistical  
Interpolation





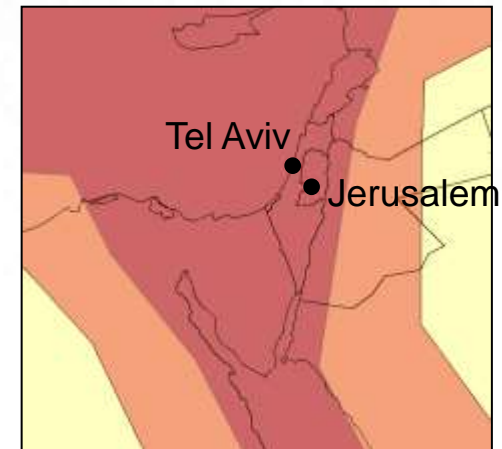
# Ground Motion Prediction Equations (GMPEs) Are Used to Estimate the Degree of Ground Shaking



GMPEs for Israel reflect an active seismic zone and the shallow crustal nature

The following GMPEs are used with equal weighting:

- Akkar and Bommer (2010)
- Ambraseys et al., (2005)
- Abrahamson and Silva (2008)
- Boore and Atkinson (2008)
- Campbell and Bozorgnia (2008)
- Chiou and Youngs (2008)

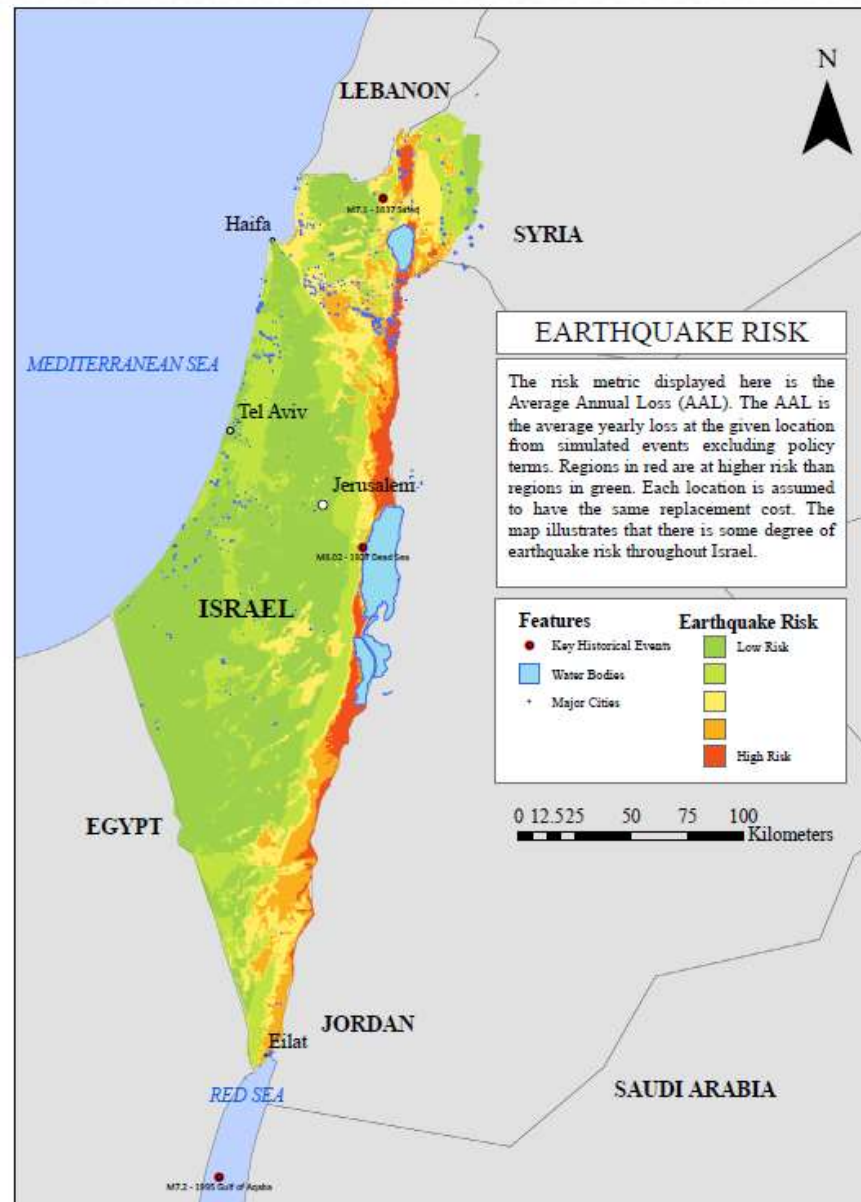


**Regions of the model domain by seismic status.**

Active zones (Red); Stable Zones (Yellow); Transition Zones (Orange);



# Summary of Earthquake Risk in Israel



# **Managing Your Earthquake Risk Using AIR's Touchstone**

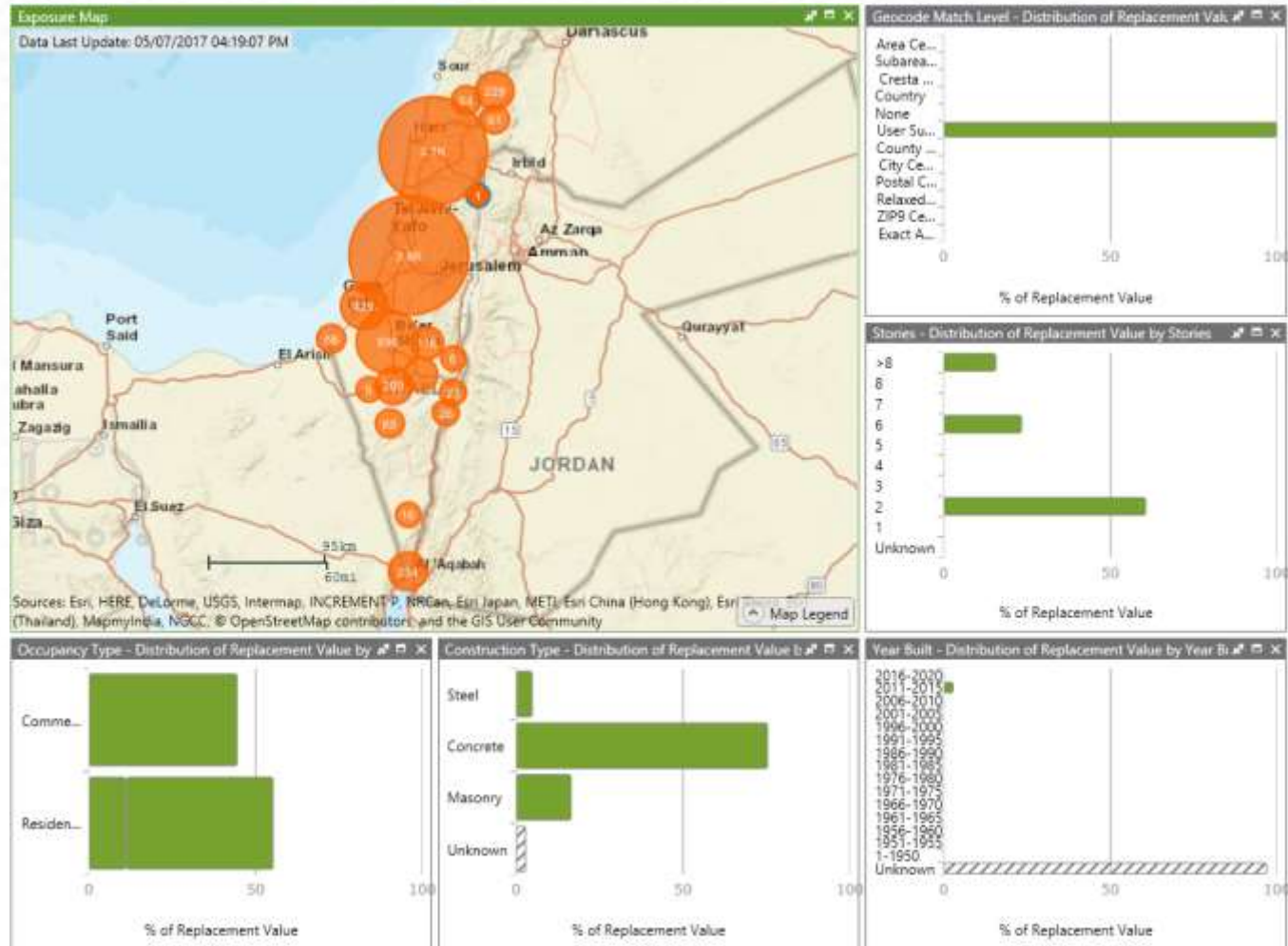


# Agenda

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- Managing your Earthquake Risk using AIR's Touchstone
  - Exposure characteristics
  - Accumulation techniques
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# Exposure Management – Know and Understand Your Exposure





# View Exposure and Attributes in Varying Levels of Detail

The image illustrates the ability to view exposure data at varying levels of detail. It features three overlapping 'Exposure Map' windows, each showing a different zoom level of the same geographic area. The top window shows a broad view of the region around Danascus and Sour. The middle window shows a more detailed view of the same area. The bottom window shows a very detailed view of the coastal area, including the city of Tel Aviv. A large satellite map of Tel Aviv is overlaid on the bottom window, showing the city's layout and the coastline. A detailed attribute window is open on the right side of the image, displaying information for a specific location in Tel Aviv.

**Exposure Map**  
Data Last Update: 05/07/2017 04:19:07 PM

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Data Last Update: 05/07/2017 04:19:07 PM

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Data Last Update: 05/07/2017 04:19:07 PM

Sources: Esri, HERE, DeLorme, US User Community

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**Enterprise**

Location Name:	A
Insured Name:	Tel Aviv Stock Exchange
Contract Name:	Tel Aviv Stock Exchange

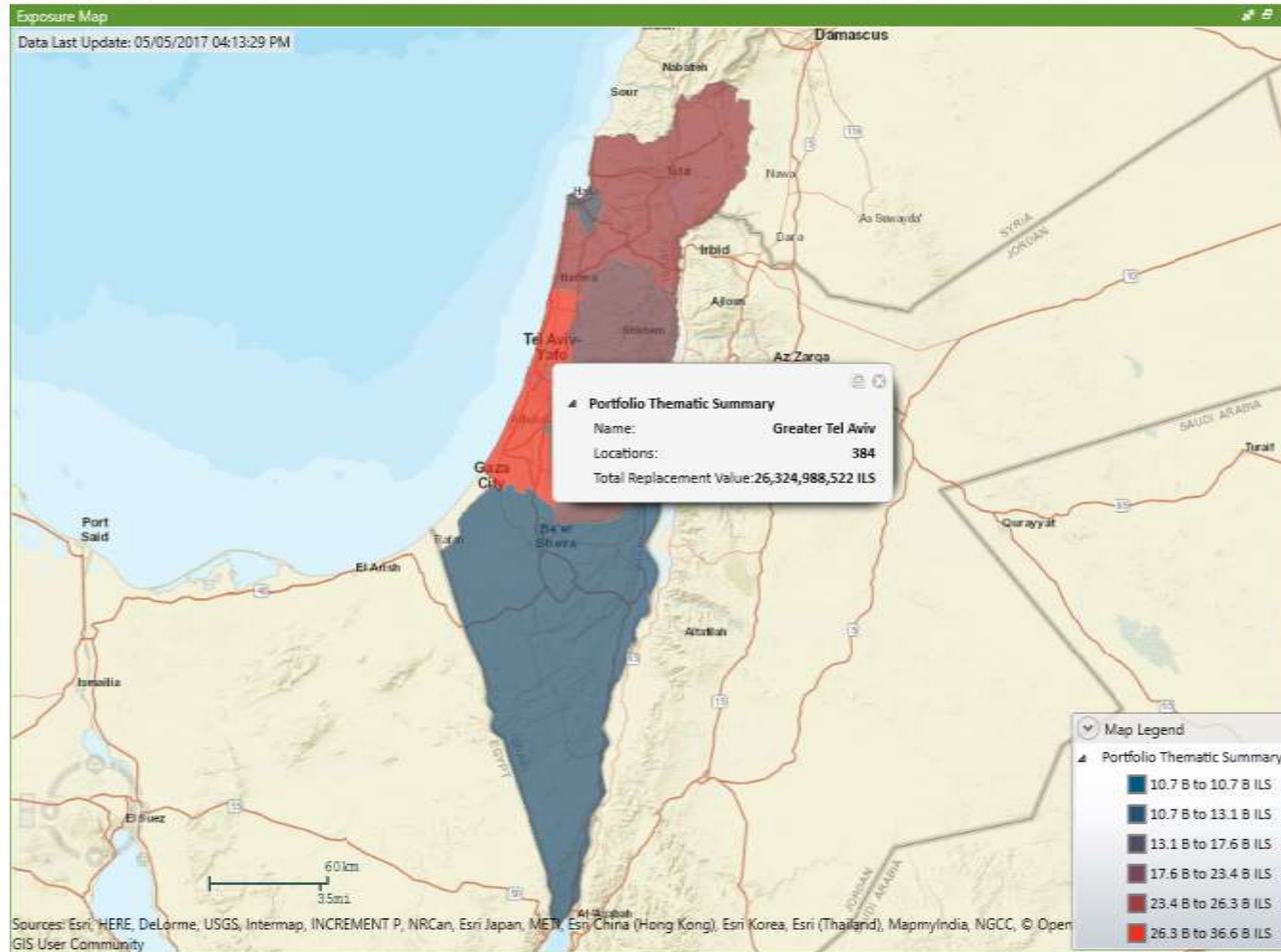
**Geography**

State:	Tel Aviv
Postal Code:	65143
Geocode Match Level:	User Supplied
Latitude:	32.064000° N
Longitude:	34.770300° E

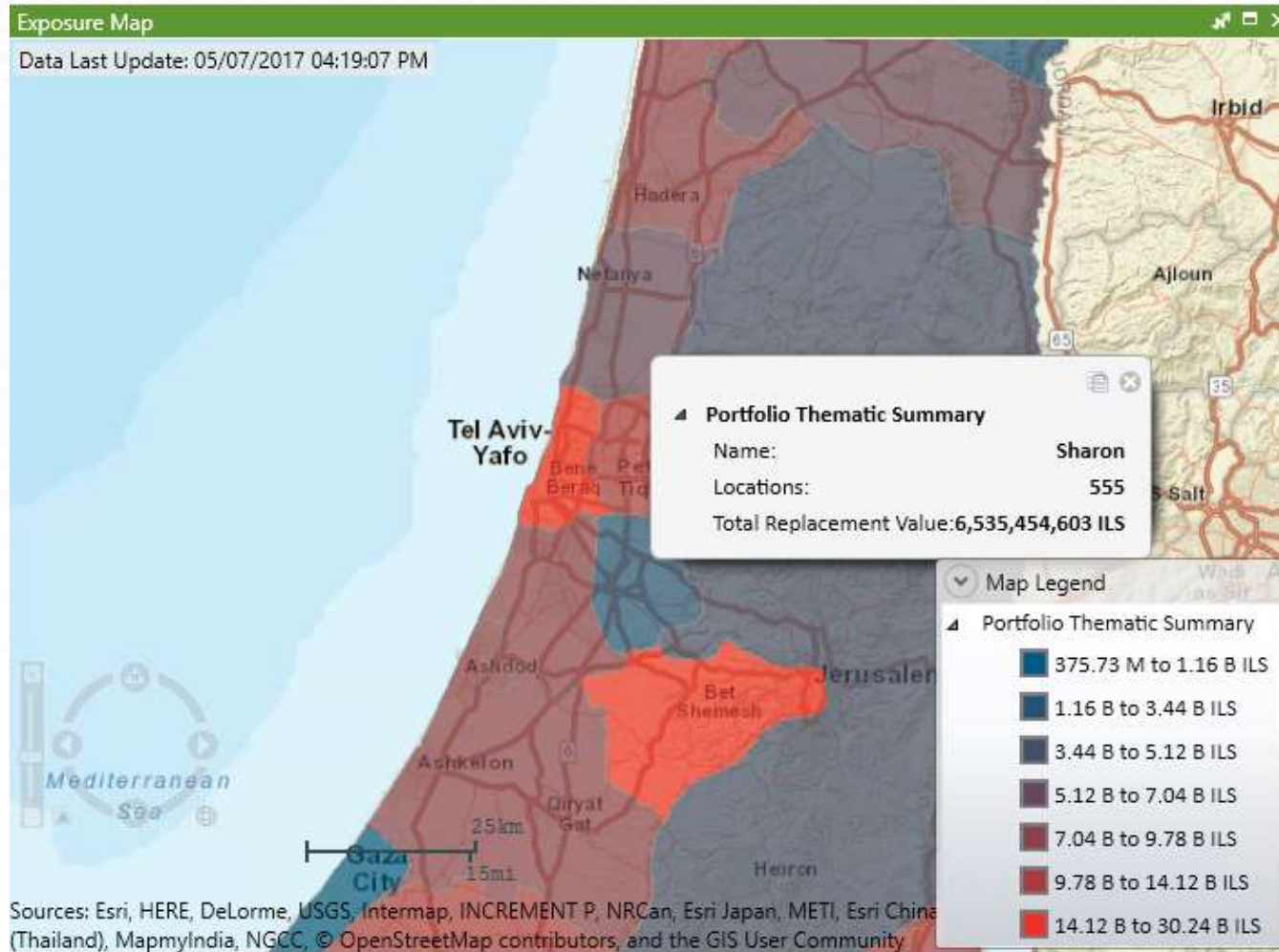
**Primary Characteristics**

Construction Code:	Unknown
Occupancy Code:	General commercial
Year Built:	2014

# View Replacement Values by CRESTA

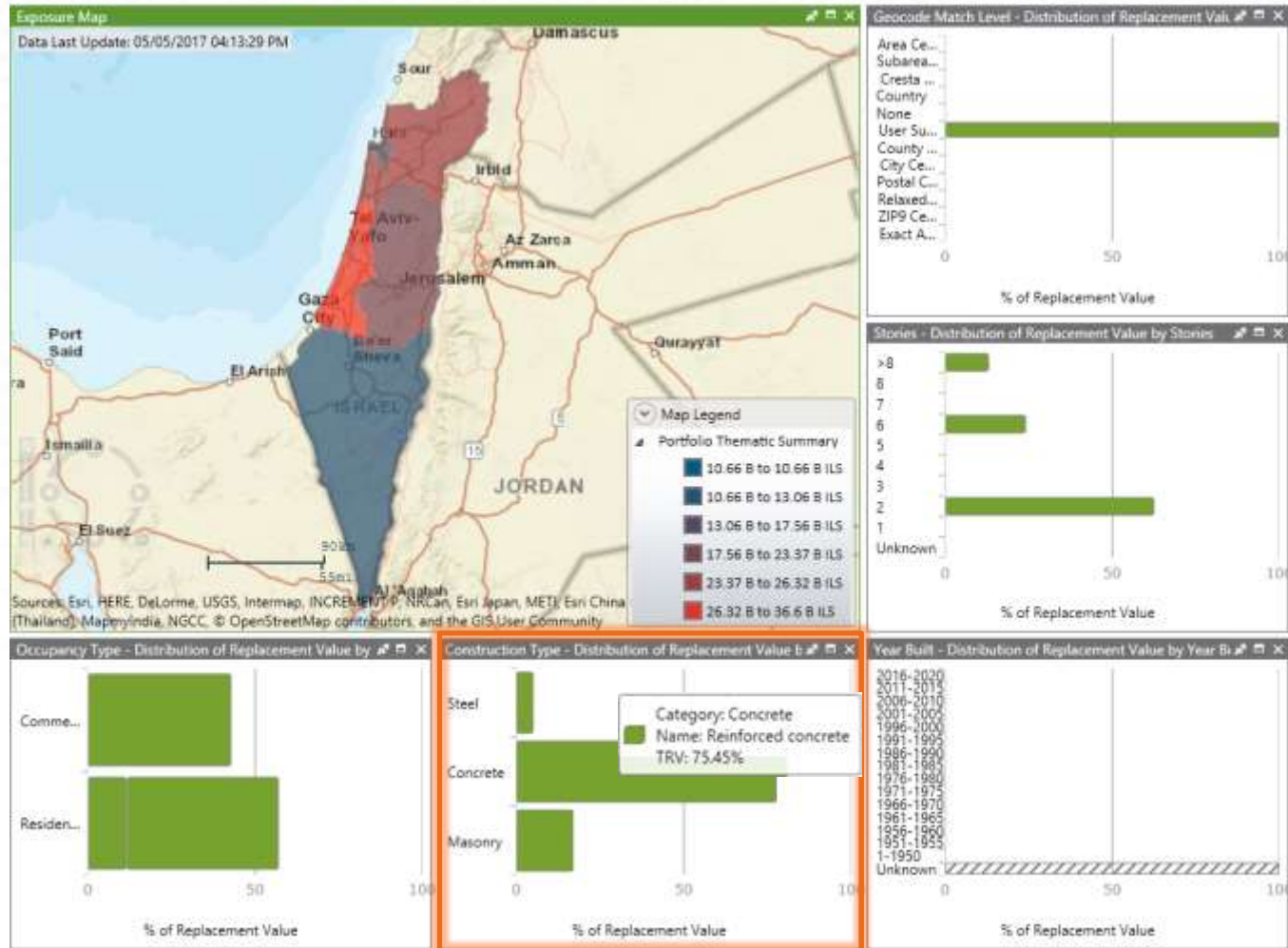


# View Replacement Values by Area





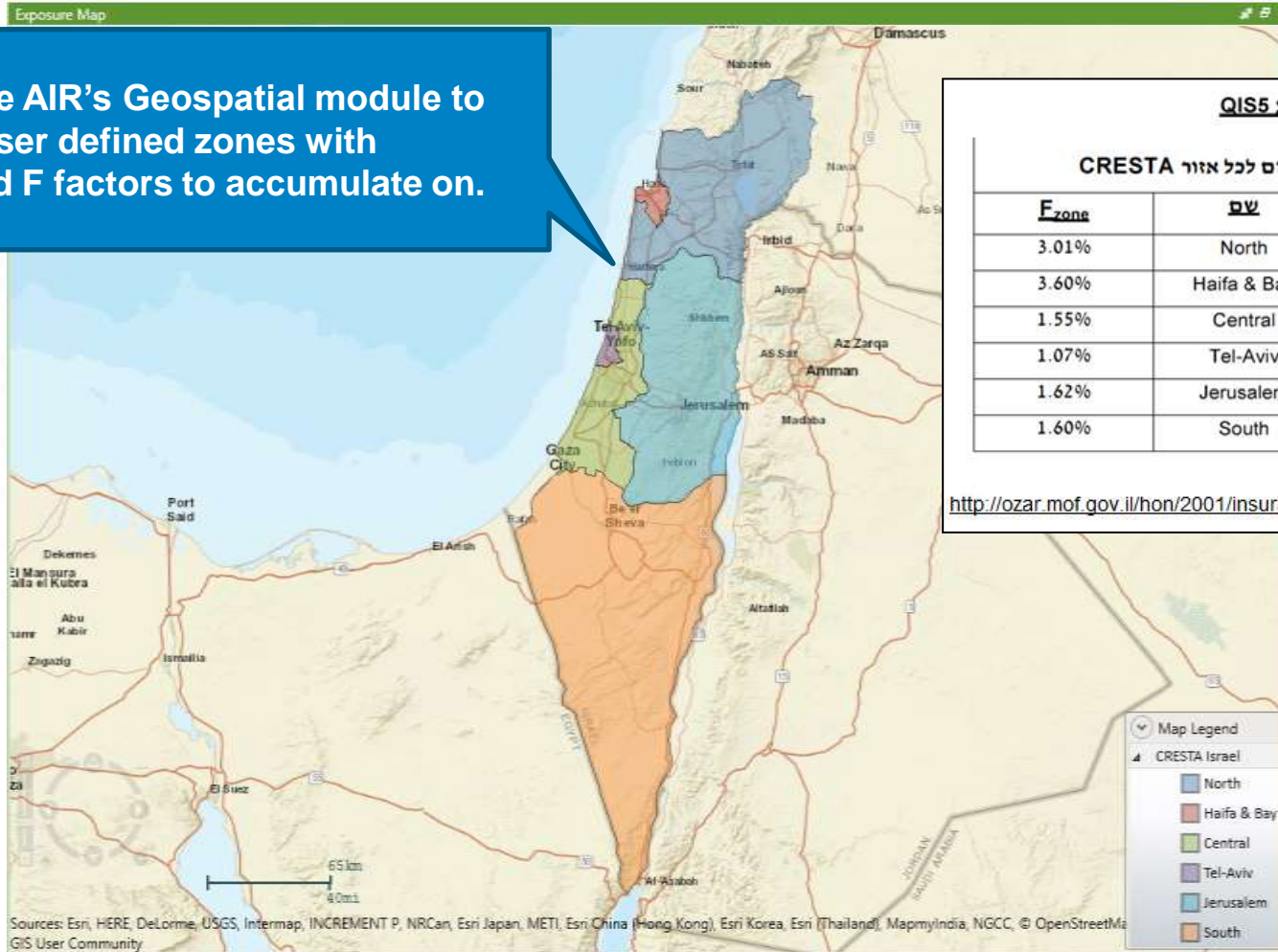
# View Exposure Characteristics





# Accumulate Exposure Based on F Zone Risk Factors

Leverage AIR's Geospatial module to create user defined zones with assigned F factors to accumulate on.



# Create Zones and Apply F Factors

- Custom zones can be used for accumulation – users can apply a damage ratio per zone:

**Zone Configurator**

Add New Zone From: Multiple

Add a zone definition from a list of administrative boundaries

**Filter Definition**

Country Code Is contained in IL

**Zones to Generate (6)**

- IL-North zone
- IL-Haifa and Haifa Bay
- IL-Central zone
- IL-Greater Tel Aviv
- IL-Jerusalem zone
- IL-South zone

**We can create zones for accumulation based on varying levels of resolution (country, area, subarea, postal, city, CRESTA)**

**Area Level Selector:**

Cresta Name

**Peril:**

Earthquake Shake

**Damage %**

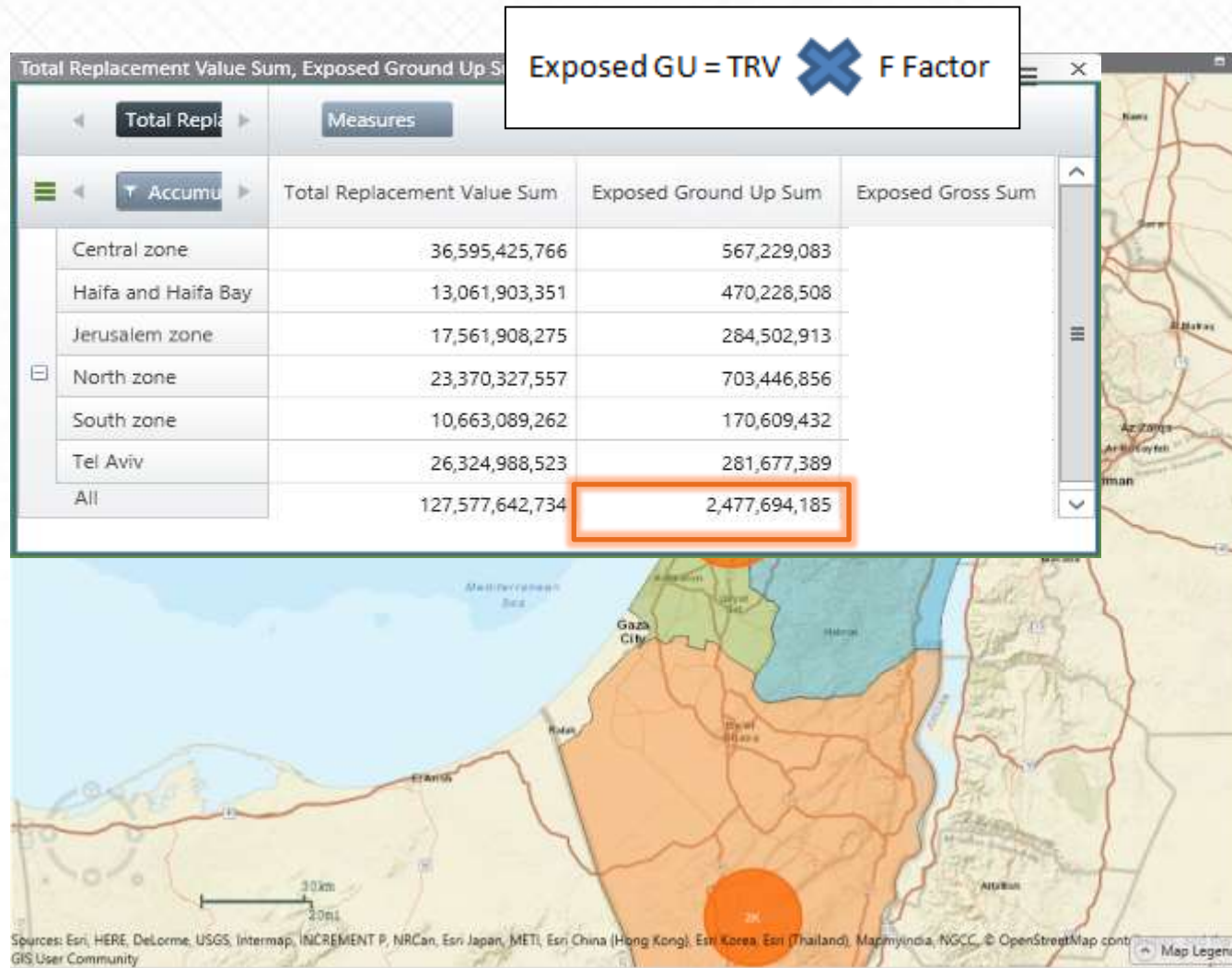
100.00

Append To List

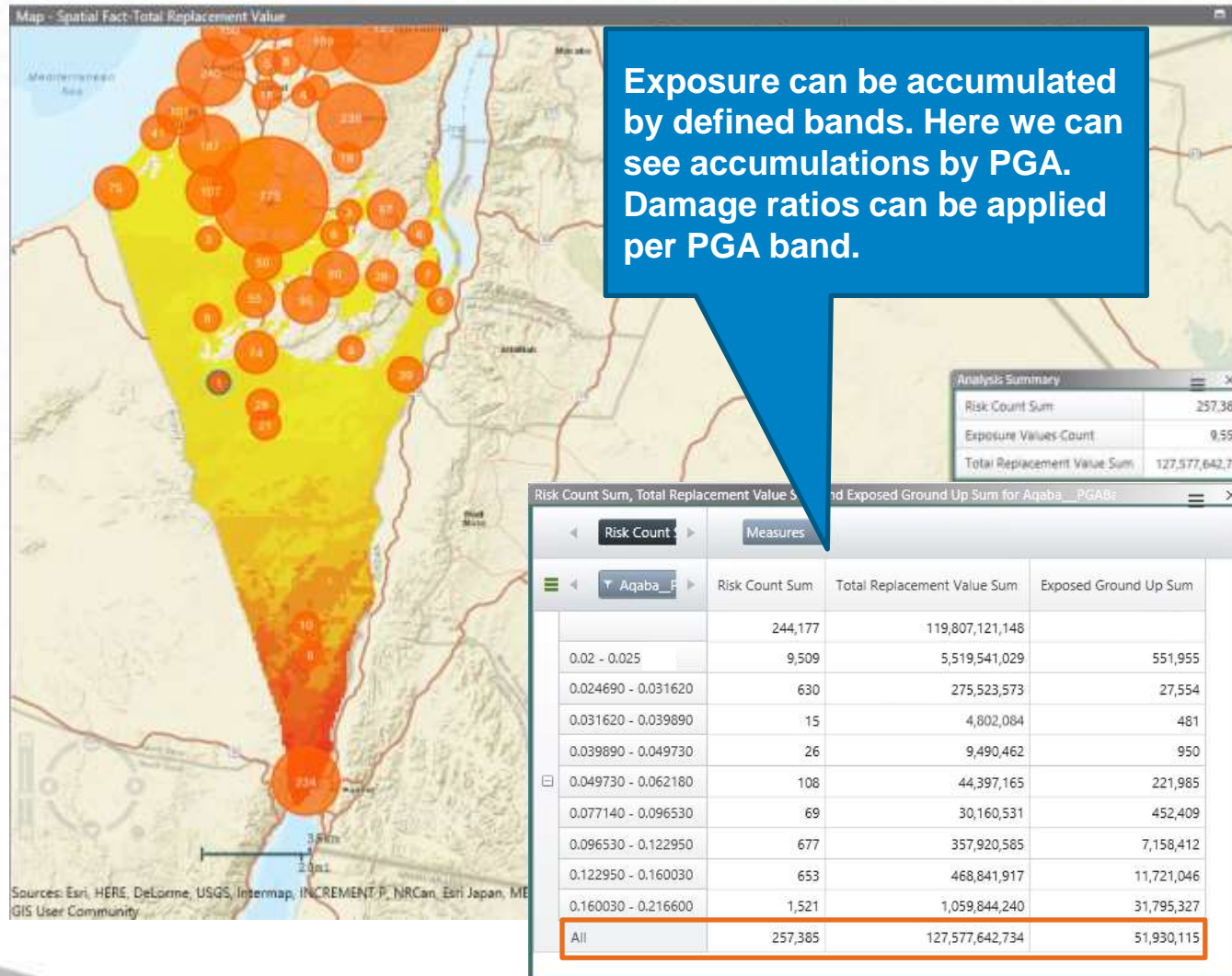
☒ Close on Add Zone Prefix:

6 Zones Add to Zone Set Cancel

# View Losses After the Application of F Factors and Financial Terms



# Accumulate and Apply Damage Ratios to Historical Events Such as Gulf of Aqaba 1995 Event



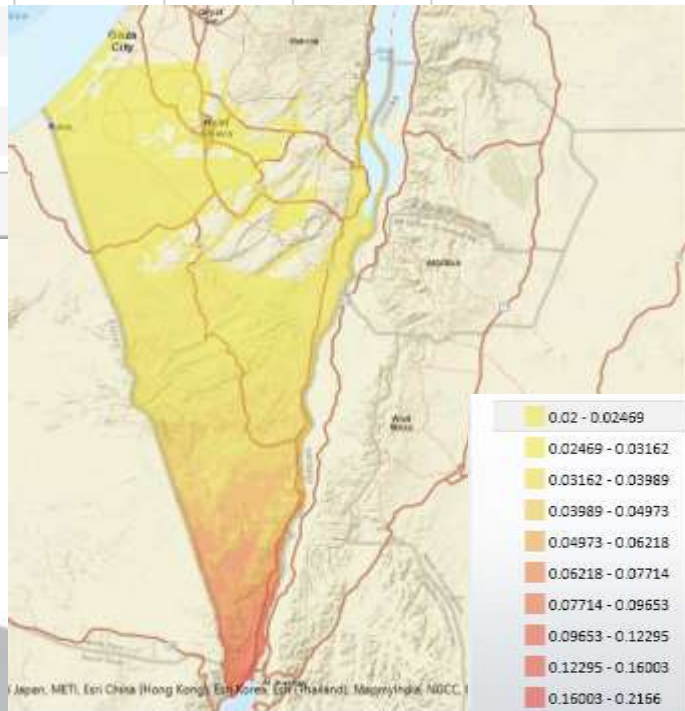


# Create Event Footprints Using AIR's Hazard Module for Both Accumulation and Model Validation

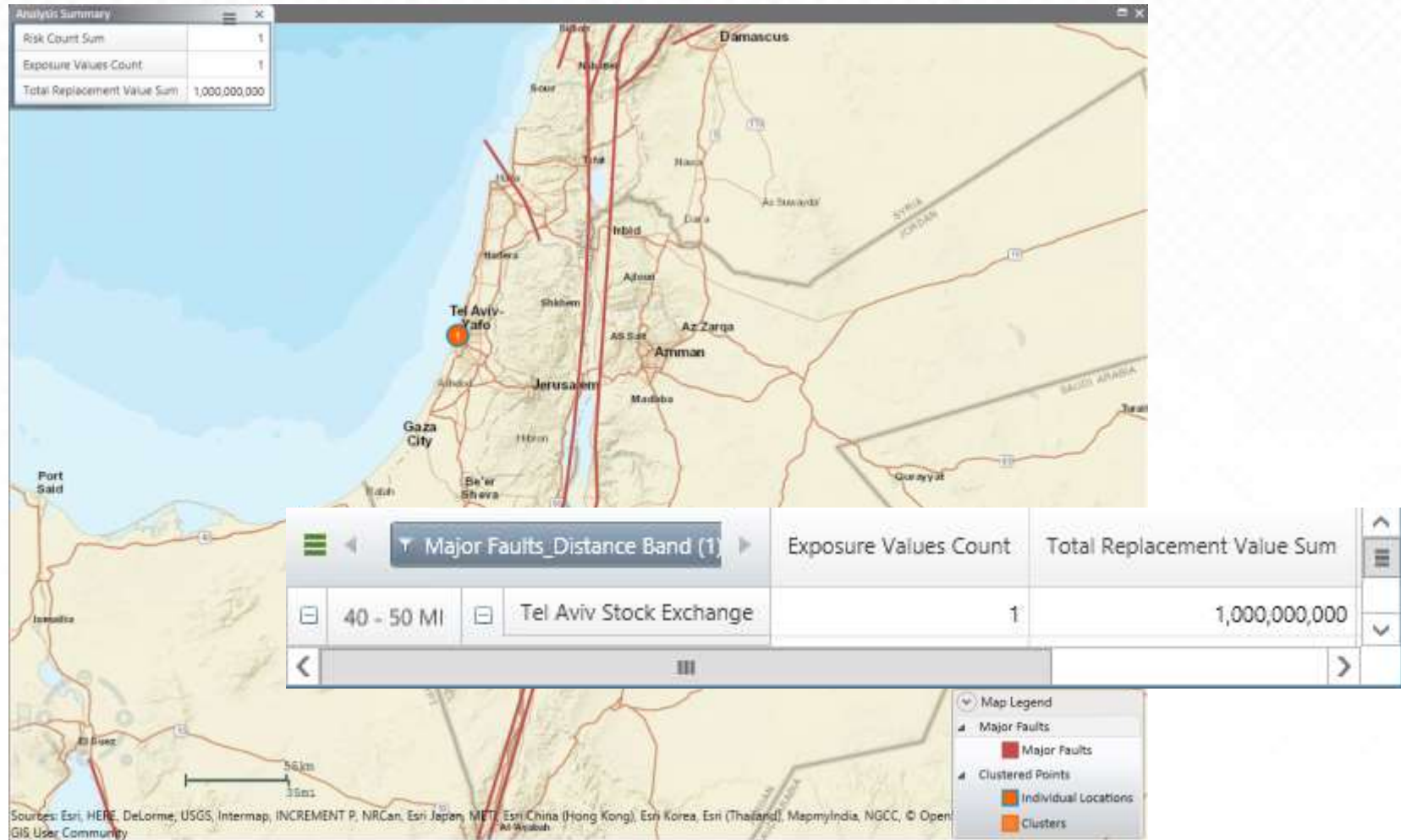
Hazard Results Intensity									
Event ID	Location ID	Latitude	Longitude	Earthquake					
				Peak Ground Acceleration (PGA)	Unit of PGA	Spectral Acceleration (SA) 0.3 s	Unit of SA 0.3 s	Spectra	
472126	6458	31.804165	35.162502	0.0584	G	0.14	G		
472126	6438	31.787498	35.162502	0.0593	G	0.14	G		
472126	6443	31.787498	35.162502	0.0593	G	0.14	G		
472126	6224	31.804165	35.137501	0.0583	G				
472126	6228	31.804165	35.137501	0.0583	G				
472126	6233	31.804165	35.137501	0.0583	G				
472126	6274	31.787498	35.145832	0.0593	G				
472126				0.0610	G				
472126				0.0610	G	0.14	G		
472126				0.0599	G	0.14	G		

First | Prev 1 2 3 4 5 ... Next | Last

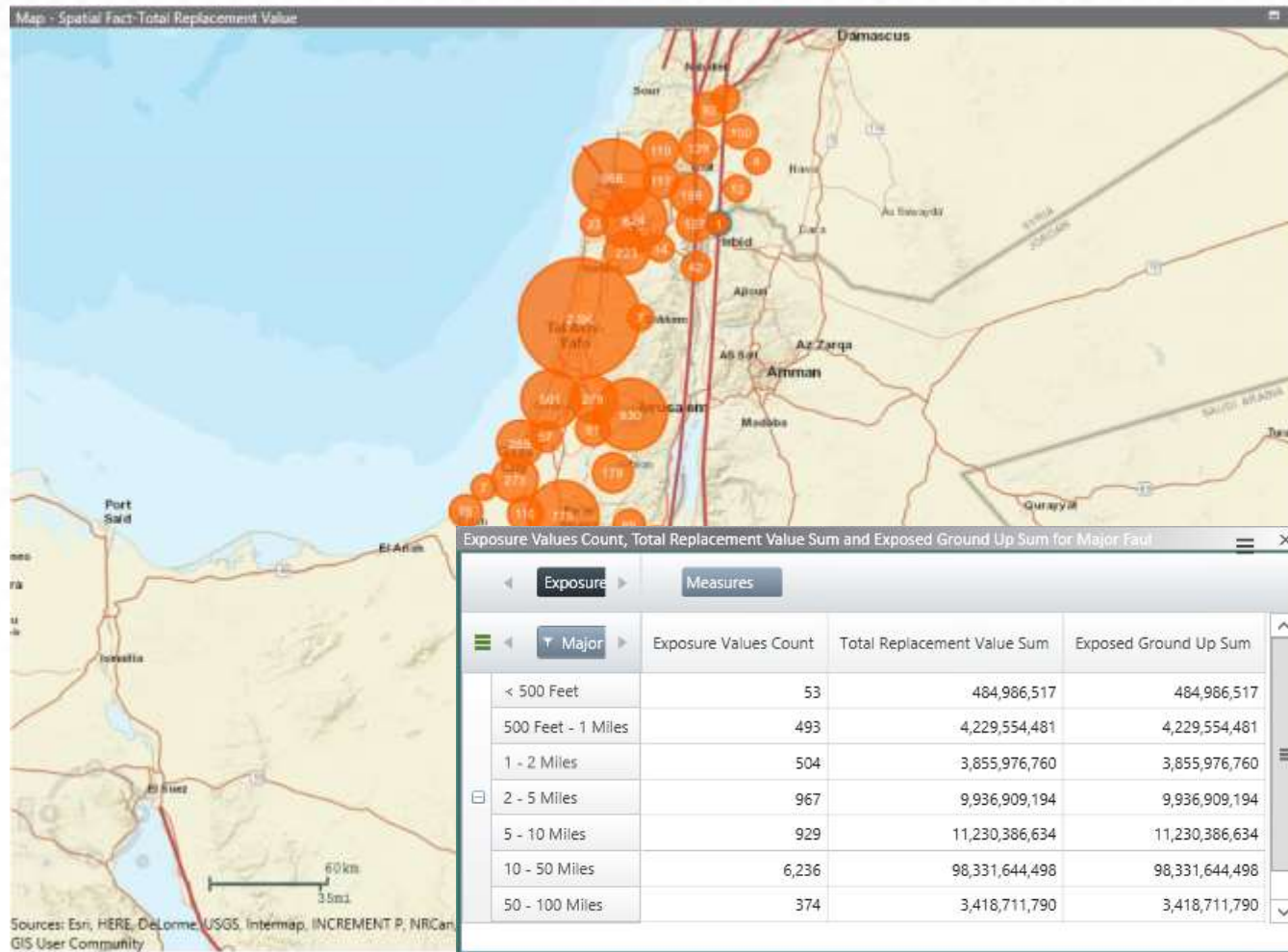
Leverage AIR's Hazard module to create your own event footprints based on location level intensities



# Evaluate Risks Based on Distance to Known Hazards



# Evaluate Your Portfolio Based on Distance to Known Hazards





# Loss Modification – Create Your Own View of Risk

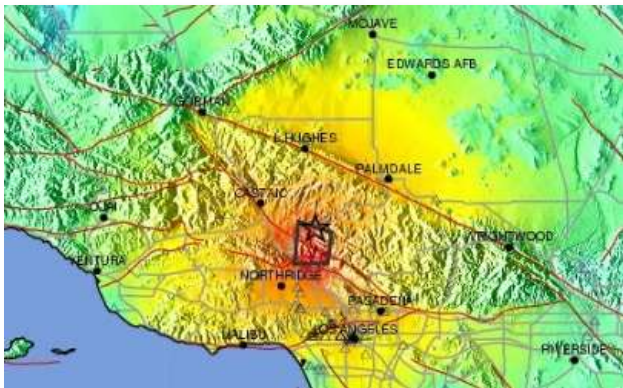
## Claims Experience



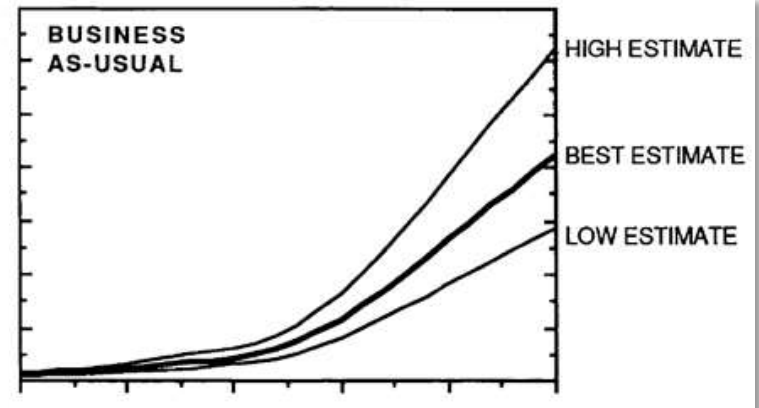
## Non-Modelled Losses



## New Scientific Findings



## Sensitivity Testing





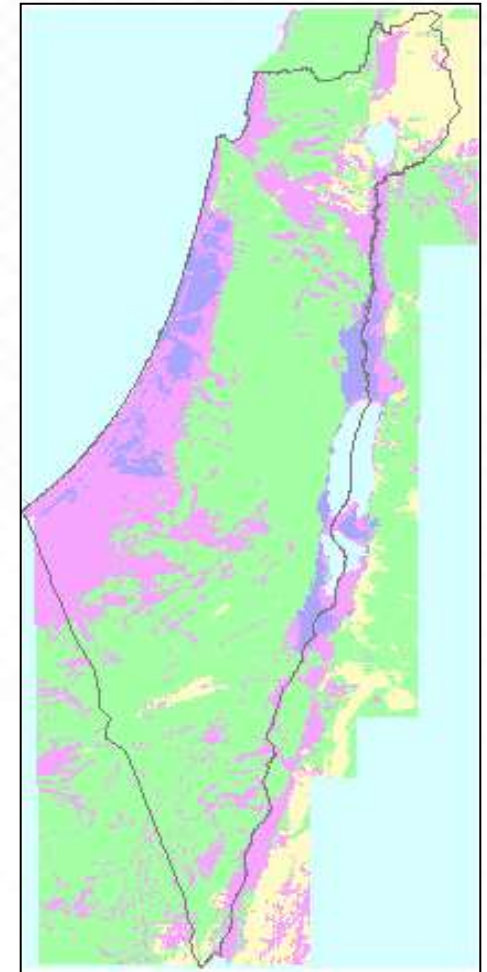
# Loss Modification – Account for Liquefaction in Your Earthquake Losses

- Perhaps we want to modify losses to include the risks from liquefaction
  - Apply a modification factor to areas susceptible to this risk:

▲ Europe  
▲ Israel  
Central zone (CRESTA)  
Greater Tel Aviv (CRESTA)

- Apply to events above a certain magnitude:

Parameter	Condition	Value 1
EQ Mw	>	6
EQ Depth(km)		
EQ Mw		



Hard Rock Firm to Hard Rock Soft to Firm Rock; Gravelly Soils Stiff Clay and Sandy Soils Soft Soils No Data

# Summary

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- AIR's Earthquake model for Israel has been built using the latest available science and explicitly accounts for time dependency
- All images were taken from AIR's software platform *Touchstone*® which allows users to:
  - Manage exposure
  - Accumulate and apply damage ratios to zones, events and hazards layers
  - Run stochastic models to evaluate risk
  - Modify losses to create your own views of risk