

A Catastrophe Risk Model for Managing Earthquake Risk in the Middle East

Many countries in the Middle East are exposed to seismic hazards. This gives a high potential for human and economic catastrophes. There have been devastating earthquakes in recent decades with significant economic, political and social consequences. These events highlight the importance of effective risk management initiatives in this region, and have created demand for model-based assessments of catastrophe risks exposures in the Middle East. CATRISK-MEQM is a first-hand effort to provide a full probabilistic earthquake loss across the Middle East and North Africa (MENA) region.

Model Components

Seismotectonic Source Model

We have studied the tectonic features, together with regional historical and instrumental earthquakes, to delineate seismic source zones and to determine seismicity parameters. We created tools using geological and tectonic maps of the Middle East, with seismic interpretation such as spatial distribution of earthquake epicentres, earthquake ruptures and seismic moment distribution. This allowed us to delineate seismic source areas, to study the completeness of the earthquake catalogue, to determine seismic activity, and to define recurrence parameters for each seismic source.

Synthetic Earthquake Scenarios

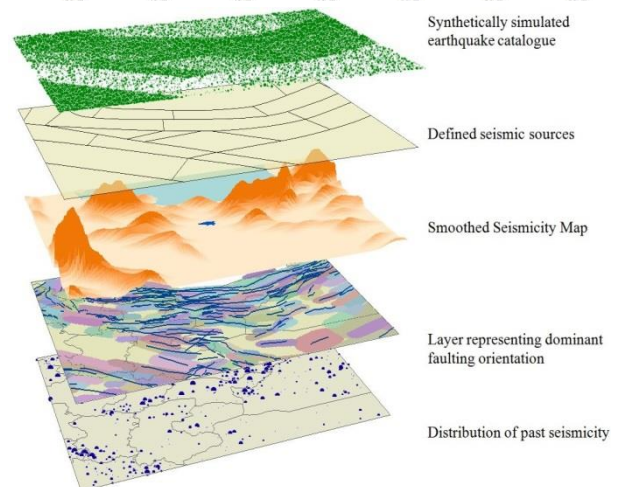
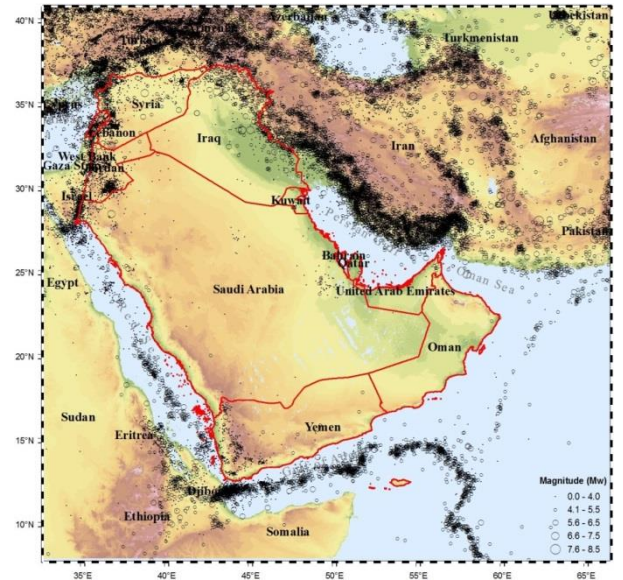
We have simulated a large number of synthetic earthquake scenarios using the seismic hazard model, modelling a fully probabilistic seismic loss distribution. We have compiled a synthetically simulated earthquake catalogue representing thousands year of possible future earthquakes for the study area, using characteristics of defined seismic source and their seismogenic parameters. The samples are representative the spatial, temporal and size distribution of possible future events. Each simulated earthquake acts like a real scenario, and we model its effect on a set of points in space to construct event by event hazard foot prints.

Ground Motion Simulation

We used Empirical Ground Motion Prediction Equations (EGMPE), known as *attenuation functions*, to model the distribution of spectral acceleration. A selection of the NGA (Next Generation Attenuation) functions are used to allow epistemic uncertainty to be modelled, while the aleatory uncertainty is taken into account by full numerical integration of a lognormal distribution for each relationship. Using total probability theory, we integrated the full ground motion distribution with the event temporal and spatial distributions to develop probabilistic seismic hazard maps. These are used by engineers for design purposes and urban planning policies.

Vulnerability Module

CATRISK-MEQM has a library of vulnerability functions, providing estimates of damage distribution by spectral acceleration, and for various types of risks are classified by Region, Risk Type, Coverage, Structural Material, Structural Height and Structural Quality. In addition to detailed vulnerability functions, default functions based on regional built environment are also provided for aggregate exposure with unknown vulnerability classes.



Hazard Model

- State-of-the-art scientific and engineering
- Fully probabilistic to incorporate uncertainties
- Regional model across the Middle East

Synthetic Eventset

- Synthetic event catalogue of 10,000 years
- 3-D fault modelling for each simulated event

Exposure Mapping

- By latitude and longitude
- By city, province or country
- Disaggregation into very fine set of points

Vulnerability Functions

- Vulnerability function to match exposure data
- Mapping system to link user exposure
- Incorporating damageability uncertainty

CATRISK-MEQM Features and Benefits

CATRISK-MEQM calculates an event by event (EBE) damage probability distribution for each imported risk. Imported risks are first mapped to their right vulnerability classes to assign vulnerability functions. Each risk is also linked to a location on the ground to read the pre-processed hazard distribution. In order to minimize the loss calculation run-time in CATRISK-MEQM, we have pre-processed the hazard calculation process, the most time-consuming part of the loss calculation module, and plugged the data into the Oasis damage calculation engine.

Exposure Handling

Exposure data quality in the Middle East varies from country to country. Insurance companies are often faced with aggregated data that contains little or no descriptions of the risk characteristics. CATRISK-MEQM provides tools and data models to import underwriting exposure and to distribute aggregated exposure to detailed locations and classes of vulnerabilities. To enable this, a hazard foot print has been developed on a set of points in space on a variable resolution grid (VRG) with clear mapping of various administrative levels such as CRESTA zones, provinces and cities. This provides flexibility for mapping exposure of various administrative levels, and allows further disaggregation of aggregated exposure for more accurate loss calculation.

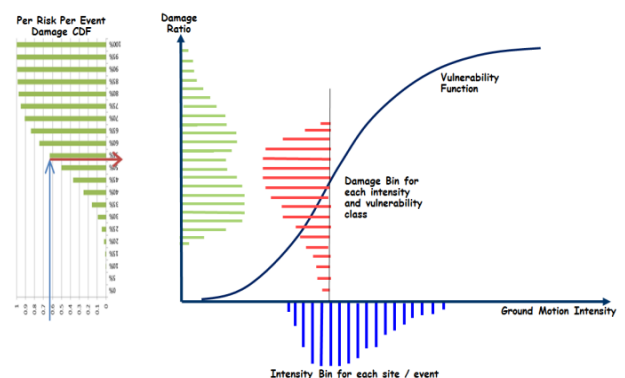
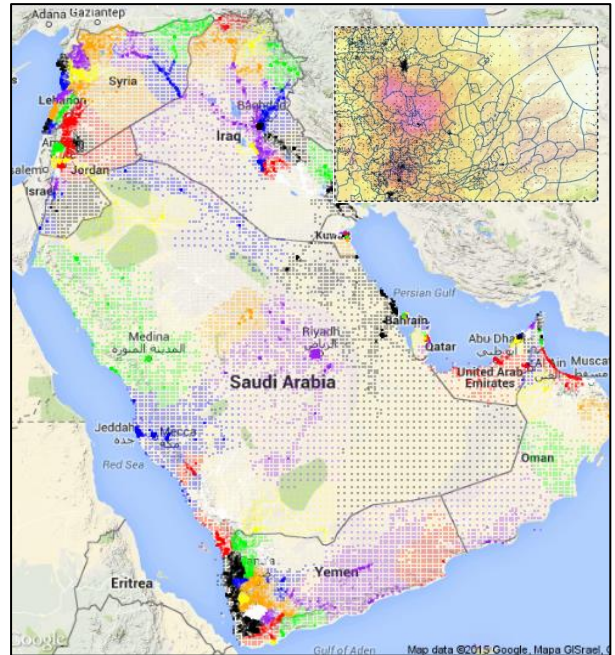
Handling Correlation

Aggregation of losses in CATRISK-MEQM is performed by Monte Carlo simulations across damage probability distributions for all risks in the portfolio. This provides the necessary framework to account for correlations between locations and coverages.

CATRISK-MEQM on the Oasis Platform

There are many sources of uncertainty associated with the hazard and vulnerability modules that contribute to modelled loss statistics. The current practice for loss modelling either ignores some of these uncertainties or, if they are incorporated, uses proxy statistical approaches. In CATRISK-MEQM the effect of every earthquake on individual risk is first represented by a hazard probability distribution, sampled in equally sized bins. Intensity measures, represented by each hazard bin, are combined with vulnerability functions to return a damage distribution. We perform a full numerical integration of hazard and damage distributions, resulting in event damage distributions. These distributions are sampled further using Monte Carlo simulations to allow the correct aggregation of loss at other levels.

CATRISK-MEQM with earthquake loss models for Bahrain, Iraq, Jordan, Lebanon, Kuwait, Oman, Syria, Saudi Arabia, Qatar, United Arab Emirates and Yemen are available for licensing now.



Analytics

- Fully integrated into the Oasis platform
- Available within CATRISK Analytical software

Financial Module Data

- Limits and deductibles of different types
- Shares of limits and multiple layers

Loss Results Handling

- EBE loss by location, risk type, policy and account
- EP curve, AAL and various loss statistics
- Tabular Losses by return period or probability

User Interface Platform

- Flamingo: a graphical user interface (GUI)
- Web-browser
- CATRISK platform
- No software needs to be installed

CATRisk® Solutions Ltd provides scientific and practical solutions towards reliable assessment of natural hazards and risks in the form of CatRisk models, consulting services and software applications. **CATRisk®** has developed natural catastrophe risk models for various parts of the world. Following the release of **CATRISK-MEQM**, **CATRisk®** is committed to develop and release earthquake model for certain countries in North and South Africa in 2016.