QUAKEIST® EARTHQUAKE SCENARIO SIMULATOR

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QuakeIST® is an integrated earthquake simulator, developed by IST (Instituto Superior Técnico, Universidade de Lisboa) and written in C++, oriented to risk calculations and damage propagations (DI (Ferreira et al., 2014)); and opens up new territory for earthquake science and engineering with the goal of reducing the potential for loss of life and property.

QuakeIST® risk software, using data stored in GIS environment, can handle different ground motion scenarios provided by the user and compute a number of output variables corresponding to the existing data under analysis.

To assess the consequences and impacts of earthquake scenarios, we not only need tools to predict the physical consequences to given "objects" in urban areas, but also assess the vulnerability and thus potential damage to the surrounding environment, infrastructure, and population.

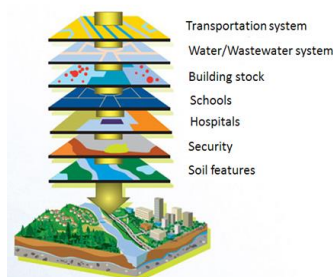Figure 1. Quake IST® city layers organized in a GIS environment

The calculator computes for each object the fraction of buildings in each damage state (QuakeIST® can also provide a damage distribution per building typology (amount of buildings in each damage state within the same building class) or the total damage distribution (sum of all the buildings in each damage state).

Example of models to calculate Building damages:
- Spectrum Capacity Model (ATC 40);
- Spectrum Capacity with Bilinear Capacity Spectrum (ATC 40);
- N2 (Peter Fajfar/ EC8 Method);
- Macroseismic Method (Giovinazzi and Lagomarsino, 2004).

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The UPStrat-MAFA Project (2012) used the QuakeIST® software in several countries (Italy, Portugal, Spain and Iceland) to generate and measure risk, quantify the impacts, and improve the capacity to define strategies to address adverse natural events. The locations under study were very important to calibrate several parameters of the model.

Below is a brief description of the key features of the QuakeIST® software:
- The simulator (QuakeIST®) can handle different ground motion scenarios provided by the user, referring the coordinates and ground motion values or other external scenarios obtained from SASHA, EXSIM, etc.
- The QuakeIST® contains well-known attenuation relationships that the user may select.
- The QuakeIST® loss model requires shaking intensity, PGA or PGV as an input parameter to some objects. PGA and/or PGV attenuation relationships as converting PGA and/or PGV into intensity (EMS) have been implemented. Soil information can be handled through EC8 soil classes.
- It uses a display platform geographical information system (GIS) to create maps and measure the possible impact caused by earthquakes in urban systems.
- Various vulnerability functions are included and users can upload their own vulnerability models or include new ones.
- Different types of assets can be modelled (buildings, schools, bridges, networks, population, etc.)
- QuakeIST® contains algorithms for propagation effects and impact assessment
- For a given asset typology can be plotted losses maps and maps illustrating the cascade effects.
- The Disruption index can be plotted, which is very important to share information to general public (people without a scientific background)

For what concerns validation or calibration (i.e. checking that the results match reality, and modifying them accordingly), such tests were performed with UPStrat-MAFA project, using real earthquakes (Lorca 2011; Faial 1998 and Iceland 1998).
The results provided by QuakeIST® identify important factors and systems contributing to main urban disruptions, providing plans and guidance for short-, medium-, and long-term investment projects to reduce risk.

REFERENCES

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UPStrat-MAFA (2012) Urban disaster prevention strategies using macroseismic fields and fault sources (UPStrat-MAFA-EU Project Num. 230301/2011/613486/SUB/A5), DG ECHO Unit A5.