5th European Congress on Regional Geoscientific Cartography and Information Systems

Barcelona, June 13-16/2006

Applications of GIS on defining Earthquake Scenarios cases in Portugal

by

C. S. Oliveira[1], M. A. Ferreira[1] and F. Mota de Sá[2]

1- Instituto Superior Técnico, Lisboa, Portugal (CSO – csoliv@civil.ist.utl.pt; MAF – monicaf@civil.ist.utl.pt)

2- Fuzzi, Engenharia de Sistemas e Decisão, Lda, Paço de Arcos, Portugal (FMS – info@fuzzi.pt)

In recent years GIS technology has been widely used within engineering application in defining earthquake scenarios for Portugal. Several examples were made in both the Continental Portugal and in the Azores. The first experiences were essentially directed to civil protection with the main objective of estimating the number of victims, deaths and injures and the homeless, so that the authorities and agents dealing with post-earthquake emergency preparedness be prepared for the possibility of a moderate to large earthquake. More recently these scenarios have been extended to other topics beyond the building stock and population, to estimate damages and impacts on networks, lifelines and also to economic direct, indirect and material consequences.

Lifeline impacts include, depending on the type, number of occurrences, repair effort and downtime. They also may consider event chain as most lifelines interact with other commodities such as triggering fire potential and lack of water for fighting fires and other consequential impacts. A holistic view is presently under way in order to consider all possible events and interactions, keeping a measure on their size.

Other implementations, also in a GIS framework, include planning an urban area in order to minimize losses and maximizing emergency efficiency, as well as to help setting policies for prior to earthquake interventions, such as rehabilitations, demolition, removal to other locations, etc.

The GIS framework is the perfect tool to help in post-disaster rapid evaluation of damage and to orientate authorities on how to manage the emergency. To accomplish all these features the GIS requires a great effort in storing all data in a database, which can be continuously upgraded to accommodate all changes that are being made constantly. In Portugal we have been working at different scales depend on the objective under way and type the available data. But the trend is to have most items at a scale where individual objects can be seen. This means that for regional studies we were able to go to the subsection Census track in which the study unit is the size of a block of houses, to individual houses when studies are made at the municipal level. The same applies to lifelines on which for regional studies only the main ducts, roads, etc., are accounted for whereas in the case of municipal studies most road systems, gas and water, etc., lines are considered.

For the housing part we use either the Census enquiry or the street, building-by-building enquiry. Nowadays, we start looking at aerial photographic to obtain the building plant layout and height of roof to obtain the volumetry (# of stories). Unfortunately, these new methods cannot identify the structural typology or the age, which are important parameters for the vulnerability analysis.

Models that are considered in the scenario simulator vary quite dramatically because in some cases only a few parameter either to define ground motion input or structural behaviour are used, whereas in other cases more sophisticated tools are developed. In either case a measure of uncertainty should be present knowing that the work at a regional scale always has to be taken as an indicative value of what can happen. In this respect there is a problem of agreement between the regional models and the detailed local models. As a good indicator, border problems should give matching results and the averaging out though the smaller units should add up to similar results as the larger units.

To illustrate these various details we present applications made in Lisbon and in the Azores. The first one presents a scenario model for the Council of Lisbon based on Census track at the subsection level. Models for propagation of seismic waves were simple as the problems would require and building typologies were just of a six types, based on their epoch of construction.

For the Azores, in the other hand analysis was very detailed, with enquires building by building. Models were a little more advanced, but not at all the most sophisticated ones. In here the most interested advanced consisted in determining the predominant frequencies of ground motion at bed-rock, the frequency of soil layers and of each building and setting the response by the interdependence of those three frequencies. Then the type of construction would be based on the EMS-98 scale with some adaptation to local characteristics.

- In both cases the Model would consider five essential modules:
    1) The ground motion definition at bedrock given the magnitude and epicentre distance and some source characteristics, such as rupture length and direction of rupture. Definition of landslide and liquefaction may be included.
    2) Model of site amplification, based on geotechnical ground description.
    3) Model of vulnerability including damage evaluation, which may include various approaches such as the ones referred above, or more sophisticated such as Hazus-98.
    4) Model of population dynamics – victims, injures and homeless
    5) Model of impact – economics, downtime, immaterial consequences, etc.

For lifelines modules 3, 4 and 5 may be different.