Geophysical Research Abstracts
Vol. 16, EGU2014-10787, 2014
EGU General Assembly 2014

Seismic hazard assessment and pattern recognition of earthquake prone areas in the Po Plain (Italy)

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A systematic and quantitative assessment, capable of providing first-order consistent information about the sites where large earthquakes may occur, is crucial for the knowledgeable seismic hazard evaluation. The methodology for the pattern recognition of areas prone to large earthquakes is based on the morphostructural zoning method (MSZ), which employs topographic data and present-day tectonic structures for the mapping of earthquake-controlling structures (i.e. the nodes formed around lineaments intersections) and does not require the knowledge about past seismicity. The nodes are assumed to be characterized by a uniform set of topographic, geologic, and geophysical parameters; on the basis of such parameters the pattern recognition algorithm defines a classification rule to discriminate seismogenic and non-seismogenic nodes. This methodology has been successfully applied since the early 1970s in a number of regions worldwide, including California, where it permitted the identification of areas that have been subsequently struck by strong events and that previously were not considered prone to strong earthquakes.

Recent studies on the Iberian Peninsula and the Rhone Valley, have demonstrated the applicability of MSZ to flat basins, with a relatively flat topography. In this study, the analysis is applied to the Po Plain (Northern Italy), an area characterized by a flat topography, to allow for the systematic identification of the nodes prone to earthquakes with magnitude larger or equal to M=5.0. The MSZ method differs from the standard morphostructural analysis where the term “lineament” is used to define the complex of alignments detectable on topographic maps or on satellite images. According to that definition the lineament is locally defined and the existence of the lineament does not depend on the surrounding areas. In MSZ, the primary element is the block - a relatively homogeneous area - while the lineament is a secondary element of the morphostructure.

The identified earthquake prone areas provide first-order systematic information that may significantly contribute to seismic hazard assessment in the Italian territory. The information about the possible location of strong earthquakes provided by the morphostructural analysis, in fact, can be naturally incorporated in the neo-deterministic procedure for seismic hazard assessment (NDSHA), so as to fill in possible gaps in known seismicity. Moreover, the space information about earthquake prone areas can be fruitfully combined with the space-time information provided by the quantitative analysis of the seismic flow, so as to identify the priority areas (with linear dimensions of few tens kilometers), where the probability of a strong earthquake is relatively high, for detailed local scale studies.

The new indications about the seismogenic potential obtained from this study, although less accurate than detailed fault studies, have the advantage of being independent on past seismicity information, since they rely on the systematic and quantitative analysis of the available geological and morphostructural data. Thus, this analysis appears particularly useful in areas where historical information is scarce; special attention should be paid to seismogenic nodes that are not related with known active faults or past earthquakes.