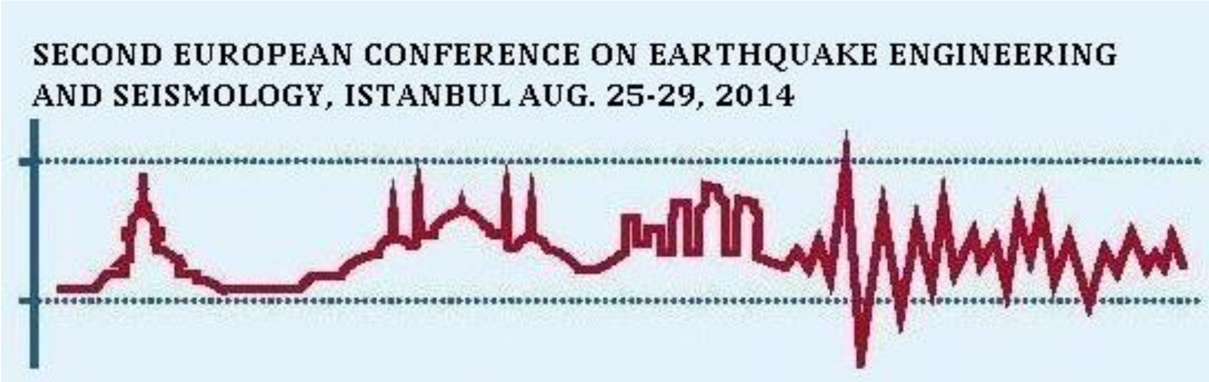

SYSTEMIC SEISMIC RISK ANALYSIS OF AN ELECTRIC POWER NETWORK, A ROAD NETWORK AND A HEALTH-CARE SYSTEM IN ITALY

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Within the SYNER-G validation studies, the applications to an electric power network (EPN), a road network (RDN) and a health-care system (HCS) in Italy are here presented. For each case study the following aspects are discussed: systemic vulnerability methodology, considered performance indicators, software implementation, general description of the site of interest, seismic hazard issues, system topology and characteristics, description of the input, results of the application. These applications allow to give a better insight into the developed methodology, to understand the main functions of the implemented software tool and to demonstrate the feasibility of a seismic vulnerability and risk analysis of infrastructures.

The power network of Sicily (Figure 1), one of the Italian major islands, is composed of 181 nodes and 220 transmission lines. The nodes, i.e. the buses, are subdivided into 175 demand or load nodes and six supply nodes, five of which are power plants and one is the balance node (or slack bus). The load nodes (two for transmission/distribution and one for distribution substations) deliver power to users. All transmission lines are overhead lines and not considered as vulnerable elements. They are classified into high (HV), medium (MV) and low voltage (LV) lines. The EPN is modelled as an undirected un-weighted graph. The total number of municipalities served by the network is 390.

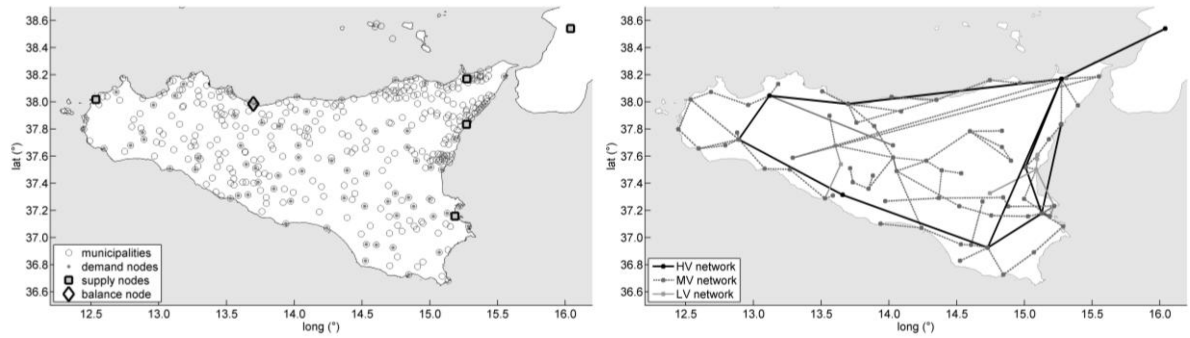

Figure 1. Position of municipalities and EPN nodes (left) and transmission lines, classified by voltage (right)

The road network of Calabria region (Figure 2), in Southern Italy, is composed of 2,861 nodes and 5,970 edges. The nodes are subdivided into 422 Traffic Analysis Zone (TAZ) centroids and simple intersections. Edges, that are the only vulnerable components in the network, are subdivided into road segments and bridges, with fragility models expressed in terms of permanent ground displacement (PGD) and peak ground acceleration (PGA), respectively. Edges are also classified as either main roads (principal roads or highways) or secondary roads, based on their free flow speed. Within the developed model the RDN is modeled as a directed graph and all edges have a travelling

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direction, from node *i* to node *j*. For this particular network, all edges are two-ways roads, effectively making the graph undirected. Finally, the graph is a weighted one, with weights being the free flow travel times of edges. Further available data include the location of ten public hospitals belonging to the regional health-care system, as well as of the landslide susceptible areas.

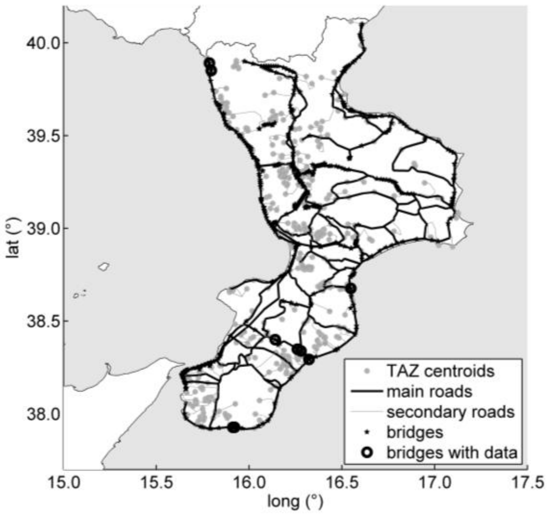

Figure 2. Road network topology

Concerning the application to a health-care system, a hypothetical region composed of towns, health-care facilities (or hospitals) and a road network has been considered (Figure 3). The distributed seismic hazard is given by five seismo-genetic area sources that can generate events affecting the region. The RDN connects 20 towns by highways with 32 bridges. A pure connectivity approach is employed, i.e. no traffic flows are computed in the damaged network. It is assumed that no other roads aside from the highways exist between cities and that the bridges are the only vulnerable components, whose earthquake-induced damage may cause paths to be disconnected. Two types of bridge are included in the road network: single-bent and two-bent overpasses. The towns centroids (TAZs) are taken as the RDN nodes. The HCS comprises five hospitals, whose fragility curves (expressed in terms of hospital treatment capacity, HTC) are relative to an existing RC hospital located in Lamezia Terme (Italy).

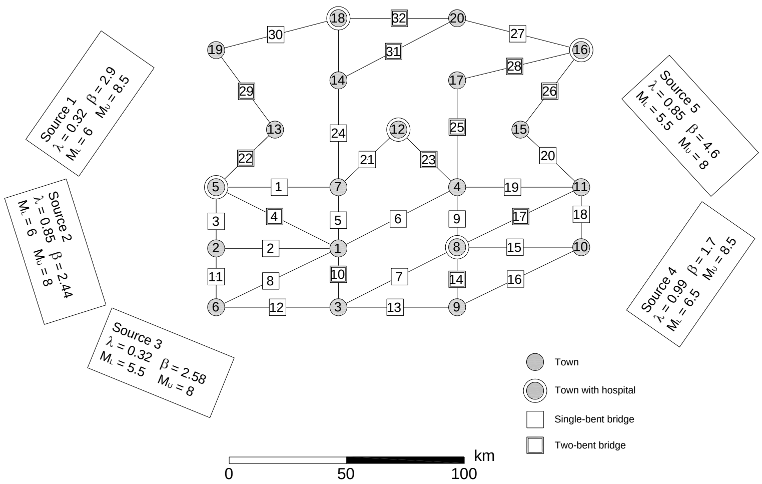

Figure 3. The hypothetical study area