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DEFINITION OF A UNIQUE MODEL FOR THE IMPROVEMENT OF THE MONITORING NETWORK AND SEISMIC RISK REDUCTION OF THE SCHOOL BUILDINGS IN ITALY

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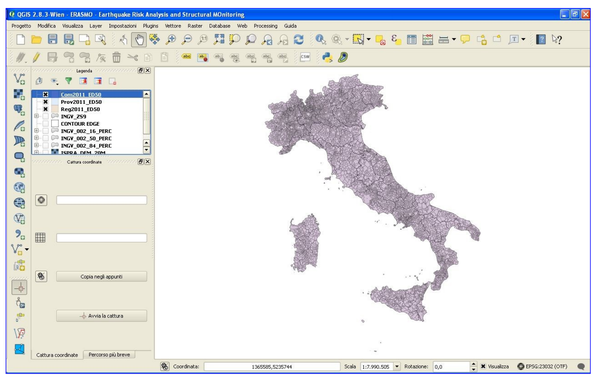
INTRODUCTION.

In the latest decade the safety of the Italian schools against seismic risk is a crucial subject for the Italian legislation as well as to the UN Convention on the DRR and the more specific priorities adopted even within the OECD.
Recently, the Italian Parliament approved a law (L98/2013) which launched the *Commissioning Safety of School Buildings Plan* and the *Definition of a Unique Mode*l, to be developed by the CGIAM, in order to improve monitoring network and seismic risk reduction (SRR).

The objectives of such a law deals with increasing in the knowledge of public actions aimed to improve the effectiveness of the SRR policy on school buildings.
The actions of the CGIAM will consist in the identification of a significant number of school buildings in Italy, mainly in terms of type of construction and material, on which calibrate specific synthetic parameters and test models.
Furthermore, the activities are addressed to quantitative evaluation of intervention efficacy, to set up simple systems of instrumental monitoring, even able to test the possibility of periodical checks of the state of general preservation.
The main issues carried on by the CGIAM mainly concern the completion and enrichment of the existing data base of school buildings, even through the collaboration of the Ministries and other relevant Italian research institutions, the evaluation of seismic hazard and site condition analysis as well as the definition of other seismic risk factors. Nevertheless a cost-benefit analysis as well as application and dissemination of such tools are proposed too.
At the same time, the CGIAM contributes to the definition of experimental installation and use of a *Simplified Accelerometric Monitoring Network* for school buildings comprehensive of testing phase on a limited number of structures.
The work proposes a synthetic overview of the employed methodologies as well as the first results arising from the research and implementation activities mainly concerning the development and implementation of the ERASMO (Earthquake Risk Analysis and Structural Monitoring) GIS platform for data mining and sorting.

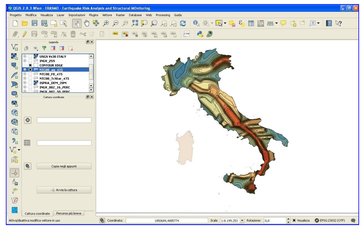
OPEN-DATA PLATFORM «ERASMO»

The first item of the project deals with the functional integration of the whole available open data in a GIS platform in order to define and characterize the seismic attributes of the national territory.
In such a view several informative layers have been developed like general system of capable faults (by ISPRA, "ITHACA - ITaly HAzard from CApable faults"), Seism-genetics features (by INGV, ZS9) and PGA and/or intensity (by INGV-DPC, NTC2008 D.M. 14.01.2008), as well as the preliminary assessment of local conditions based on the knowledge of the mean velocities of shear waves inside the first 30 m of ground, Vs30 (by USGS, United States Geological Survey - Global Vs30 Map Server) and geomorphology (by NASA-SRTM, National Aeronautics and Space Administration - Shuttle Radar Topography Mission).
The main phases are concerning the data mining focused on data recognition, sorting and cataloguing of different open–database in a GIS platform named "ERASMO - Earthquake Risk Analysis and Structural MOnitoring" ("Open Source", QGIS), addressed to characterize and analyse the seismicity of the territory extended to the whole national area for different return periods (PR) as well as annual exceeding frequency (FAS).

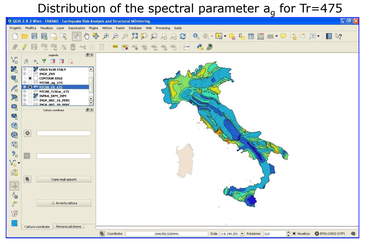


Spectral parameters for seismic strength of buildings

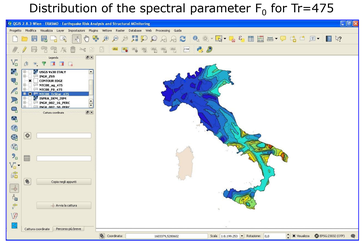
The spectral parameters for seismic hazard are defined in terms of maximum ground acceleration corresponding to the 10% exceeding probability in 50 years for rigid ground (Cat. A, Vs30>800 m/s). Such values have been determined along a grid generated overlapping two meshes with different size of 0.05 deg and 0.02 deg obtaining about 104565 counting points in which the 50th percentile "a_g" and the corresponding 16th and 84th percentiles for the uncertainty, are computed.



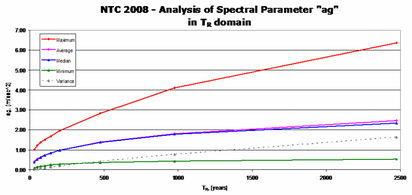
Distribution of the spectral parameter a_g for Tr=475

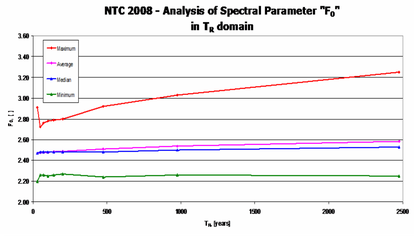


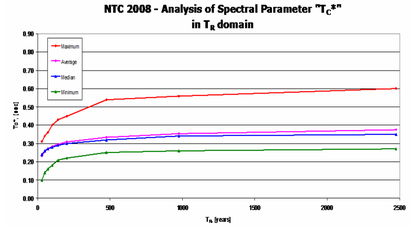
Distribution of the spectral parameter F_0 for Tr=475



Distribution of the spectral parameter T_c for Tr=475







Spectral reference parameters

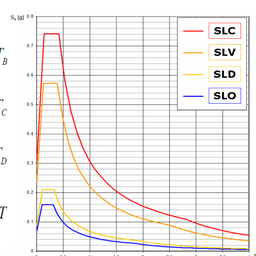
The Italian National Building Code (NTC 2008) reports the seismic strength in terms of the normalised spectral functions a_g, F_0 and T_c and the elastic spectral response for the horizontal acceleration components can be described through the following equation referred to the corresponding time domains:

$$S_e(T) = a_g \cdot S \cdot \eta \cdot F_0 \cdot \left[\frac{T}{T_B} + \frac{1}{\eta \cdot F_0} \cdot \left(1 - \frac{T}{T_B}\right)\right] \qquad 0 \le T < T_B$$

$$S_e(T) = a_g \cdot S \cdot \eta \cdot F_0 \qquad T_B \le T < T_C$$

$$S_e(T) = a_g \cdot S \cdot \eta \cdot F_0 \cdot \left(\frac{T_C}{T}\right) \qquad T_C \le T < T_D$$

$$S_e(T) = a_g \cdot S \cdot \eta \cdot F_0 \cdot \left(\frac{T_C \cdot T_D}{T^2}\right) \qquad T_D \le T$$

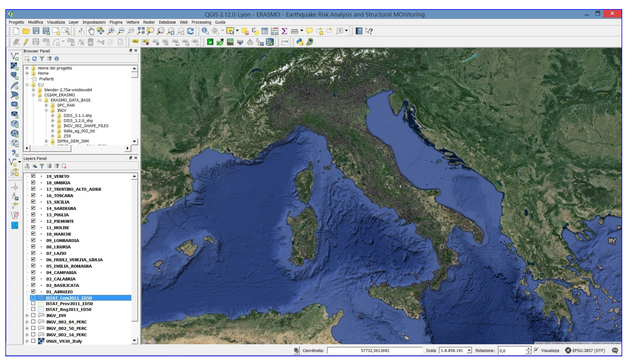


Italian National School building catalogue

In the last year 2015 the Italian Government proposes the Italian National School Buildings Catalogue "La buona scuola" as results of an extensive campaign of detailed data collection of the whole school buildings wealth consisting of about 42292 buildings.
The database has been developed in order to obtain a fruitful decision support system to plan and programme intervention for the school building reinforcement and improve structural and not structural efficiency. The catalogue might be used even to determine the intervention priority in order to provide a national intervention plan.
The criteria adopted during the data-mining focused on several main issues like type of construction, age of construction, facilities, architectural barrages, energetic consumptions and efficiency, etc. which allow us to define the minimum amount of economic resources to be invested in order to increase efficiency and security. In such a frame, several founding action have been started over addressed to structural investigation and diagnosis, innovation and a suitable model for structural monitoring network for seismic reduction which refers the present work.

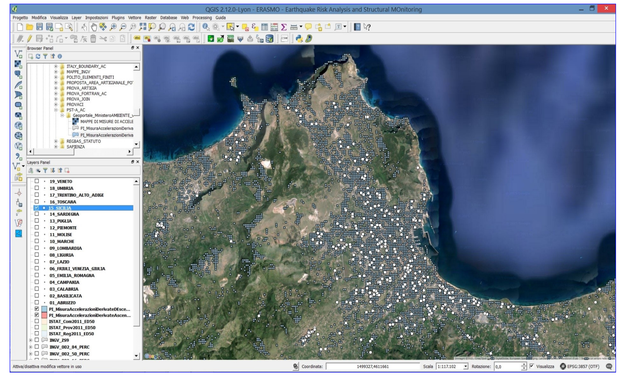
Regione	Nr edifici totali	Nr edifici attivi	Nr edifici non attivi	N edifici non attivi per calamità naturali
Abruzzo	1281	1102	176	3
Basilicata	710	544	166	
Calabria	1919	1742	177	
Campania	2423	2129	294	
Emilia Romagna	2675	2324	337	14
Friuli-Venezia G.	1012	1012		
Lazio	4345	2423	1922	
Liguria	878	845	33	
Lombardia	5964	5532	432	
Marche	1376	1299	77	
Molise	354	298	56	
Piemonte	3115	3112	3	
Puglia	2541	2486	55	
Sardegna	1941	326	1615	
Sicilia	4260	1680	2580	
Toscana	2594	2516	78	
Umbria	898	789	109	
Valle d'Aosta	154	148	6	
Veneto	3852	3518	334	
Totale	42292	33825	8450	17

Regional distribution of the total, active and not active catalogued school buildings

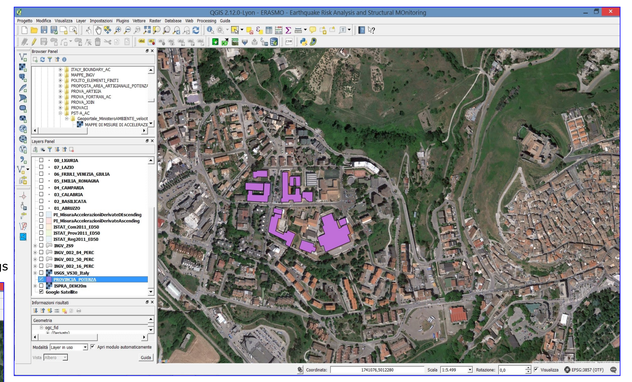


SAR analysis for building displacement assessments

In order to provide as detailed as possible the frame of information concerning the observed building displacement, mainly referring to the school infrastrucutres, a interferometric SAR analysis methodology has been proposed basing on the data available from the Remote Sensing Straordinay Plan (PST-A).
Satellite SAR data from ERS and ENVISAT catalogues have been analyzed and computed in order to derive the velocity mapping and, further, a preliminary measures of the derived acceleration.



Distribution of derived acceleration measures by ERS and ENVISAT data analysis



Particular of the derived acceleration measures distribution for a complex of school buildings

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