Perception on seismic risk: the importance of knowledge in landscape analysis for social awareness and resilience

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Abstract

The earthquake that hit the Po Plain from May to June 2012 has highlighted the lack of seismic hazard perception within the civil population of this area in northern Italy. This assumption represents a starting point driven to indentify effective strategies to empower the population towards local or regional hazards consciousness and territorial risk assessment.

Could deeper and widespread knowledge in earth sciences contribute for social seismic awareness? The earthquake experience has increase within the society the attention to landscape analysis and correlated territorial risks ? The spatial geographic information may reach throughout the visualization of uncertainty a differentiate and broader audience?

This paper explores the role of earth sciences knowledge as strategy to overcome the gap between professionals (scientists) and civilians in disaster and risks. The study outline how the citizen science perspective represent an alternative opportunity to better divulgate and even to capacitate the population on hazard territorial evaluations in order to achieve a safer human environment and collective resilient responses. The study focuses on the young generation communities of the Emilia Romagna region, for whom the earthquake experience has changed their understanding on seismic local hazard and risk and their seismic awareness during the last two years.

Keywords

2012 Emilia Earthquake, risk perception, knowledge, education, seismic awareness, resilience

Introduction

From the 20th of May 2012 during more than one month a seismic sequence impacted on a wide territory of the PO Plain within the provinces of Modena, Ferrara, Rovigo and Mantua. This area of northern Italy is economical well urbanized with specialized manufacturing production and intense agriculture.

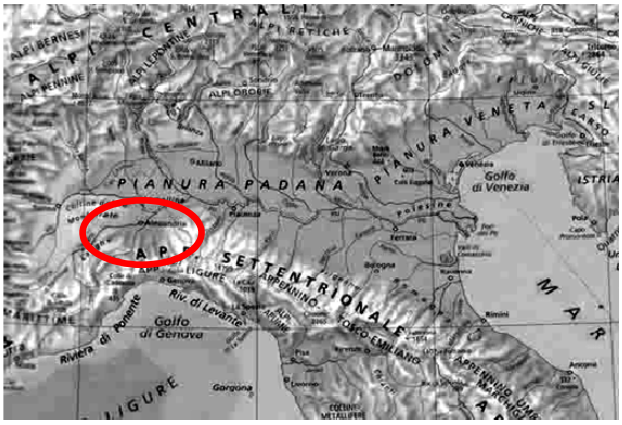

Fig.1 The Po Plain area affected by the 2012 seismic sequences

The main damage concerned historical buildings, masonry buildings, industrial structures, and cultural heritage of historical city centers. The paper introduces the geological characteristic and the tectonic setting of the Po Plain with a next general overview on the seismic sequence causes and dynamics. The comparison of data from macroseismic surveys and historical information on the main events that struck the area in the past has shown that the present sequence was the most violent in the last 500 years highlighting the possible criticality in this sector of the Italian territory seismic hazard assessment.

The article discusses the seismic risk and hazard perception of the population referred to this area of Italy, introducing moreover a comparison between the earthquake perception with others natural hazards. Perceptions of seismic risk across the region diverged from the reality that Emilia Romagna is

at serious risk from Italy's overall vulnerability to earthquakes. This contribution considers the important role of earth sciences knowledge and their communication to the civil population as fundamental approach to enhance the social risk awareness. Students from different high schools of the region are the representative target group of this study stating how the earthquake experience influence the young generation mindfulness on seismic risk and their skills on landscape analysis for local risks assessment.Students from high schools in the areas struck by the earthquake were interviewed trough a questionnaire detecting seismic hazard and risk awareness of young generations. The paper concludes with considerations on risk perception in order to rethink new conceptual paradigm of hazards communication and education.

Materials and Methods

1.a. Earthquake characteristics and geological setting.

Italy, and particularly the area of Central Apennines, is geologically active and is affected by most natural hazards (seismic, volcanic, landslides, floods, soil and coastal erosion). Concerning seismic risks, from past to recent earthquakes (Friuli, 1976; Irpina, 1980; UmbriaMarche, 1997; San Giuliano di Puglia, 2002; L'Aquila, 2009, Emilia, 2012), it is shown that the damages due to site effects could in some cases exceed the economic and social losses directly connected to the seismic shaking.(Miccadei et al.).

An overview on the tectonic setting is conceived fundamental to understand at large scale, the seismic activity of the central Mediterranean area. Most seismic activity is attributed to the Adriatic plate that is part of the African plate, moving towards North. Within the different points of view in literature Cuffaro et al. (2010) resumes that: "The northern Adriatic plate boundaries are deformed by the three belts,i.e., Apennines, Alps, and Dinarides.... Northeast Italy is usually interpreted as an area affected by N–S compression due to the African-Adriatic indenter. However, this comes from a misleading kinematic approach, where local stress field is assumed to be an indicator of plate motion. The stress field rotates along oblique plate margins, and the WNW-ward motion of the Adriatic plate relative to Europe can generate right-lateral transgression and consequent NW–SE to N–S compression along the

central-eastern Alps. Apart from local regional details, the main conclusions based on seismic reflection profiles and space geodesy data are that the three belts around the northern Adriatic plate are still converging and seismically active ...".

The geology of this area is characterized by compressional tectonics forming thrust belt type structures such as the Apennine chains The tectonic compression has produced asymmetric buried folds, and thrust and reverse faults verging north-northeast. The seismic sequence, caused by Apennine faulted folds, known as the "Ferrara Folds", was characterized by another five M L = 5 events, and more than 2500 aftershocks of lower magnitude during one year by the Italian National Institute of Geophysics and Volcanology (INGV). The two main shocks have induced almost the 80% of particular surface geological phenomenon also known as coseismic or environmental effects (USGS;2012b).

1.b. The social and economical records of the Emilia earthquake

The Emilia seismic sequence that struck northern Italy on May-June 2012 had important social, cultural, emotional and economical impacts. There were 17 victims, and it caused severe damage in many localities, especially to the historical centers and factories. The seismic sequence was characterized by two main shocks (May 20 and 29, 2012) with magnitudes slightly less than M L 6.0, five more shocks with M L >5.0, and about 2,500 located earthquakes. In the past a comparable earthquake occurred in Ferrara on 1570 (M W 5.4), it was characterized by complex seismic sequence that lasted for four years and caused severe damage in Ferrara and its surroundings. The major seismic shocks dated to the 20th and 29th of May 2012 have induced earthquake environmental effects EEE, Environmental effects, also defined as coseismic effects. This phenomena appeared both in the countryside and in urban area in forms of ground cracks, liquefaction, soil uplift or depression, changes in water levels. The following figures displays the sequence of shocks occurred during one year on the Po Plain, specifying the strongest quakes that have induced the superficial geological effects.

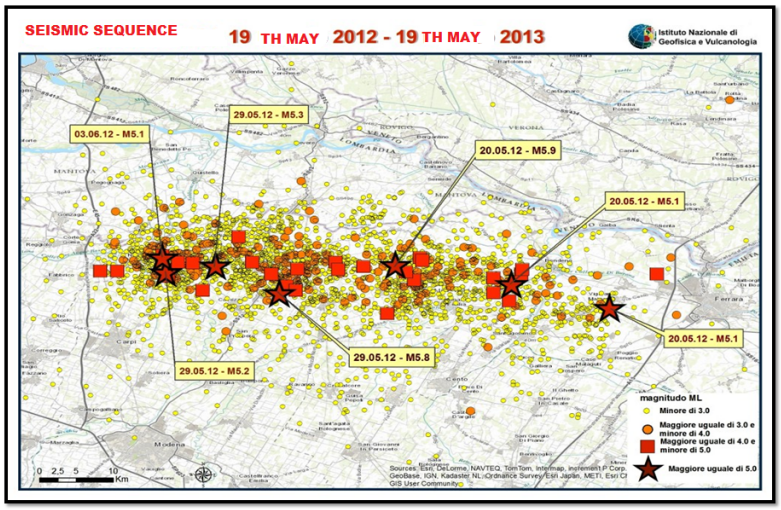

Fig.2. The Po Plain Seismic Sequence of 2012

The seismic sequence occurred on an area traditionally considered as characterized by low seismicity, where the population is or rather, was not very accustomed to earthquakes and where, unfortunately, the anti-seismic techniques were applied to a marginal portion of the housing. In fact, the area was included in the low seismic level category only in 2003 (OPCM 3274/03), but only in 2005 designing with anti-seismic techniques became mandatory. In the past, the area between Ferrara and Novi di Modena had already been affected by seismic events. Some of these were destructive, such as the 1570 earthquake, while others, though causing less damage, aroused deep feeling in the population; in both cases the events left their traces in the chronicles of the time.

The Emilia earthquake affected 58 municipalities, involved about 900,000 inhabitants, specifically within the area around the epicenter has interested 33 districts with 550,000 residents. This earthquake has caused 27 deaths, 400 injuries its damages have touched 270,000 workers in agriculture, industry and services over a territory that in 2012, only in the area of the crater, has produced 2% of GDP national.

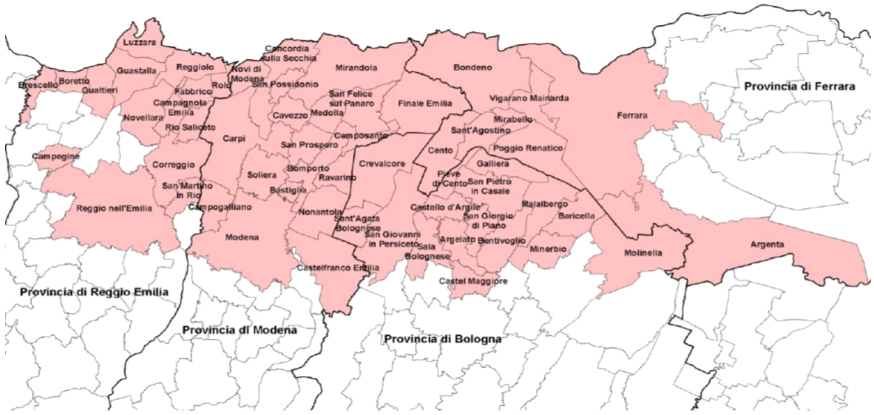

Fig.3 The municipalities hit by the 2012 earthquake in the Emilia Po Plain

The Center for Research on the Epidemiology of Disasters (CRED) and the Iinstitute of Health and Society (IRSS) refer that the Emilia earthquake is one of the first ten natural disasters with the highest economic losses of 2012 (almost $ 16 billion). After the initial emergency period (90days), the management of the reconstruction has leveraged on the involvement of citizens and local institutions, focusing on local participation as a key factor of efficiency, transparency and governance. The local autonomy role has been reflected in the creation of the " Institutional Committee for the reconstruction and the economic recovery"; the body was composed by provinces and municipalities and chaired by a special Commissioner appointed by the Government. In this section of the paper the data related to the reconstruction are synthesized in order to give a general overview of the damages and economical efforts put in place during the last two years. The damages assessment has estimated a total damage of 13 billion Euros, but the deposits and loans fund has allocated only 6 billion in 20 months from the earthquake, and in reality it have been assigned (but not paid) only 300 million euro. "Sisma.12" revels a feeble dialogue between the citizens and the policies makers during the reconstruction phases.

(http://www.regione.emilia-romagna.it)

1.c. Seismic hazard perception versus awareness

In the common belief the Po Plain has been always conceived as a static and homogeneous landscape where seismic signal should have been reduced by the alluvial soil deposits. The widespread wrong perception that the lower Po Plain is a low-seismic area is may be related to the fact that this part of Italy is classified as “low seismic hazard” (Alexander, 2002). In my opinion, the main cause of erroneous convictions deals with the deficiencies of knowledge on earth system sciences bringing weak landscape analysis competence among civil society. The lack of knowledge on seismic regional hazard should be related to the loss of historical memory referred to past earthquakes and the induced environmental effects have generated also misinterpretations about coseismic phenomena. Despite the generalized lack of awareness on seismic hazard in Emilia Romagna there was a commendable community resilient response in post disaster situation (both during the emergency and reconstruction period). Risk perception is subjective and socially constructed, induced by many cognitive, personal, situational and contextual factors became a central element for the hazard and risk assessment and management (Sjöberg, L., 2000). Experiences, knowledge, values, attitudes and feelings all affect the acceptability of risks, for this reason to understand the population's perception about hazards and risks, is necessary to take into account the interaction of different concerns: psychological, social, cultural. [8] A risk perception theory that offers an integrative, empirically valid approach is still missing; otherwise at international level among researchers the semantic method seems to be one of the most applied and shared approach (Crescimbene ed al; 2012). The complexity of risk perception analysis implies flexible methods of investigation in order to return measurable values besides qualitative evaluations. My research on risk perception investigates the level of seismic knowledge diffuses within the Emilia population. For the study I also opted, in part, for the semantic differential methodology trough the construction of a questionnaire structured in different part in order to assess the community awareness on seismic hazard, vulnerability, exposure etc.; introducing moreover comparison between seismic risk and other natural hazards (Osgood, C.E., et al., 1957). Beside

demographic parameters and informative data including: town of residence or level of education different questionnaires was constructed both for the general public and specifically for students. The seismic risk perception survey is still underway and it has been conducted online via web, using institutional sites of municipalities or in collaboration with educational institutions. This paper shows only the questionnaires have been addressed to the students of the regional high schools that until present involved 220 students. Questionnaire structure includes more 50 questions in differentiated formats: multiple choices, yes-no-may be and free open answers, closed ended, and semantic differential (to compare opposite adjectives or terms with five Liker's modified scale). In relation to the question about the geological causes of the Po Plain seismic sequence, student's answers evidence only broad knowledge about continental tectonic movements and express correlation between earthquakes and human extractives activities. In general students reveal superficial understanding and confusing ideas on seismic hazards despite the earthquake experience from 2012 has enhanced their attention and degree of awareness. Therefore, as stated also by De Marchi, the dissemination of scientific culture should be promoted to students and among the population taking into account not only technical criteria and scientific arguments, but also the cultural and traditional aspects of a given territory. The questionnaires responses confirm this assumption. 84% of the interviewed have affirmed that more knowledge in earth sciences should be helpful to enhance skills in the landscape analysis and for understanding natural hazards intrinsic the territories. The answers referring the degree of knowledge concerning the geological causes that have determined the 2012 seismic sequence show that the fifty percent of the students sample have no idea or are not sure about the attributable causes that induce the Emilia earthquake.

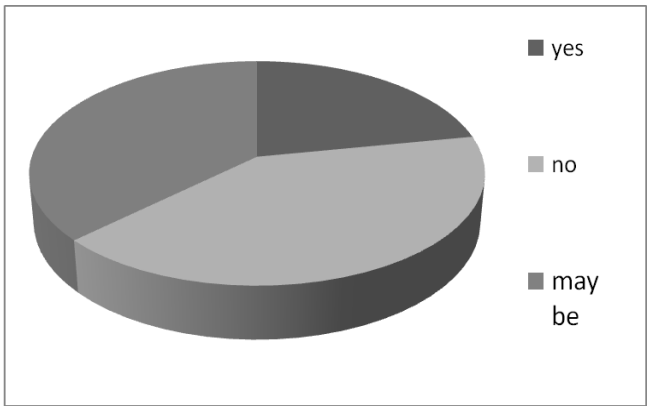

Fig. 2 Do you possessed the same knowledge about the geological causes related to the earthquake before the 2012.

Despite the feeble scientific understanding, the graphic in the above figure shows how the 2012 earthquake had been a noteworthy experience leading the population to enhance their knowledge and deepen the attention on hazards focusing more on the variables linking environment and risks.

Conclusion

Boroughs defines risk communication as a dialogue among interested parties: scientists, policymakers, and the affected general public. Risk need to be addressed regularly by means of of knowledge in order to provide information for any decision which needs to be taken by any party involved in the emergency, recovery and reconstruction. Knowledge of natural processes and their interaction with human activities provides the most effective tools and methods to prevent natural risks and ensure a safer human environment; this can only be achieved through complete multidisciplinary, multi-scale and multi-temporal studies. Aapplied earth sciences need to be considered as fundamental background giving to general public the interpretative key for the environmental hazard and risk comprehension at regional and local scale. With reference to natural hazards, the Utility of applied earth sciences deals for instance with the clarification of magnitude and frequency issues for emergency planning policy; the identification and zonation of hazardous areas for landuse planning,

explanation of some of the processes of geophysical hazards in terms that are useful for avoidance, search and-rescue and damage limitation. [14] The greater contribution of to the factual basis of hazard perception among non-scientists, enhancing their awareness and consequent develop or induce community response to natural disasters.

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