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From seismic alert to near real-time products: an overview of OGS research activities and operational services in northeastern Italy

Chiara Scaini[1], Valerio Poggi[2], Bojana Petrovic[3], Elisa Venturini[4], Paolo Comelli[5], Stefano Parolai[6]

[1] *Research fellow*, S*eismological Research Center, National Institute of Oceanography and Applied Geophysics - OGS, cscaini@inogs.it*
[2] *Researcher*, Seismological Research Center, National Institute of Oceanography and Applied Geophysics - OGS, *vpoggi@inogs.it*
[3] *Research fellow*, Seismological Research Center, National Institute of Oceanography and Applied Geophysics - OGS, *bpetrovic@inogs.it*
[4] *Research fellow*, Seismological Research Center, National Institute of Oceanography and Applied Geophysics - OGS, *eventurini@inogs.it*
[5] *Deputy-director of Seismological Research Center*, National Institute of Oceanography and Applied Geophysics - OGS, *pcomelli@inogs.it*
[6] *Director of Seismological Research Center*, National Institute of Oceanography and Applied Geophysics - OGS, *sparolai@inogs.it*

Abstract

OGS (National Institute of Oceanography and Applied Geophysics) manages a dense earthquake monitoring network in northeastern Italy created after the 1976 Friuli earthquake that caused nearly 1000 victims. When the Friuli earthquake occurred, there was only one station in the Friuli Venezia-Giulia region, in Trieste. After the earthquake, the Seismological Research Center was created in order to develop and manage the northeastern Italy seismic network and support the Regional Civil Protection (PCR) in case of emergency.

Key words: seismic damage assessment, early warning, applied seismology, civil protection, seismic monitoring, near real-time

OGS (National Institute of Oceanography and Applied Geophysics) manages a dense earthquake monitoring network in northeastern Italy created after the 1976 Friuli earthquake that caused nearly 1000 victims. When the Friuli earthquake occurred, there was only one station in the Friuli Venezia-Giulia region, in Trieste. After the earthquake, the Seismological Research Center was created in order to develop and manage the northeastern Italy seismic network and support the Regional Civil Protection (PCR) in case of emergency. Nowadays, the network (called SMINO - Sistema di Monitoraggio terrestre dell'Italia Nord Orientale, [1]) is constituted by 43 velocimeters (broad-band, short and mean period seismic stations), 83 strong motion stations, and 19 GNSS stations operating in real-time. Of the 83 accelerometers, 54 consist of low-cost accelerometric sensors installed on selected target buildings (Sentinella buildings), previously characterised through ambient vibration analysis. This activity was developed during past and ongoing projects (e.g. ARMONIA, [2]). Accelerometer sensors were installed at the base of the structures and in most of them at the top, allowing local estimates of ground motion to be refined and building response to be estimated in near real-time. Figure 1 shows the distribution of OGS velocimeters and accelerometers in northeastern Italy, including both the free-field sensors (triangles) and the sensors installed on target buildings (squares).

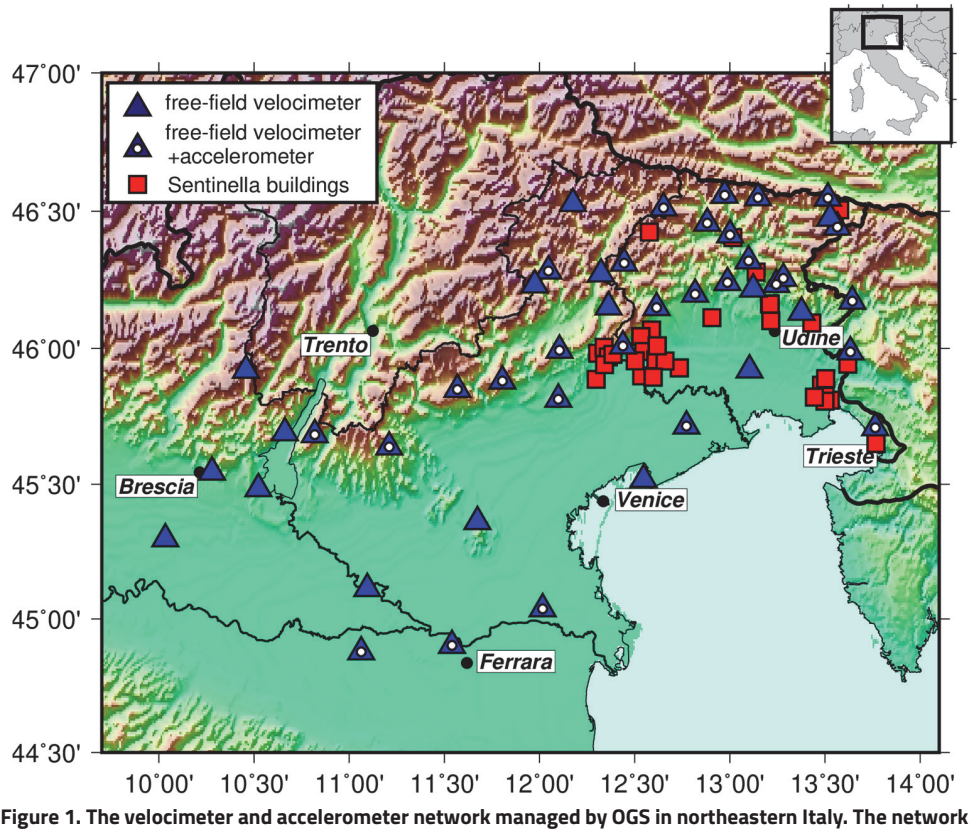

Figure 1. The velocimeter and accelerometer network managed by OGS in northeastern Italy. The network includes free-field sensors (triangles) and sensors installed in target buildings (squares)

The data collected by the low-cost sensors at the bottom and top of the instrumented buildings allow the development and testing of new procedures for assessing damages. Damage assessment of previously-characterized building typologies in the proximal area can be carried out using the recording at the bottom of a single building [3]. The recordings are thus used as input to compute the expected total displacement and interstory drift of the buildings modeled as SDOF oscillators. However, this approach requires the preliminary characterization of structural typologies and the evaluation of at least the fundamental resonance period, either extrapolated from simplified relations or from field measurements. The estimation of displacement has been tested on single buildings based on real weak motion recordings and in a pilot area based on synthetic seismograms related to an historical earthquake in the area [3].

This approach is complementary to the near real-time damage assessment currently produced at municipality scale [4], which is based on ground shaking maps, and on exposure and fragility models representative of most common building typologies in northeastern Italy. The current exposure dataset is derived from the last complete building census in Italy (2011) at municipality scale, while fragility curves have been selected from literature. The damage assessment calculation has been automated and integrated into the existing near real-time infrastructure of OGS [4]. The produced damage maps are shared with the PCR, that manage the post-event emergency operations in the Friuli Venezia Giulia region. Figure 2 shows an example of a damage map displayed on the Friuli Venezia-Giulia PCR interface, generated for training purposes. Such maps are intended for quick response and the model is subsequently complemented with damage information from the direct reports (e.g. vulnerability or post-event damage forms for buildings, [5]), collected by National Civil Protection, PCR and other associated institutions.

Future work is focused on developing specific fragility curves and/or simplified models for building typologies in Northeastern Italy. The integration of such data in the existing exposure database allows the automated application of the method described in [6] for all target areas in northeastern Italy. Finally, a Decentralized On-Site Earthquake Early Warning (DOSEEW) has been tested for northeastern Italy ([6]). The system is currently being tested in an industrial facility located in the area that suffered the consequences of the 1976 Friuli earthquake.

The near real-time methods presented here contribute to improving the response in the aftermath of seismic events in northeastern Italy. OGS intends to promote further cooperation with national and international institutions and share the methods developed and tested in northeastern Italy for their application in areas with similar needs.

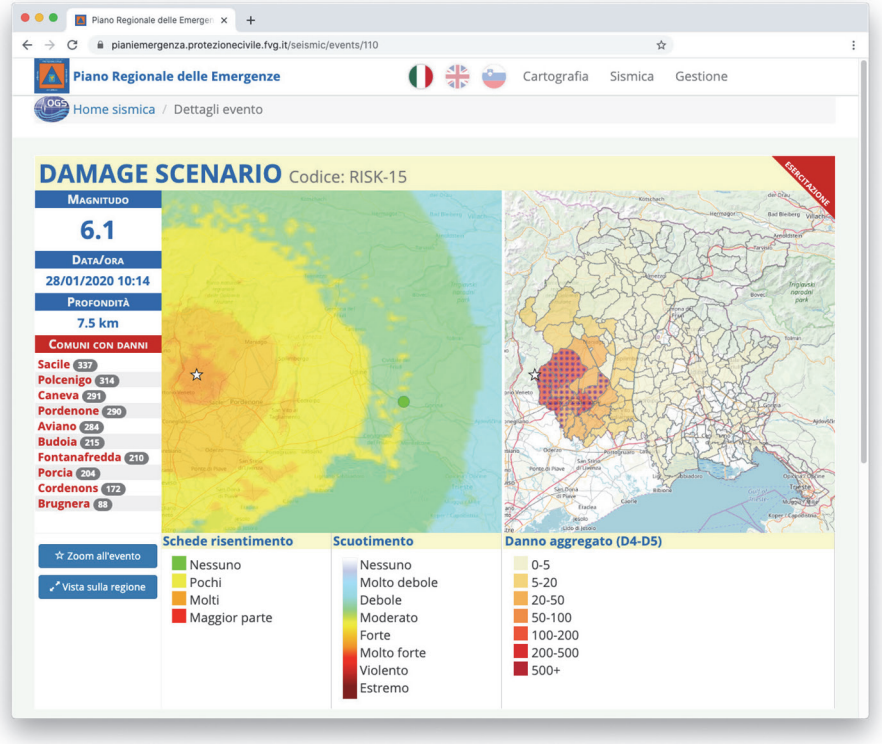

Figure 2. Screenshot of the near real-time damage assessment interface developed by the Friuli Venezia-Giulia civil protection. The damage map visualized in the interface has been produced for training purposes.

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