



## **Earth is speaking: listen her! On-line questionnaire about anomalous geological and biological phenomena**

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Earthquakes can be associated with non-seismic phenomena which may manifest many weeks before and after the main shock. These phenomena are characterized by ground fractures and soil liquefactions at surface often coupled with degassing events, chemical alterations of water and soils, changes in temperature and/or waters level in the epicentral area. Further manifestations include radio disturbances and light emissions. On the other hand, anomalous behavior of animals has been reported to occur before environmental changes.

The co-occurrence of several phenomena may be considered as a signal of subsurface changes, and their analysis may be used as possible forecast indicators for seismic events, landslides, damages in infrastructure (e.g., dam) and groundwaters contamination. In order to obtain an accurate statistical analysis of these factors, a pre-crisis large database over a prolonged period of time is a pre-requisite.

To this end, we elaborated a questionnaire for the population to pick up signs about anomalous phenomena like as: animal behavior, geological manifestations, effect on vegetation, degassing, changes on aquifers, wells and springs.

After the January 25, 2013, mainshock (ML 4.8) in the Garfagnana seismic district, the Bagni di Lucca Municipality was selected as pilot site for testing this questionnaire. The complexity, variety and extension of this territory (165 kmq) sound suitable for this project. Bagni di Lucca is located in the southern border of the Garfagnana seismogenic source, characterized by the carbonate Mesozoic sequences and the Tertiary terrigenous sedimentary deposits of the Tuscan Nappe.

The questionnaire was published on Bagni di Lucca web site

(<https://docs.google.com/file/d/0Bzw3vOYX47XoTGltTVJRbkJuajA/edit>) in collaboration with Municipal Committee, Local Civil Protection and Local Red Cross, and sent by ordinary mail to the citizenry. It is possible to answer to the questionnaire, also anonymously, direct on line ([https://docs.google.com/forms/d/1LVNVQFzMoJJfNxp2eSPAc4pcwj4\\_qIdbAnvbCWGyXy8/viewform?pli=1](https://docs.google.com/forms/d/1LVNVQFzMoJJfNxp2eSPAc4pcwj4_qIdbAnvbCWGyXy8/viewform?pli=1)), calling the Local Civil Protection or Local Red Cross, and by mail. In a second time, an application for Smartphone and Tablets will be developed to allow a faster reply.

The questionnaire, constituted by eleven questions and organized in four macro-themes (i.e. animal behavior, geological factors, vegetation anomalies and hydrogeological changes) has been published in June 2013 and will remain on-line for several years. Indeed, the social perception is not fully trustworthy during and soon after an earthquake. So far this is the first attempt to acquire data during quiescent times for comparison with post-seismic ones. This approach may provide clues to identify phenomena properly linked to the event.

This questionnaire can be a useful tool to educate population not only about earthquake precursors but also to recognize the "Earth language".

Submitted testimonies will be statistically analyzed evidencing the specific responses to the different phenomena in space and time. On the basis of obtained results the questionnaire project could be extended to national level.