



## Integrated study of geophysical and biological anomalies before earthquakes (seismic and non-seismic), in Austria and Indonesia

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Earthquakes are commonly seen as unpredictable. Even when scientists believe an earthquake is likely, it is still hard to understand the indications observed, as well as their theoretical and practical implications. There is some controversy surrounding the concept of using animals as a precursor of earthquakes. Nonetheless, several institutes at University of Natural Resources and Life Sciences, and Vienna University of Technology, both Vienna, Austria, and Syiah Kuala University, Banda Aceh, as well as Terramath Indonesia, Buleleng, both Indonesia, cooperate in a long-term project, funded by Red Bull Media House, Salzburg, Austria, which aims at getting some decisive step forward from anecdotal to scientific evidence of those interdependencies, and show their possible use in forecasting seismic hazard on a short-term basis.

Though no conclusive research has yet been published, an idea in this study is that even if animals do not respond to specific geophysical precursors and with enough notice to enable earthquake forecasting on that basis, they may at least enhance, in conjunction with other indications, the degree of certainty we can get of a prediction of an impending earthquake.

In Indonesia, indeed, before the great earthquakes of 2004 and 2005, ominous geophysical as well as biological phenomena occurred (but were realized as precursors only in retrospect). Numerous comparable stories can be told from other times and regions. Nearly 2000 perceptible earthquakes ( $> M3.5$ ) occur each year in Indonesia. Also, in 2007, the government has launched a program, focused on West Sumatra, for investigating earthquake precursors. Therefore, Indonesia is an excellent target area for a study concerning possible interconnections between geophysical and biological earthquake precursors. Geophysical and atmospheric measurements and behavioral observation of several animal species (elephant, domestic cattle, water buffalo, chicken, rat, catfish) are conducted in three areas of different geological and seismological character (Sabang and Simeulue, Sumatra, and Buleleng, Bali). Field studies, at the moment, are focused on Nias Island, Sumatra, Indonesia, and the Mur-Mürz-Transform Fault (Semmering area) in Austria. Next year it is planned to extend activities to Yogyakarta Province, Java, Indonesia. Geophysical factors selected for analysis include weather (the usual parameters), high-frequency magnetic variations, air ionization, soil gas emissions, and seismic and acoustic vibrations. Long-term measurements are needed to look for behavioral correlates of geophysical variations in general, in order to define "normal", before conclusive evidence can be presented in regard to "abnormal" precursory earthquake phenomena in particular.