**Interseismic deformation reveals precious information for earthquake forecasting: A proof of concept based on analog modelling and machine learning.**

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Subduction zones are complex dynamic systems hosting two of the most dangerous geo-hazards: mega-earthquakes and tsunamis. Despite the growing spatio-temporal density of geophysical observations at subduction zones, our understanding of the megathrust earthquake cycle continues to be limited by a series of factors. Among the others the short observation time compared to mega-earthquake recurrence and the partial spatial coverage of geodetic data. Here, I contribute to improving this understanding by simulating dozens of seismic cycles in a laboratory-scale analogue model of subduction. The model creates analog earthquakes of magnitude Mw 6.2–8.3, with a coefficient of variation in recurrence intervals of 0.5, similar to real subduction megathrusts. Using a digital image correlation technique, I measure coseismic and interseismic deformation with high accuracy (few tens of μm) and resolution (few mm). This is equivalent to having a very dense geodetic network homogeneously distributed over the whole margin, including the generally offshore seismogenic zone. I show that interseismic deformation reveals precious information for earthquake forecasting. The common procedure of analyzing slip-deficit is only partially useful for forecasting purposes. In fact, slip-deficit appears to be diagnostic of the location of highest slip but is poorly informative of the size of next event, even in the case of an ideally designed geodetic network. On the contrary, machine learning predicts well the timing and size of laboratory earthquakes by reconstructing and properly interpreting the spatiotemporally complex loading history of the system. I conclude showing future research paths for exporting this method to real subduction zones and demonstrating the contribute of this method for designing an efficient geodetic network, including the minimum space-time coverage requirements for imminence classification.

*During his PhD and the following two years post-doc (2008-2013) Fabio Corbi joined the research activities of the Laboratory of Experimental Tectonics (LET, Univ. Roma Tre), where he used well established techniques for investigating long-term subduction-related processes and developed a new apparatus for reproducing lab-scale megathrust earthquakes. In 2013-2015, Fabio Corbi moved to GFZ (Germany) joining the activities of the Physics of Earthquakes and Volcanoes section and focusing on volcano-tectonics. In 2016 – 2017 Fabio Corbi got funded by a Marie Curie fellowship (MSCA-IF) with Univ. Montpellier (France) as host institution, and seismic asperities interaction as main investigation topic. Then (2018-2019) he came back to Univ. Roma Tre with a strongly multi-methodological background involving a blended combination of analog, numerical and analytical skills for investigating megathrust earthquakes and volcano-tectonics processes for which he has been awarded the TS Division Outstanding Early Carrier Scientist Award by the European Geosciences Union. At present (2019-2021), Fabio Corbi is supported by another fellowship funded by the German Academic Exchange Service (DAAD) with Freie Univ. Berlin (Germany) as host institution and in cooperation with Univ. Roma Tre. He is currently working on machine learning methods for deciphering the geodetic signals associated to the seismic cycle.*