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Time-dependent seismic hazard assessment through a self-correcting point process for the slip

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Stochastic models describing the distribution of the earthquakes can be defined as probabilistic translations of physical conjectures and observations made on seismic events.

We propose a self-correcting-type model based on both the historical and geological data and the newly-developed geodetic measurements. The aim is to link an observed quantity per event, M_0, with an observed geological quantity, the slip rate $\dot{u}$ on a sufficiently large region.
The magnitude M_w of each event is converted into the seismic moment M_0 and then into the seismic slip (or displacement) u by the equations $M_0 = 10^{1.5\ M_w + 9.1}$ and $M_0 = \mu A\, u$, where μ is the shear modulus of the rocks and A is the area of the fault generating the earthquake. The obtained values allow us to define the function $S(t)$ of the displacement due to the events up to t.
Geodetic studies provide the fraction c of the total slip due to the aseismic slip a; if $\dot{u}$ and $\dot{a}$ denote the slip rate and the aseismic slip rate respectively, then $\dot{a} = c\dot{u}$.

We consider the discrepancy between the average displacement $\dot{u}t$ and the observed displacement $(\dot{a}t + S(t))$ in the time interval $(0, t]$:

$$D(t) = d_0 + \dot{u}t - (\dot{a}t + S(t)) \qquad ,$$

where d_0 represents the unknown initial discrepancy. We assume that the larger the discrepancy is, the proner the region is to earthquakes.
We propose a point process such that its conditional intensity is an increasing function of the discrepancy:

$$\lambda(t|\mathcal{H}_t) = exp\left\{\alpha + \beta\left[d_0 + \dot{u}\, t - (\dot{a}\, t + S(t))\right]\right\} \qquad .$$

We analyse the Database of Individual Seismogenic Sources (DISS). The principal purpose of DISS is to supply an integrated view of potentially damaging seismogenic process in Italy through a fault segmentation model of Italy based on the assumption that seismicity may be approximated by a finite number of potential seismogenic sources. DISS contains 74 seismogenic areas gathered in eight tectonically coherent regions, each of them is dominated by a well characterised geodynamic process, and contains the least possible number of faulting types, and a significant number of historical earthquakes.

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