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Hazard forecasting: is it a matter of time?

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Hazard models aim at making explicit our forecasting capability about future potentially adverse natural events. Hazard events are typically rare and not deterministically predictable, forcing hazard models to speak the language of certainty and uncertainty, that is, of probability. This is valid for any forecasting time window, from years to days/hours in the future (long- to short-term hazard), to the evaluation of the potential impact of an ongoing event in the next seconds/minutes/hours (warning/now-casting to urgent computing). Even though the definition of the target time window is driven by the users of the forecast (e.g. civil protections) and is not a scientific matter, the quantification of existing uncertainty given the time frame is certainly a scientific matter. Probabilistic hazard is commonly discussed mainly for long-term hazards, where large uncertainty dominates. In shorter-term forecasts, uncertainty may deacrease and practitioners are often tempted by simplified approaches that neglect uncertainty, like for eruption forecasting during volcanic crises, or for tsunami warning models after seismic or volcanic events. Nevertheless, uncertainty may still exist, and a rational scientific approach should let the results to speak about existing uncertainty, rather than to neglect it by definition. Is it possible to define a unified approach to probabilistic hazard entailing all time scales? The long-term integral hazard integrating all potential sources and generation/propagation conditions can be adapted to the different forecasting time windows, generating a unified framework in which the different time scales may feed to each other, producing homogeneous and easy-to-interpret results. This unified vision of hazard models, embracing long- to short-term hazard as well as warning and urgent computing models, is here discussed based on the recent advancements in models for volcanic, seismic and tsunami hazard and warning.