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# Raising a red flag: application of Bayesian statistics to surface subsidence issues

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There are situations where one has to produce an estimation of the probability that some event will occur, and when, in order to take timely measures. For many applications it is critical that the probability is quickly updated when measurements of a relevant variable from a monitoring system become available. In this contribution we present a general method to perform this task and show examples in the field of surface subsidence.

We assume that we possess an appropriate suite of model realizations of the system under scrutiny, in which the event may or may not turn up. These model realizations differ only with respect to the values of characteristic variables. In a Bayesian setting it is now possible to attribute a probability to the viability of each model by comparing actually measured and computed results. This probability "lives" in the universe of all model realizations. For each time step we can compute the probability that the event happens as the sum of the probabilities of each model realization multiplied by the probability that the event shows up in that model at that time step. The probability that the event will happen at all can be found by integrating this result over time.

In surface subsidence issues the event may be exceeding a subsidence maximum at a specific point (e.g. GPS station or benchmark location), or at any point in a specific area (e.g. location with the largest expected subsidence). Equally, it may be exceeding a certain subsidence rate over a specific time window at a point in space, or averaged over a specific area. The method also applies to situations in which the threshold subsidence (rate) varies in time. This may be relevant in the presence of autonomous subsidence or changing sea level.

The necessary work on modeling may be time consuming, but one comes up with event probabilities that have a serious scientific basis. They are far more reliable than subjective expert opinion or (necessarily) arbitrary extrapolation of measured data at any point in time.