

Title: Planning and Communicating Risk for Nonstationary Natural Hazards

By Laura Read

Abstract:

This work investigates the probabilistic behavior of the time to occurrence of natural hazards that exhibit nonstationarity through time with special attention to floods. Findings indicate that the underlying distribution of the return period exhibits a more complex shape than the exponential distribution under stationary conditions. In the second part of this research, we apply concepts and theory from the field of hazard function analysis (HFA) to understand how HFA can be used to characterize the probability distribution of the return period and the reliability – two primary metrics in hydrologic design. This is the first work to explicitly link the probabilistic properties of a flood series (X) with failure times (t) associated with a particular infrastructure design. This project investigates the suitability of HFA to characterize a wide class of nonstationary natural hazards whose partial duration series (PDS) magnitudes are assumed to follow the widely applied Generalized Pareto (GP) model. Such natural hazards might include: wind speeds, landslides, wildfires, precipitation, streamflow, sea levels, and earthquakes. The hazard function equations are derived for a natural hazard event series (X) whose PDS follows the 2-parameter GP distribution. The derived model and HFA are used to compute reliabilities and average return periods associated with nonstationary behavior of the original hazard series. These generalized results for a wide class of natural hazards are consistent with the results for floods: nonstationarity adds complexity to computation of traditional design metrics and changes the shape of the probability distribution of the return period. General implications for planning and design of nonstationary natural hazards are discussed.