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Objectively Detecting Streamflow Response to Megathrust Earthquakes

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Numerous observations demonstrate that river discharge can change during seismic ground shaking caused by earthquakes. Many studies have used stream-gauge data to report distinct co-seismic peaks or drops in river flow, although little guidance is available to how objectively identify these changes in time series. To this end, we review the available R packages for detecting change points in time series. We offer an alternative by adapting an analytical Bayesian approach for finding a single change point in raw daily discharge time series from some 250 Chilean gauging stations covering the timing of several historic megathrust earthquakes. We show that our approach produces high (>0.95) posterior probabilities of credible discharge changes coinciding with the earthquake dates, and exclusively at stations close to the rupture zone. We also show that this spatial pattern of credible river response is consistent with empirical observations and theoretical considerations, and capable of masking out local effects of storm runoff. We discuss the constraints of our approach in terms of finding an optimal search interval or pre-processing the input data; compare it to other, more sophisticated techniques; and highlight the scope of simple and reproducible change-point detection methods for other common tasks in the geosciences.