Regional Earthflow Activity and Seasonal Downslope Kinematics Constrained by InSAR: Examples From California and New Zealand

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We present InSAR results showing several slow-moving earthflow complexes at three sites in California and New Zealand. At the Palos Verdes Peninsula in Southern California, we resolve the seasonal displacement of the Portuguese Bend landslide, a block-glide landslide with a well-documented seasonal response. During the summer, conventional InSAR methods are sufficient to infer a downslope displacement rate of 1.0 ± 0.3 m/yr and map the spatial extent of the slide using ERS data. In the winter, the slide accelerates beyond the feasible range of InSAR, requiring us to explore unconventional approaches. By mapping the decorrelated phase of the ERS interferograms during the winter months over 5 years, we find that the slide accelerates and expands in a systematic spatial pattern with downslope rates greater than 2.5 m/yr. This acceleration lags the onset of winter rainfall by ~1 month. Using existing analytic models of pore pressure induced sliding and knowledge of the rainfall record, we constrain the diffusivity of the Portuguese Bend landslide to be ~2x10^(-6) m^2/s. In Northern California, we have processed SAR data from the ALOS satellite to image the active slides in the Eel River basin. Although the ALOS data span a shorter period of time than other satellites, these data provide an unprecedented snapshot of the active slides across the California coast range. The longer wavelength for the ALOS satellite (which operates in the L-band) provides greater phase coherence in vegetated regions at the cost of increased phase noise compared to C-band data. Currently, four slides along the Eel River are well resolved in a stack of over 20 differential interferograms that span February 2007 to February 2008. Deformation closely matches the topographic boundaries of the active slides as inferred from high resolution LiDAR. For the Boulder Creek earthflow, spatial variations in sliding rate reveal the source, transport, and toe regions of the slide complex. We find that a downslope rate of 0.3 m/yr is required to explain the line-of-sight observations over most of the earthflow during the spring through fall season. However, velocities as high as 1.2 m/yr are observed in the fastest moving regions. The downslope rates are used to constrain the flux rate of sediment into the Eel river system and suggest a minimum denudation rate of 1.6±0.5 mm/yr in the catchment. To accommodate the fast-moving transport region of the earthflow which is located upslope, we propose that an extensive gully network allows for much of this material to exit directly into the Eel river and circumnavigate the slow moving toe. We also present new results for landslide activity in the Waipaoa basin, New Zealand. Preliminary ALOS interferograms indicate several localized slope failures along the Mangatua River. Our results from California and New Zealand demonstrate the potential for InSAR to resolve active slope failures over an entire drainage basin and constrain regional sediment production rates from earthflows.