

## ***Interactive comment on “New developments in ambient noise analysis to characterise the seismic response of landslide prone slopes” by V. Del Gaudio et al.***

### **Anonymous Referee #2**

Received and published: 19 April 2013

This paper describes results from a field investigation to identify seismic directivity in a mountainous area prone to landslides using seismic noise analysis techniques. The authors find that despite limitations and ambiguity related to the seasonal variation in groundwater conditions, that a horizontal/vertical noise spectral ratio can be used identify directivity. However, directivity at one landslide site was parallel with landslide motion, directivity was roughly orthogonal to landslide motion. This result is apparently consistent with work in press by same group on landslides initiated by the 1999 Ch-Chi earthquake in Taiwan.

I cannot address the technical details of the seismic noise analysis, but from a general-

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ist perspective, the paper appears sound and is suitable for publication after moderate revision.

The main contributions of the paper are the documentation of the analysis methods and the data collected. Few site characterizations are reported in complex topography and this paper provides a case example where seismically induced landslides are known to have occurred. Although the results are negative with respect to understanding the directivity affects on existing landslides (i.e. directivity obtained from seismic noise analysis does not correlate with the orientation of landslide motion) documenting this result is significant enough to warrant publication. Some additional discussion of the implications of this finding for seismic slope stability analysis would amplify the the link to hazard assessment.

The paper is well written and the figures are of generally high quality although the print version of the 3-D histograms are too small. The first part of the paper could be more concise. Parts of the Introduction, Measurements, and Data Processing sections are heavy with jargon and acronyms that are opaque to the non-specialist. The description of the study area would benefit from a subheading under "Measurements". Finally, additional discussion of the effects of groundwater on the CAR2 site are needed to support the notion that groundwater is the cause of variability in the seismic results. Apparently data were obtained in May of 2011. Presumably at this time groundwater levels are high and moisture contents in the vadose zone are high due to snowmelt at this elevation and latitude.

Below are some detailed editorial suggestions

Abstract:

Include a sentence stating that directivity was parallel to landslide motion in one case and not in another. Also include a statement that groundwater/soil moisture has an influence.

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p.1319 line 6: delete "an", should read "...where ongoing..." line 7: should read "...monitoring of the..." line 14: should read "...variations may be..." line 16: should read "Therefore we recommend conducting simultaneous..."

p.1320 line 7: "...effects have been..." line 11: "...seismic slope failures..." line 18: "However, covering a broad region of landslide-prone slopes with long-term accelerometer monitoring appears..." line 22: "...based on Nakamura's method..." line 24: "...consisting of analyzing..." line 25: "...noise recordings..."

p.1321 line 1: "...explained by assuming..." line 27: "...windows also allows the estimation of..."

p. 1322 line 1: "...properties of the transient noise..." lines 3-20: This paragraph is not clear what microseismic signal? That recorded by Peterson? Is this paragraph needed? line 22: "...signals can propagate over very..."

p. 1323 line 1: "...frequencies larger than...propagate through the..." line 10: "...be faced by acquiring..." line 12: "...specific to certain..." line 15: delete "permanent" line 18: "...related to the space-time variation..."

p. 1325 line 1: "...sensors and data acquisition..." line 20: "...often recording continuously at a..." line 23: Add "Study Area Setting" subheading here. Include short climatic/groundwater recharge description to link to soil moisture effects in seismic analysis.

p. 1326 line 3: distinguish between historic and recent earthquakes. Recent quakes are part of history. line 10: "...1989 involved colluvial deposits about 40-m thick..." Is the landslide 40 m thick? Does it matter? line 17: "...breccias that overly Miocene..."

p.1327 line 2: "...debris is less than 5 m."

p. 1330 line 2: "...network demonstrated..." lines 10 - 13: Is the comparison a simple difference? Quantify the comparison. line 13: "...mostly between 40 and 60 km distant."

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pg. 1331 line 9: "...prototype of the Tromino instrument (Del Gaudio..." Use the trade name in the first description of the instrument and use a generic name (e.g. broadband instrument) in the rest of the text. The trade names mean very little. Don't ask the reader to remember which is which.

pg. 1332 Restate colluvial thickness and something about climate to support this hypothesis. Does this finding have implications for landslide potential?

p. 1335: line 19: "...factors may..." line 26: "...noise measurements were also conducted in an area that is a major..."

p. 1336 line 14: "...complexity requires a more sophisticated analysis..." line 24: "...analysis may produce..."

p. 1337 line 12: "...signal that shows..." line 14: "...a simple way to do this consists of averaging..." line 17: "...1 Hz still appears difficult..." lines 25 on: What does this mean for seismic slope stability modeling or regional hazard assessment?

p. 1338 line 15: "...due to the noise source..." line 23: "...where the vertical component of ground motion is not..."

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Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 1, 1319, 2013.