Nat. Hazards Earth Syst. Sci. Discuss., 2, C2609–C2614, 2014
www.nat-hazards-earth-syst-sci-discuss.net/2/C2609/2014/

Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Secondary lahar hazard assessment for Villa la Angostura, Argentina, using Two-Phase-Titan modelling code during 2011 Cordón Caulle eruption" *by* G. Córdoba et al.

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Received and published: 3 December 2014

The reviewer asks: What means secondary lahar?
Reply: According to the definition proposed by Legowo in 1981 "secondary or rain lahars" are those "not directly caused by volcanic activity but is due to rainfalls after (or during) an eruption". However, we changed the term "secondary lahars" by other simple forms like "lahars mobilized from recent ash falls".

The reviewer makes the statement: This term is not of current use in international literature.

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Reply: the term has been frequently used since the original definition, explained in literature Blong, R. (1984); Tilling, R. (1996) and is used in the 2011 United Nations UNEP-OCHA (2011) mission report (Dr. Jean Friedrich Schneider). Tilling refers to "secondary debris flows (lahars)" as indirect volcano hazards in contrast to "primary debris flows (lahars)" considered as direct volcano hazards.

Reviewer: I wonder in which kind of deposits, and under which conditions the authors assume that it is further available for formation of lahars.
Reply: The manuscript deals with tephra fall deposits resulting from the Cordón Caulle eruption that are described in Villarosa, et-al. (2012). We describe these tephras and the particular situation derived from the coeval and alternated deposition of snow and pyroclastic materials during the first stages of the eruption. Mobilization of this kind of unconsolidated pyroclastic deposits during intense pluvial events may form secondary lahars, as it has been indicated by the United Nations UNEP-OCHA mission, (UNEP-OCHA, 2011; Baumann et al., 2011; Elissondo et al., 2011; Wilson et-al., 2013)

Reviewer: I wonder if the new program, which derives from TITAN2D, is able to account also for more diluted flows, in which the fluid phase contributes to particle support and flow motion. This is an issue not sufficiently explained in the text. In particular, which is the maximum dilution at which the model outputs are physically sound?
Reply: as explained in the paper, the program take into account for both of the phases, accounting " for the two phase behavior of lahars" (page 6376, line 26). In page 6379, line 4, we stated " if $\varphi_f \rightarrow 1$ Eq. (3) becomes the " typical shallow water approach of hydraulics", which mean that the model copes even with pure fluid extreme. However, we add an statement to make this capabilities more clear.
Reviewer: Lines 5-10 page 6379. The statement requires references
Reply: we are sending a companion paper and adding the respective reference.

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Reviewer: The assumptions made for setting the initial conditions seems to contradict some previous statements It is not clear which kind of thickness they used.
Reply: we modified the respective redaction to provide more clarity.

Reviewer: The assumed solid fluid ratio of 0.3 seems not effective, because they previously stated that these deposits are no longer present on the valley catchments. Therefore, this is a pure hypothesis that needs to be better constrained (as an example using observed lahars in the area), or compared with results obtained using other solid-fluid ratios
Reply: the initial volume fraction was estimated from the actual snow-ash pack deposited during the 2011 eruption as stated in page 6379, lines 19-23. The idea was to study the actual hazard from the deposits of the Cordon Caulle 2011 eruption.

Reviewer: Which kind of probability you are talking about? From which data you derived it?
Reply: we modified the redaction to privide a more clear statement, which avoids references to non measured probabilities.
Reviewer: The authors consider exceptionally good that the simulated flows inundate the urban expansion zone?
Reply: we changed the world "outstanding" and modified the redaction accordingly.

Reviewer: It is not clear throughout the manuscript if the Authors describe results used during the volcanic crisis or they talk about something that could be happen in the future
Reply: as explained through the paper, we decribed the results during the volcanic crisis. However, we modified the redaction in order to the paper to avoid this doubt

Reviewer: If this is true, the results need to be compared with what really

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occurred in the following 3 years As there is no lahars large enough to reach the town up to now, we cannot do any comparison other than to describe what have happen from 2011. We add some paragraphs in page 6376 that relate what have happen from 2011.

Reviewer: The DEM precision is a vital parameter A good discussion of this point can be found in Capra et al. , and should be cited
Reply: that was one of the points on the paper, where we found critical diferences in the results using different DEMs. This is compatible with the studies done by Capra el al (2011) and Stefanescu et al (2011). We are including such references in the paper.

Reviewer: NHESS is a scientific journal, not a report for authorities. Therefore, the science need to be better explained and discussed in order to be of appeal for a wide international audience. A more accurate and expanded discussion section is therefore needed.
Reply: we are modifiying the conclusions in order to account for these recomendations.

References

Legowo, D.: Volcanic debris control applied in Indonesia. J. Hydrol. (NZ), 20, 71-79, 1981.

Wilson, T., Stewart, C., Bickerton, H., Baxter, P., Outes, V., Villarosa, G. and Rovere, E.: Impacts of the 2011 Puyehue Cordón Caulle volcanic complex on urban infrastructure, agriculture and public health. GNS Science Report 2012/20, 88 pp. ISSN 1177-2425, ISBN 978-1-972192-02-3, 2013.

Villarosa, G., Schneider, M., Outes, V., López, E., Dzendoletas, M.A., Beigt, D., Villarosa, F., Galosi, C., and Ruiz, M.: Estudio de Peligrosidad de avalanchas en el Parque Nahuel Huapi vinculados a la erupción del Cordón Caulle (CC), Informe Final, pp 81, Asesoría Institucional, Convenio CONICET-Administración de Parques Nacionales, 2012.

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UNEP-OCHA, Effects of the Puyehue-Cordón Caulle Eruption,Technical Cooperation Mission, Internal Report, Argentina, 4-19 July 2011, 2011.
Blong, R., Volcanic Hazards: A Sourcebook on the Effects of Eruptions, Academic Press, Sydney, 1984.
Tilling, R.I., Volcanoes, U.S. Geological Survey, 1996.
Baumann, V., Elissondo, M., Fauqué, L., and Gonzáles, R.: Peligro de generación de flujos de detritos o lahares secundarios en Villa la Angostura, Informe preliminar, Servicio Geológico Mimero Argentino, SEGEMAR, Internal Report, 2011.
Chow, V.: Open channel hydraulics, McGraw Hill, New York, 1969.
Colebrook, C. and White, C.: Experiments with fluid friction in Roughened pipes, Proc. R. Soc. London, 161, 367–381, 1937.
Collini, E., Osores, M. A., Folch, A., Viramonte, J. G., Villarosa, G., and Salmuni, G.: Volcanic ash forecast during the June 2011 Cordón Caulle eruption, Natural Hazards, 66, 389–412, 2013.
Córdoba, G., Sheridan, M., and Pitman, B.: A two-phase, depth-averaged model for geophysical mass flows in the TITAN code framework, CMG-IUGG, Pissa, Italy, 2010.
Coulomb, C.: Mémoires fe Mathematique et de Physique, vol. VII, chap. Essai sur une application des règles de maximis and minimis à quelques problèmes de statique, relatifs à l'architecture, pp. 343–382, Annèe, Paris, 1773.
Elissondo, M., Gomzales, R., Sruoga, P., Fauqué, L., Tejedo, A., Alonso, S., Carrizo, R., Herrero, J., Murruni, L., Ojada, E., Sánchez, L., and Costado, C.: Erupción del 4 de Junio de 2011 del Cordón Caulle, Chile y su impacto ambiental en territorio argentino, Tech. rep., Servicio Geológico y Minero Argentino, SEGEMAR, Buenos Aires, Argentina, internal Report, 2011.
Folch, A., Costa, A., and Macedonio, G.: An automatic procedure to forecast tephra fallout, Journal of Volcanology and Geothermal Research, 177, 767–777, 2008.
Guo, Z.: Velocity-depth coupling in shallow-water flows, Journal of Hydraulic Engineering, 121, 717–724, 1995.
Lara, L.E. and Moreno, H. Geoloía del Complejo Volcánico Puyehue-Cordón Caulle, Región de Los Lagos, Chile, Carta geológica de Chile, Serie Geología Básica No. 99, Servicio Geoógico y Minero de Chile, 2006.
Iverson, R.: The physics of debris flows, Reviews of Geophysics, 35, 2454–296, 1997.
Iverson, R. and Denlinger, R.: Flow of variably fluidized granular material across three-

dimensional terrain 1: Coulomb mixture theory., J. Geophys. Res., 6, 537–552, 2001.
OVDAS-SERNAGEOMIN: Reporte Especial de Actividad Volánica, Internal report 13, OVDAS-SERNAGEOMIN, Chile, 2011a.
OVDAS-SERNAGEOMIN: Reporte Especial de Actividad Volánica, Internal report 28, OVDAS-SERNAGEOMIN, Chile, 2011b.
Savage, S. and Hutter, K.: The motion of a finite mass of granular material down a rough incline, J. of Fluid Mechanics, 199, 177–215, 1989.
Sheridan, M., Córdoba, G., Pitman, E., Cronin, S., and Procter, J.: Application of a wide-ranging two-phase Debris Flow Model to the 2007 Crater Lake break-out lahar at Mt. Ruapehu, New Zealand, vol. V53E-2691 of *Fall Meeting*, American Geophysical Union, San Francisco (CA), 5-9 Dec., 2011.
Villarosa, G. and Outes, V.: Efectos de la caída de cenizas del Complejo Volcánico Puyehue (CPCC) sobre la región del lago Nahuel Nuapi., chap. La erupción del Cordón Caulle del 4 de junio de 2011: Mapa de distribución, características de la ceniza volcánica caída en la región e impactos en la comunidad (in Spanish), pp. 12–59, Universidad del Comahue, Bariloche, Argentina, convenio de Asistencia Técnica Centro Regional Universitario Bariloche, 2013.
Villarosa, G., Outes, V., Hajduk, A., sellés, D., Fernández, M., Montero, C., and Crivelli, E.: Explosive volcanism during the Holocene in the upper Limay river basin: The effects of ashfalls on human societies. Northern Patagonia, Argentina, Quaternary International, 158, 44–57, 2006.