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New advances for the recharge quantification in deep-seated landslide under tropical climate

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The landslide activity is commonly controlled by the variation of hydraulic head inside the instable mass. Consequently, the study of the aquifer recharge function is an essential step to predict landslide dynamic. Under tropical climate, the intense rainfall precipitated during the rainy season and the erosion rates generate large instabilities. However, hydrogeological studies of landslides in tropical environments are mainly focused on surface instabilities.

In this context, the Grand Ilet landslide (250 Mm^3) (Reunion Island) allows us to implement an innovative approach to quantify the landslide aquifer recharge in a tropical humid climate. Here, we deploy during 2 years (2011 to 2012) surface water and groundwater monitoring network (springs and piezometers) coupled with the monitoring of stable isotopes of rainwater and groundwater. These data allow the establishment of a daily water balance and the quantification of groundwater inflow and outflow at the landslide scale.

The results of daily water balance show that the recharge during 2011-2012 period (1728 mm) constitutes 35% of the total rainfall (4777 mm). Furthermore the aquifer recharge occurs mainly during the wet season (99% of annual recharge), for rainfall event greater than 80 mm/event. The monitoring of stable isotopes supports and completes these results: the isotopic signature of landslide groundwater appears comparable to the isotopic signatures of wet season rainfalls. Moreover, the hydrologic monitoring allow us to quantify exceptional low runoff coefficients ($<5\%$) on the landslide soils, even for extreme rainfall events. Consequently, the surface processes, such as interception by forest cover and water storage in soils, strongly limit the recharge flow.

This study establishes a reference context for recharge of deep seated landslides in tropical climate. From an operational point of view, these results provide crucial elements for the selection of remedial methods to be implemented for displacement rate limitation. Drainage of groundwater appears to be the most appropriate solution. The collection of surface runoff does not act significantly, due to the low runoff coefficients. Furthermore, the using of efficient rainfall significantly improves the displacement rates prediction (inverse model) for the Salazie landslides.