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Hydrogeological processes on the active Pont Bourquin landslide, Swiss Alps

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Rainfall events are playing the mayor role for triggering the Pont Bourquin landslide. But also during dry periods several springs have been observed on the landslide. Where does this groundwater come from? Does it influence the landslide movement? To answer these questions, a combined hydrological, geophysical and ground-based remote sensing survey has been carried out on the Pont Bourquin landslide since summer 2009.

The 250 m long Pont Bourquin landslide is located in the Western Alps of Switzerland in a tectonically complex zone and affects mainly black shale and moraine material. In the lower part of the landslide, also flysch and cornieule rocks are affected. The Pont Bourquin landslide is a composite earth slide-earth flow. The reactivation of the slope started before 1995. Important movements are observed since 2004. Three years later, heavy rainfall triggered an earth flow with a volume of about 11'000 m3 which was cutting the cantonal road passing at the toe of the landslide. In summer 2010 successive events of debris slides-earth flows were triggered and reached again the edge of the road.

Springs have been mapped on the landslides and their flux has been measured. Periodically, groundwater from boreholes and springs was sampled and chemically analyzed. Groundwater tables are monitored in several piezometers between 2 and 5 m depth. Additionally, TLS (Terrestrial Laser Scanning), Differential GNSS (Digital Global Navigation Satellite System) as well as Total Station measurements are performed and several Seismic Refraction and ERT (Electric Resistivity Tomography) profiles were made along and across the landslide.

We found that the main slip surface of the Pont Bourquin landslide is localized at about 10 m depth. Important movements occur also along shallower secondary slip surfaces. In summer 2010, in a time period of three months, a 20 m-displacement could be measured in the middle part of the landslide. The geological predisposition (fractured schist covered by low permeable moraine) and the steep slope angle between 30 and 35° favour clearly the occurrence of landslides in the area. But water is playing the key role for the triggering of the Pont Bourquin landslide. On one hand, meteoric water is pounding on the low permeable landslide mass and is infiltrating in large superficial extensional cracks. On the other hand, groundwater which most likely comes from the moraine located above the landslide is flowing along fractures in the black shale into the landslide mass and is extruding at perennial springs located on the landslide.

The strong activity of the Pont Bourquin landslide allows not only observing how hydrogeological processes influence the landslide but also how the hydrogeological system reacts to fast and continuous mass movement processes.