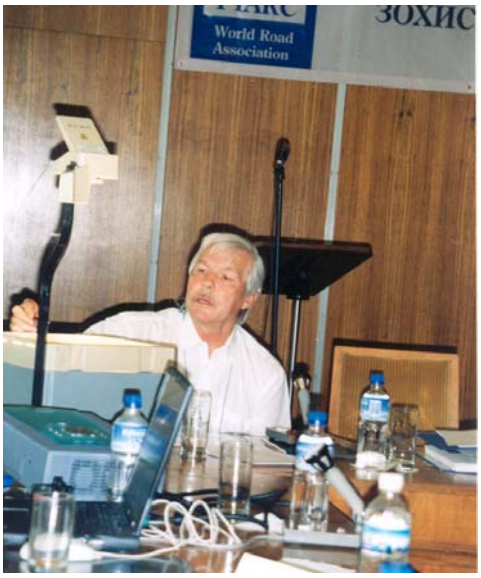

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Vulnerability of Roads of Swiss Alps to Water Erosion

(Extended Abstract)

Since 1987, Switzerland suffered of many extreme pluvial events. They caused heavy damages to the infrastructures, especially to roads.

The first event was in summer 1987. The geographic area which was touched is the entire country, from the Jura Range to the Alps, from western to eastern. There was the conjonction of long time rainfall and snowmelt on the Alps. Many sectors of the country were flooded. Numerous roads were cut by embankment erosion but also destruction of piles of bridges. Several debris flow occured localy. A very recent bridge of the motoway of central Switzerland was so seriously damaged by a pile settlement that the trafic was interrupted for a long time.

In 1993, a very local erosion event in the upper Rhone valley caused a large debris flow. The river Saltina abandonned its bed to flow directily in the streets of the city Brig. At the center of the old city, more than 2 m debris were deposited, causing fatalities and very heavy damages. The railway station was covered by mud.

Two years later, a local storm caused a very sudden rain on the Pissot catchment, near Montreux and the Geneva Lake. Just before midnight, a huge erosion occured in the very steep brooks. These river beds had a large charge of debris ~om morenic origin and from a high cliff dominating the head of the catchment. This erosion caused an important debris flow. At this place, the brook is crossing one of the main motorways of the country in an artificial channel pearched over the road. Due to the extreme discharge of debris, a part of the flow left the channel and deposited in the road trench. Cars collide this mass by chance without enjuries. A block of 65 m3 crossed the motorway in the channel and stopped downward, causing only small damages. Its minimum trajectory is 300 m long. This main motorway was closed during two days in a very urban zone.

In winter 1999, the thick snow cover caused dramatic avalanches in many parts of the country, just as in the whole Alps. In summer, the exceptionnal snowmelt connectep with

heavy rains let to large flooding of the main rivers. Some dams were overflowed. The city of Bern had important damages due to the flood of Aar. Many landslides had an increase of activity during this year.

In October 2000, a very catastrophic meteorological event came from Marocco. It was a kind of monsoom over the Mediterranean Sea which arrived against the relief of Alps. The Tessin Cantoon and the southern part of Valais received a lot of rains during about one week. In the region of the Simplon-Pass, we measured more than 600 mm rain in a week (about 1/3 of the annual mean precipitation at this site). The meteorologists attribute to this event a return period of more than thousand years. A: ponctual erosion occured upwards the small village of Gondo, neat the Italian Border. A mud flow arrived gently against a wall for retaining rock- falls. The water of the mud tongue eroded the fond at ion of this big concrete wall. Suddenly, the wall falled on a series of houses, destroying them like a big bulldozer. About ten people lost their life. The village was cut into two parts with a large erosion trough inbetween. The imortant road of Simp lon-Pass connecting Switzerland and Italy was interrupted during several weeks.

This succession of dramatic events needs to update our data base which is used in the methodological approach of hydrological and geological hasards. It seems that the frequency of rare events is increasing with climate warming. In our Laboratory, we are now improving the field characterisation in order to define better the erodability of geological material. This "Geotype approach" will be presented in the PIARC seminar of Nepal in 2003.

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