

## INTEGRATED WATERMANAGEMENT OF THE GRANDE EAU CATCHMENT BASSIN IN SWITZERLAND FOR SUSTAINABLE PROTECTION WORKS

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### INTRODUCTION

The Grande Eau river has its source in the "Massif des Diablerets" and flows into the Rhône, downstream the city of Aigle (Fig. 1). Its catchment basin covers 147 km<sup>2</sup> and is characterized by very steep superior under-catchments which are located in partially glacial and periglacial areas.

The last floods in 1999 and 2005 have lead to significant damages. This was due to a stones and rocks supply in the upstream under-catchments, riversides erosion and overflows in the village of Les Diablerets (Fig. 1). Downstream, this river lines the landslide of La Frasse which risks to block the river. In addition, the erosion capacity of the river during floods keeps the landslide movements.

Finally, the last floods of the Grande Eau have shown that the hydraulic and solid capacities of the river are limited in the urban section in Aigle city (Fig. 1): there are real risks of solid obstructions and of overflows in this town.

These observations together with the increasing risks due to climatic changes have lead the Canton de Vaud to start a global integrated study dealing with risk analysis and protection strategies, with the goal to mitigate the Grande Eau risks over its all catchment area.

The present paper shows the different practical experiences and mitigation works from the upstream to the downstream of the Grand Eau river.

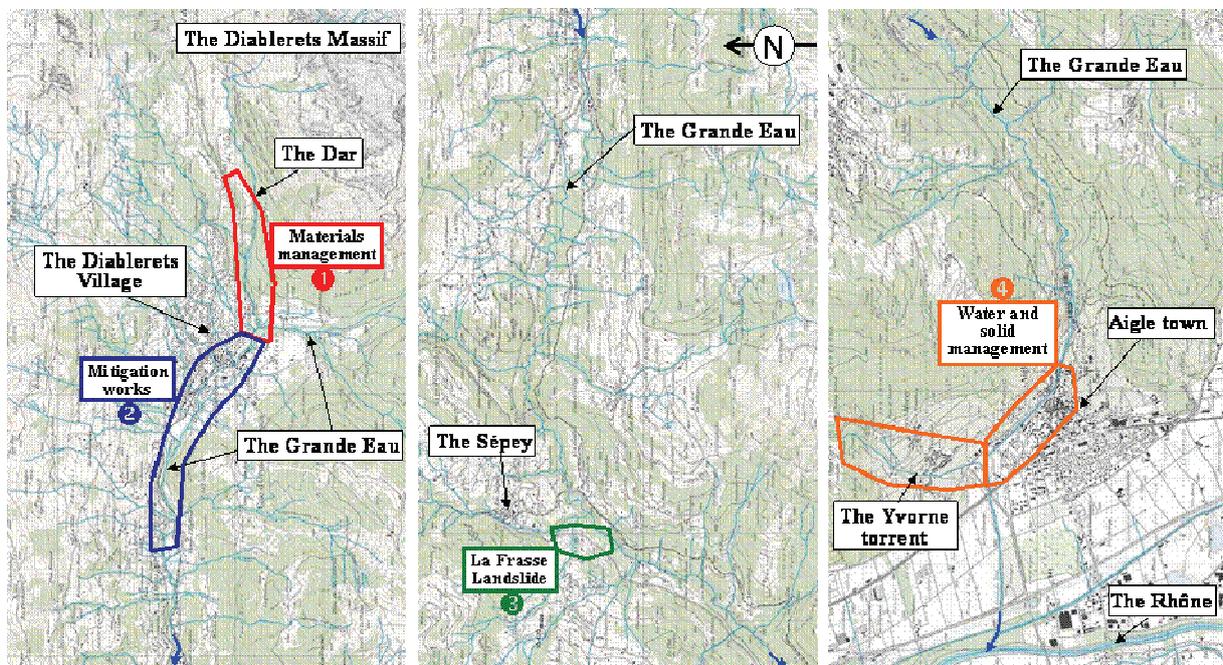


Fig. 1 Grande Eau catchment area

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## MATERIALS MANAGEMENT OF THE SUPERIOR GLACIAL AND PERIGLACIAL CATCHMENTS OF THE DAR AFFLUENT (FIG 1 - 1)

The climate change leads progressively to the permafrost melt in the superior catchments of the Grande Eau. In the same time, it can be observed an increase of the extreme pluvial events. This results in increasing risks of debris flows as well as rockfalls in the Dar, affluent of the Grande Eau. Indeed, important materials deposits have been observed in the abatement cone of the Dar and in the upstream of the Grande Eau during last floods. That has involved a deflected and concentrated flow which has caused erosion of the riversides and overflows.

A study is in progress to analyse the moving materials process and to provide a sustainable management of the materials by creating strategic deposit areas and overflow corridors.

## PROTECTION STRATEGIES AND MITIGATION WORKS IN THE DIABLERETS VILLAGE (FIG 1 - 2)

Downstream the Dar mouth, the Grande Eau flows through the Diablerets village. During the last floods (return period of about twenty and fifty years), houses and hotels have suffered important damages. A hydraulic and morphologic study has shown the underestimated capacity of the river in the Village. Due to the urban context, protection strategies have been adapted to preserve land use planning and to integrate environmental improvements. The mitigation works have consisted to establish a continuous stable slope of the river bed, the increase of the hydraulic and material capacities under bridges, the reinforcement of riversides and privileged overflows corridors.

## LA FRASSE LANDSLIDE STABILISATION (FIG 1 - 3)

La Frasse landslide represents a dynamic volume of  $40 \times 10^6 \text{ m}^3$  in movement (Fig. 2). The principal risks were not only the sweep away of the roads and the residential area but also the obstruction of the Grande Eau river. It could lead to a sudden failure and submersion wave in the Aigle city.

To stabilise this landslide, a 700 m long drainage gallery (Fig. 2) has been realised under the unstable mass in order to minimize pore pressures. In addition, the right riverside of the Grande Eau section (800 m long) lining the toe of the landslide will be stabilised by ripraps. That would avoid riverside erosion and then mitigate the landslide movements.

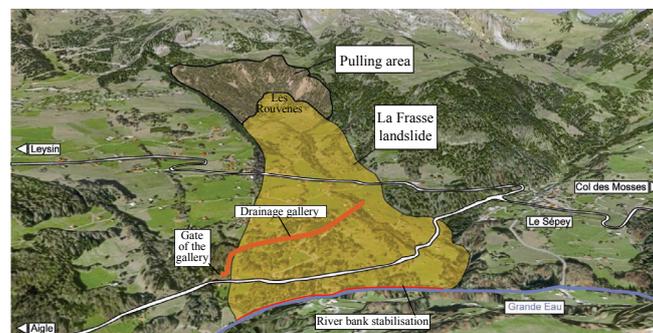


Fig. 2 Stabilizing of La Frasse landslide

## SUSTAINABLE WATER AND SOLID MANAGEMENT OF THE GRAND EAU IN AIGLE AND OF THE YVORNE AFFLUENT (FIG 1 - 4)

Downstream, the Grande Eau flows through the Aigle city. In this section, the river is totally embanked. The risk analysis has shown that the hydraulic capacity of this urban part of the river is only of about 20 to 30 years return period: half of the town suffer of a medium danger risk. The same conclusions have been observed for its affluent, the Yvorne torrent. Then, the Canton de Vaud is implementing an alarm and intervention plan. In parallel, a fluvial correction is in study in order to guaranty the materials and hydraulic management for hundred years return events.

**Keywords:** floods, materials management, mitigation works, landslides