

## Sedimentation management in the Livigno Reservoir: Technical measures to reduce the effects of sedimentation due to turbidity currents (2005)

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### Introduction

The aim of this study is to analyze and propose technical solutions against the effects of sedimentation due to turbidity currents in the Livigno Reservoir, formed by the Punt dal Gall dam at the Swiss-Italian border (Figure 1). The simulations have been performed with CFX4.4, a 3D numerical solver of the Navier-Stokes equations. In this program, some FORTRAN routines developed in LCH have been implemented for sedimentation and erosion.

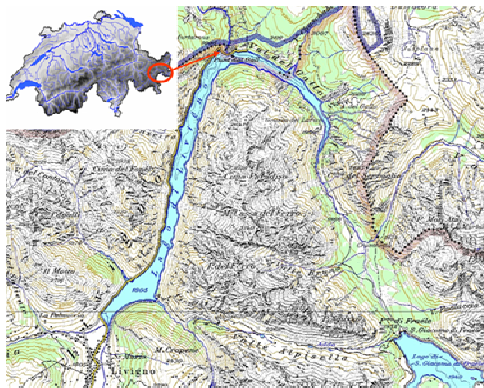


Figure 1: Location on the Swiss-Italian border and map of the Livigno Reservoir

For the current situation, the behaviour of the reservoir related to the sedimentation have been analyzed for the annual flood event, the October 2000 flood event, the highest flood event ever measured in the catchment area (1960) and the 100 years return period flood event. For all cases, the maximum sediment concentrations of 15 and 30 g/l have been considered. For the analyses of the performance of the proposed technical solutions, only the 2000 event (max. discharge 90 m<sup>3</sup>/s) with maximum concentration of 15 g/l was considered.

### Studied technical measures

In this study, two types of technical measures namely a submerged permeable rockfill dam 3.0 km downstream of the inlet of the west arm of the reservoir at the maximum operation level (Section 1) and a permeable screen some 2.5 km upstream of the Punt dal Gall dam (Section 2) are considered in order to try to stop the turbidity currents in the reservoir (Figure 2).

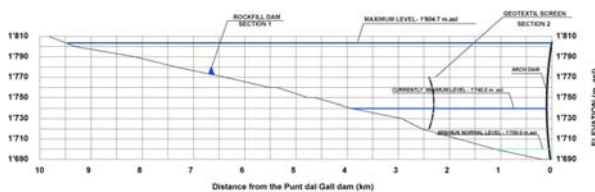


Figure 2: Technical alternatives in the west arm of the reservoir

### Numerical simulations using CFX-4

The simulations of the current situation of the reservoir (Figure 3) showed that approximately 60% of the total deposited sediments occur in the first 3.0 km of the reservoir in the present situation for all studied events, except for the annual flood where 74% is deposited within this reach. At Section 2, more than 90% of the sediments are already settled. Thus, the screen is not necessary. For all simulations, the quantity of sediments deposited close to the Punt dal Gall dam is not relevant.

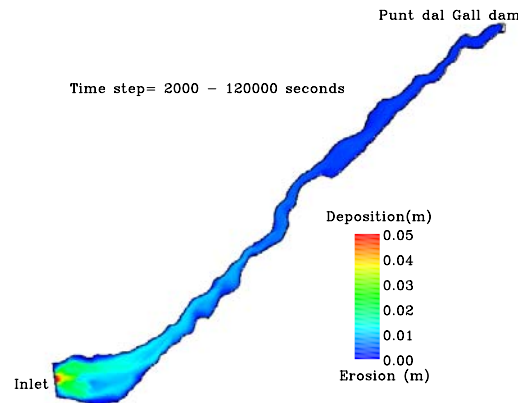


Figure 3: Final condition for the October 2000 flood event with maximum inflow concentration 15g/l

For the simulation of a pervious dam in the reservoir, heights of 4, 8 and 12 m have been considered. Table 1 shows the ratio of sedimentation for the different studied obstacles as well as the volume of material needed to its construction. In this table, the present situation of the reservoir is also presented.

Alternative	Deposition upstream of the Section 1	Deposition upstream of the Section 2	Volume of the rockfill dam (m <sup>3</sup> )
Actual situation	63%	94%	-
Obstacle 12m	87%	99%	34'600
Obstacle 8m	76%	97%	12'300
Obstacle 4m	69%	95%	1'700

Table 1 : Ratio between the deposition upstream Sections 1 and 2 and total deposition in full reservoir for different obstacles heights

The performance of an obstacle against turbidity currents starts to be significant for the structures higher than 8 m. In this case, the sedimentation upstream of the obstacle increases from 63% to 76% and to 87% for a 12 m high obstacle. For both cases, the sediments are already completely deposited upstream of Section 2.

### Conclusions and recommendations

The simulations showed that the inlet of the Livigno Reservoir act as a "natural desilting" basin and the implementation of a rockfill dam increases its efficiency. Moreover, this obstacle can become crucial during the emptying of the reservoir blocking the sediments already settled.

A topographic survey before and after the implementation of the obstacle enables to monitor its efficiency and operations for removal the sediment deposits can be organised if necessary over the years.

The proposed technical measure can be part of the sustainable sediment management of the Livigno Reservoir.