Influence of channel bank roughness and geometry on unsteady flow and wave propagations

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Introduction

The flow regime of many alpine rivers is characterized by hydropeaking caused by the rejections of high head schemes, which starts their turbines quickly to satisfy the electricity peak demand. This kind of exploitation causes important and fast flow fluctuations, accompanied by significant water level variations. The phenomenon occurs particularly in channelled rivers as for example the Rhone in Switzerland. The flow change rate exceeds much the one of a natural change as it occurs during floods.

Adequate morphological measures such as banks or irregular streambed axis, groynes, local widenings, braided channels as well as hydraulic measures, like retaining basins or side-channels, can moderate or make disappear the effects of hydropeaking.

The experience and first simulations on "Flow-3D" show that more natural river banks help probably to reduce importance of hydropeaking. Within river restoration projects, control of hydropeaking is important because this phenomenon influences principally flow regime, but also water quality and morphology of the river (Figure 1).

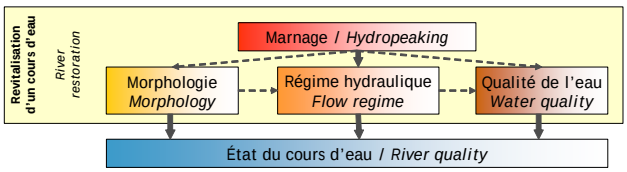

Figure 1: Hydropeaking influences the main parameters of river restoration projects

The revitalisation measures induce a reduction of the propagation velocities of surge flow, they support favourably interferences due to refractions and reflexions of surface waves and finally they increase the effect of river retention. However, scientific bases for quantifying the Influence of channel bank roughness and geometry on unsteady flow and wave propagations and making possible the optimisation of these various effects are still lacking.

Scientific and technical goals

The main scientific goal of the research at the Laboratory of Hydraulic Constructions (LCH) is to analyse physical phenomena of transient free surface flow and to quantify correctly the impact of a natural river (i.e. the influence of bank macro roughness) on unsteady flow conditions caused by hydropeaking.

The technical goals of the thesis project are:

- to quantify the reduction of hydropeaking in rivers with natural morphology
- to compare the efficiency of morphological and hydraulic measures
- to generate non-dimensional diagrams allowing to estimate easily the river-form-roughness according to its geometry
- to propose how to proceed in case of a real project

Methodology

The methodology of the research project is subdivided into three phases as shown in Figure 2.

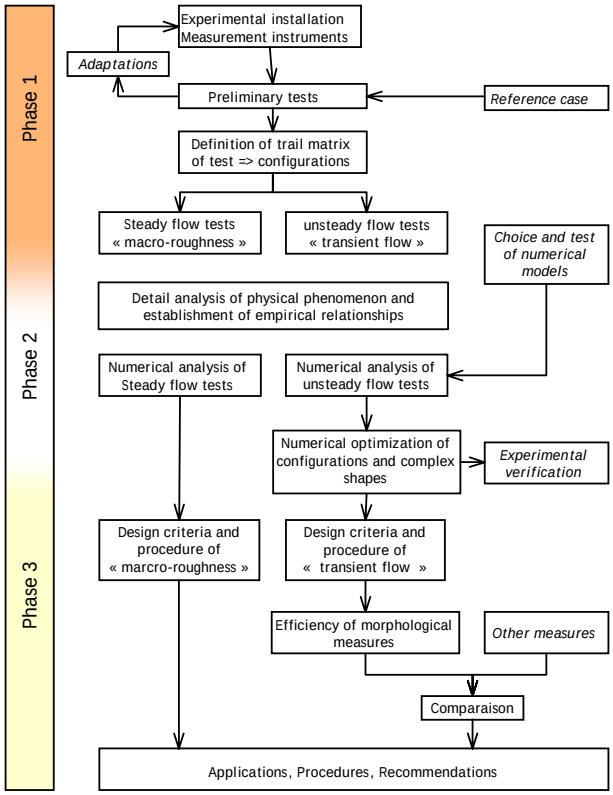

Figure 2: Adopted methodology for the research program

Phase 1 relates to stationary and nonstationary experiments in a 42 m long flume. Phase 2 will be devoted to analyse the tests by a numeric model as well as to optimize river morphology. In the third phase, dimension criterias and procedures for adequate river measures are proposed.