**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 the phenomena of transient free surface flow and to quantify correctly the impact of the natural river (i.e. the influence of bank macro roughness) on unsteady flow conditions caused by hydropoeaking. Adequate morphological measures such as banks or irregular streambed axis, groyne, local widenings, braided channels as well as hydraulic measures, like retaining basins or side-channels, can moderate or make disappear the effects of hydropoeaking.

The experience and first simulations on "Flow-3D" show that more natural river banks help probably to reduce importance of hydropoeaking. 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.

**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 the natural river (i.e. the influence of bank macro roughness) on unsteady flow conditions caused by hydropoeaking.

The technical goals of the thesis project are:

- to quantify the reduction of hydropoeaking 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.

### Phase 1 - Preliminary tests

- Definition of trail matrix of test ➔ configurations
- Steady flow tests ➔ unsteady flow tests ➔ transient flow
- Detail analysis of physical phenomenon and establishment of empirical relationships
- Numerical analysis of unsteady flow tests
- Numerical optimization of configurations and complex shapes
- Experimental verification

### Phase 2 - Numerical analysis

- Design criteria and procedure of ➔ efficiency of morphological measures ➔ Other measures ➔ Applications, Procedures, Recommendations
- Efficiency of morphological measures ➔ Design criteria and procedure of ➔ Numerical analysis of ➔ Numerical optimization of ➔ Experimental verification ➔ Numerical analysis of ➔ Numerical optimization of configurations and complex shapes ➔ Numerical optimization of ➔ Experimental verification

### Phase 3 - Applications, Procedures, Recommendations

Further research, development of empirical relationships and establishment of new laws, comparisons with real cases, applications, procedures, recommendations and other measures.

**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.