

Research subject – XXXIII cycle

Scholarship A6 - Curriculum: Civil and Environmental Engineering

Title: Formative discharge and style of morphological response of gravel bed rivers at the reach scale

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Synthetic description of the project and research outcome (see below):

River bars are fundamental units of alluvial streams and characterize the morphodynamic response of gravel bed rivers at the reach scale. Practical interest in the study of bars has often related to the need to control their development and migration in river systems, with the aim of improving navigation and preventing structural damage or undesired channel shift. The present knowledge of bar morphodynamics results from a combination of laboratory and field observations and mathematical models. A considerable number of theoretical and laboratory-scale models have been proposed in the last half century to understand bar dynamics in alluvial channels and to predict their main properties based on reach-averaged channel characteristics. They mostly assume a constant discharge and therefore their predictions refer to a given flow stage.

The question then arises of understanding the morphodynamic response of river reaches to sequences of typical hydrographs. Previous analytical work on bars suggest that in gravel bed rivers the time scale of bar growth may be comparable to that of discharge changes. Furthermore, in single-thread channels the control parameter of bar growth (the width to depth ratio) decreases in the rising limb of flood events, bankfull conditions possibly falling below the threshold for bar formation. This implies that lower (still formative) stages are more favourable conditions for bar development, though the timescale of bed response gets longer. On the other hand, field studies on medium-term bar dynamics are relatively few. This is due to the long observational period required to include multiple channel-forming events in order to capture the features of bar dynamics at the proper timescale.

The proposed doctoral research topic aims to address the relation between flow regime and bar morphology, both at the scale of single event and in the medium-term. The proposed research is meant to combine analytical and numerical modelling, along with laboratory investigations and information on evolutionary trajectories and statistical properties of bars (length, migration, depth of erosion and deposition) derived from remotely sensed satellite images and field observations on several Alpine gravel bed rivers (Rhine, Isere, Arc, ...). The ultimate goal of the proposed research is that of building a new concept of formative discharge suitable to interpret the style of the morphodynamic response of gravel bed river reaches and analysing its changes due to the variation/alteration of external control parameters (flow regime, sediment availability, land and river use).

The foreseen research outcomes are:

- (1) a theoretical model for bar morphology (at the scale of flood event and in the medium term) for given characteristics of the river reach and flow hydrographs;
- (2) the collection of field data on evolutionary trajectories and medium-term statistical properties of river bars in gravel bed rivers;
- (3) a novel concept of formative discharge and the analysis of its dependence on

variation/alteration of external control variables.

The Ph.D. student is intended to produce at least two papers in major journals, of which, at least one as first Author.