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Photogrammetric survey to measure the bed topography of a laboratory large amplitude meandering channel

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One of the main characteristics of the rivers that exhibit a meandering planform is the continuous evolution of the planimetric shape. In order to limit flooding risks and to control the ecological equilibrium of the areas neighboring the channel, it is important to define a forecast methodology of the channel evolution.
The pattern of the channel evolution strongly depends on the configuration of the “stable” bed topography along the channel in every stage of the evolution itself. Previous works [Schumm, 1963; Schumm, 1972; Jackson, 1975; Hooke, 1976; Ren and Jun, 1989; Whiting and Dietrich, 1993] show that the localization of the erosion and deposition zones along the channel is not standard but it depends on the planimetric shape of the channel itself. For example, it was shown that at the early stage of a meander wave evolution (small value of deflection angle J0) the deepest erosion of the bed is localized at the inner bank between the sections corresponding respectively to the inflection point and to the apex of the bend. In channels with “large” sinuosity (large value of deflection angle J0) the deepest erosion is localized in the outer bank near the apex of the bend [Yalin, 1992]. Recently, da Silva et al. [2006] verified that every different sinuosity (every J0) has its own convective flow pattern and, as previously observed in a large amplitude meandering channel by Termini (1996), the knowledge of the convective structure of the depth-averaged “initial” (determined at t=0 with flat bed) flow, which is associated only to changing channel curvature, can be used to predict the general features of bed topography. Thus, the knowledge of the stable bed topography is important to predict the channel planimetric evolution.
In this paper the equilibrium bed topography determined in a large meandering laboratory channel has been first measured by a using a profile indicator PV09 by Delft Hydraulics (precision of 0.1 mm). The PV09 is designed to maintain a constant distance between the probe and the bed (or between the probe and the free surface) in order to maintain a constant electric capacity. Thus, the instrument is able to monitor the temporal or the spatial variation of the bed (or the free surface) sampling a value per second. Then, the analogical output is converted into digital, filtered and recorded by the help of a PC card NI-DAQ (National Instruments) and of a data acquisition algorithm expressly scheduled in Labview (ver. 7.0) environment.
Then a photogrammetric survey has been carried out to produce in a fully automatic way a very dense Digital Surface Model (DSM) of the bed topography of the laboratory channel. The image acquisition has been performed using a Nikon D80 digital camera with a focal length of 28 mm and a resolution of 3872 pixel x 2592 pixel; the pixel size was 6.1 mm. The camera-to-object distance was 0.65 m and the photo scale was 1:23. The photos were taken providing the stereo coverage necessary for automatic DSM generation. The photos orientation was executed by bundle adjustment without control points using only several calibrated scale bar to scale the photogrammetric model. The very dense DSM has been produced with a step of 2 mm for the whole channel using image matching techniques without editing.