Hydrological and Hydraulic Parameters for Bio-Engineering Bank Stabilization and Riparian Vegetated Buffer Strips Design

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Abstract: Planning bank stabilization and vegetated buffer (or filter) strips (VBS or VFS) works requires the estimation of some hydrologic and hydraulic parameters.

First of all it is important to consider the relationships among water levels of the river cross section and of the groundwater in different seasons and flood or river bed.

From a hydrological point of view, having at disposal historical data series of discharge measurements in a given river cross section (direct measurements or re-constructed) it is possible to determine a *"duration" curve* of the daily discharges (discharge values which are exceeded for a given duration in days as a function of the duration) and an *"increasing" curve* of the maximum annual discharge (maximum annual peak discharge values as a function of the return time).

For example it is possible to couple the two curves obtaining the non-dimensional [Q/Qm] variation with time [years] for 3 rivers in Central Italy.

Keywords: bio-engineering, bank stabilization, vegetated buffer strips, modeling

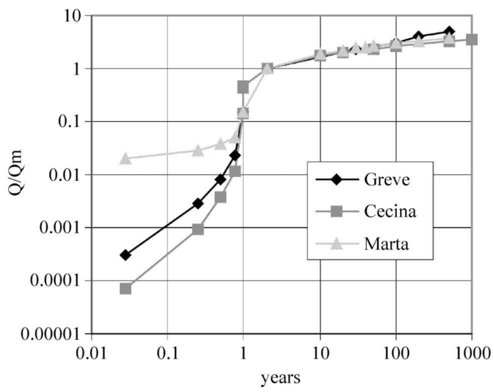

Fig.1 Some rivers duration and return period discharge curves

From the *"level-discharge" curve* to a given discharge value it is associated a water depth in the section using a hydraulic model.

In the Figure 2 is shown an example of the influence of the width/depth ratio on the discharge and the water level for one of these rivers (Marta) taking into account the presence of vegetation on the banks (Darby, 1995; Masterman & Thorne, 1992).

In the case of the Greve river, for example, the water level corresponding to the discharge value "mean annual" (daily with a duration of 7—10 days consecutively) is located, respectively, below the hc2 value and above the hg355 one (*qg = daily discharge with duration h; QcTr = peak discharge with return time Tr*).

Below the qg355 level, there is water for all the year (out of 10 days) in the low part of the banks, to be protected, if the case, with artificial materials.

Bio-engineering methods can be realized above the qg10 level that would be overcome only for 10 days in a year, for avoiding the submersion in succession for more than a week.

If the intervention is realized on the banks of the central part of the river, it could be submerged almost every year (in average every 2 years would occur the "cross section modelling" discharge or every

1.33 years the "ordinary discharge" would occur with a probability of 75% according to the italian *Circolare n. 780/1907 del Ministero LL.PP "Sulla delimitazione dell'alveo dei corsi d'acqua e sulle piantagioni nelle alluvioni"*).

Below the water depth corresponding to Qc30, according to the *D.P.R. April 14, 1993*, it *should be removed from the river banks and bed itself, all the trees causing a limitation to the water flowing, on the basis of their influence on the regular water flowing and bank instability*, saving when possible the conservation of the vegetation association which are able to permanently colonize the riparial habitat and the nearby drifts, causing the rinaturalization of the river banks, defined as protection of the instable banks with flexible structures which will rinaturalize by themselves.

In this case the water depth corresponding to peak runoff value of Qc2 would flow with a b/h ratio equal to 4, causing high risk of flowing in the case of increasing roughness values or obstructed section due to vegetation presence on the river banks.

In any case, the resistance to dragging of the interventions on the river banks and at its lower part should be evaluated on the basis of discharge values with a minor occurring (e.g. return time 30—50 flowing in the "flooding" areas) .

The Qc30, Qc100 and Qc200 overflow and moreover, since the b/h ratio is roughly equal to 8, less risks of level rising could happen at the vegetation presence in the "flooding" areas. Clearly, it would not be like that if the river embanked.

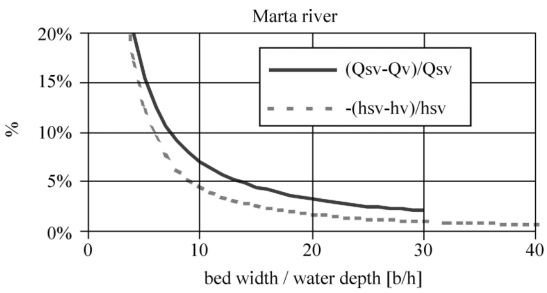

Fig.2 Influence of the width/depth ratio on the discharge and the water level for one of these rivers (Marta) taking into account the presence of vegetation on the banks (Preti, 1998)

In this paper the conditions of water level in the river cross section and in the groundwater are investigated in order to design the appropriate soil stabilization bio-engineering structures for reduction of the bank instability and the sediment transport, to model the vegetated buffer (or filter) strips (VBS or VFS).

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