A procedure for human safety assessment during hydropeaking events

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Abstract Human safety can be assessed in two different ways: one is by studying human stability during hydropeaking events and the other is exploring the possibility of a "target person" leaving the reach during hydropeaking waves, adapting proper escape strategies. For the escape strategy Dijkstra's algorithm is used, where the distance between adjacent nodes is defined as the difficulty of moving from one node to the other. The present work proposes a possible investigational tool to evaluate and parameterize the risk for the population during hydropeaking events through quantitative indices.

Keywords: open channel flow, hydropeaking, escape route, human stability, human safety.

Methods

The procedure proposed for risk assessment is structured into two steps. In the first one, **hydraulic simulation** of the hydropeaking are performed. Secondly, **Dijkstra's algorithm** (Cormen et al., 2009) is applied defining the penalty functions for the distance parameter for each cell in which the reach is subdivided. The relative penalty values of these have been assigned according to the following scheme:

1. higher penalty value was assigned to steep uphill paths;
2. higher penalty values for cells containing trees or bushes and cells containing large boulders;
3. hydrodynamic limit values (hydraulic parameter) have been proposed by (Bischof et al., 2002) and the most penalizing values are assigned to hydrodynamic parameters that exceeds the higher risk threshold.

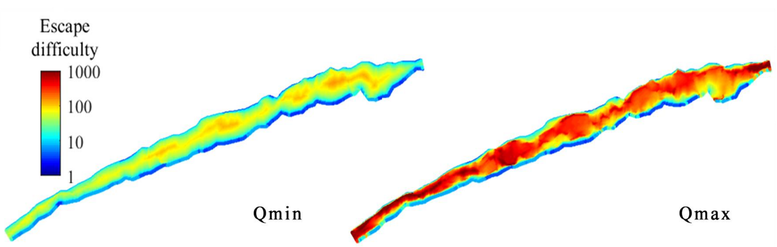

Figure 1: Escape difficulty for the minimum flow (Qmin) and maximum flow (Qmax).

Results

- The difficulty of escape increases in the few areas that are **distant from the banks** and when the water depth is quite high.
- In addition, the escape map for the minimum flow rate can also be read as the **map of ease of access** to the watercourse so it also represents which areas are most easily accessible by the population.
- In the central areas of the river the escape readiness is very low and in some areas it is totally impossible to leave the river. Two reasons:
  1. **increase in the distance** to travel necessary to exit the riverbed
  2. **hydraulic aspect** linked to the difficulty of escape. This aspect is evident in the red areas that, despite the relative proximity to the banks, are extremely difficult to leave for high flow rates

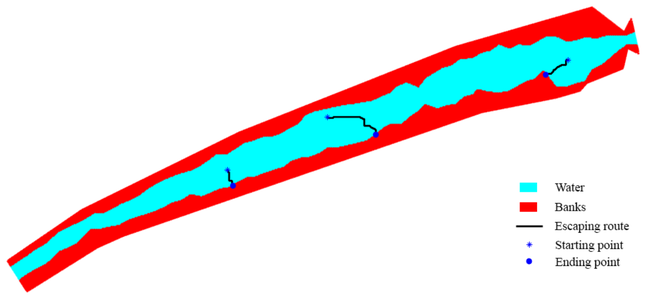

Figure 2: Comparison of three exemplary escaping route from different positions.

Conclusions

The method proposed is able to provide indications about the possibility of using rivers for recreational purposes. In fact, the approach can define which **areas can be safely reached and abandoned** if the flow rate increases during hydropeaking. Moreover, the same maps can be used **during the people recovery** phases who are blocked in the water course. Finally, the method can be also utilized to **evaluate the efficiency against human safety of typical mitigation measures** adopted to increase the level of good habitat in the stream. The main source of uncertainty in our research is the penalty definition and they need to be better investigated with information from field experts and local security bodies such as firemen.

Bibliography

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