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Integrating Remote Sensing and 2D Hydraulic Modelling for Meso-habitat Modelling in the Aurino, a Gravel-bed Alpine River

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Abstract

Integration of remote sensing and 2D hydraulic modelling offers the potential for broader applicability of habitat modelling at the meso-scale, extending applications to larger non-wadeable streams, and allowing to survey longer river stretches. We present an example of the application of a methodological framework for meso-scale habitat suitability modelling, on a reach of the gravel-bed Aurino River (NE Italy). The framework implements the following main steps: remote sensing-based acquisition of the topo-bathymetry and a high-resolution orthophoto; 2D hydraulic modelling coupled with an unsupervised algorithm to map hydro-morphologically defined units; semi-automated mapping of substrate and refugia; and finally, the estimation of meso-scale habitat suitabilities for a target species or community.

Keywords: UAV; hydro-morphological units; bathymetric LiDAR; fish habitat.

1. INTRODUCTION

Meso-scale habitat models have become widely accepted to quantify the impact of hydro-morphological pressures and of river restoration measures, as well as to support the definition of environmental flows. Integrating remote sensing (RS) surveys with 2D hydraulic modelling can help overcome some of the issues that limit a broader applicability of meso-scale habitat modelling: the requirement of repeated surveys at a number of streamflows, which can be very time consuming; the surveying effort, which limits the maximum size of the surveyable reach; the challenge of conducting in-stream surveys in large and non-wadeable rivers.

2. MODELLING FRAMEWORK

The modelling framework integrates RS and 2D hydraulic modelling to map meso-scale fish habitat suitabilities (Fig. 1). In this contribution, we present an example for a 750 m reach of a recently restored meandering section of the Aurino River (NE Italy). The workflow implements: RS-based survey of the topo-bathymetry (in the form of a DTM, acquired via Airborne LiDAR Bathymetry) and the acquisition of a high-resolution RGB orthophoto (acquired with a drone); 2D hydraulic modelling to numerically estimate the distribution of water depth and velocity at a number of discharges; the outputs of the 2D hydraulic model are used to automatically map hydro-morphologically defined units (following the procedure described in Farò et al. 2022); a semi-automated approach to describe the spatial distribution of non-hydraulic habitat descriptors (e.g. substrate and flow refugia) from the orthophoto; and finally, the estimation of meso-scale habitat suitabilities, used to derive the habitat – flow rating curves, according to the MesoHABSIM methodology (Vezza et al. 2014).

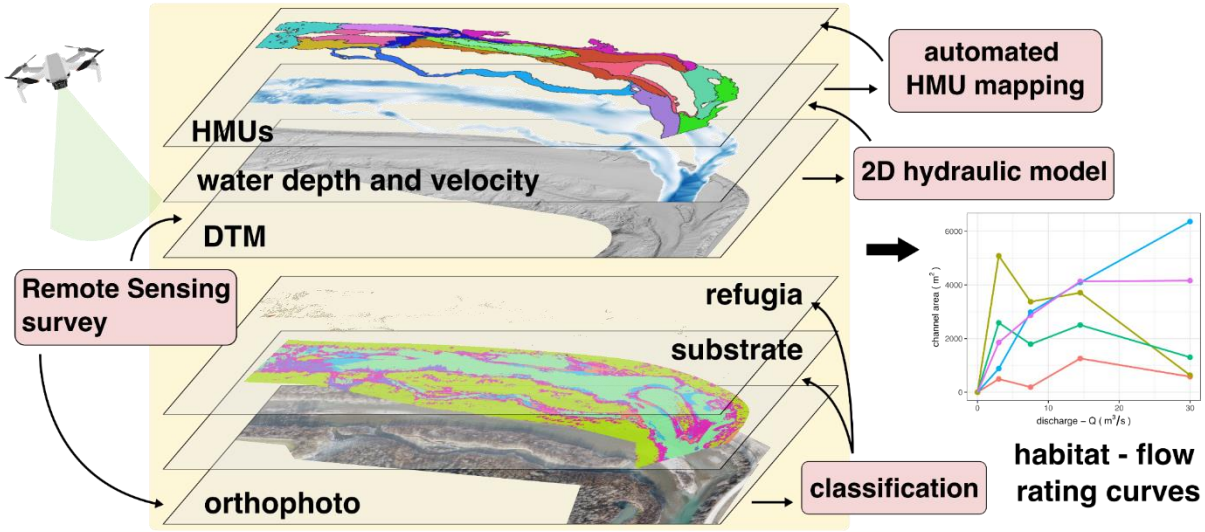

Fig. 1. Modelling framework (and examples from the Aurino reach).

3. CONCLUSION

We show the potential of combining RS and 2D hydraulic modelling coupled with automated procedures to map meso-scale hydro-morphologically defined units and habitat descriptors to derive fish suitability maps and hence habitat-flow rating curves. The presented framework allows objective and repeatable surveys on large gravel bed rivers, with lower surveying effort, making it possible to increase the modelled reach size, survey non-wadeable in-stream conditions, and potentially increasing the number of habitat modelling applications.

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