Modelling Of Hydro-Geomorphological Processes Related To Sediment Transport: Case Study of the Baganza River (Italy)

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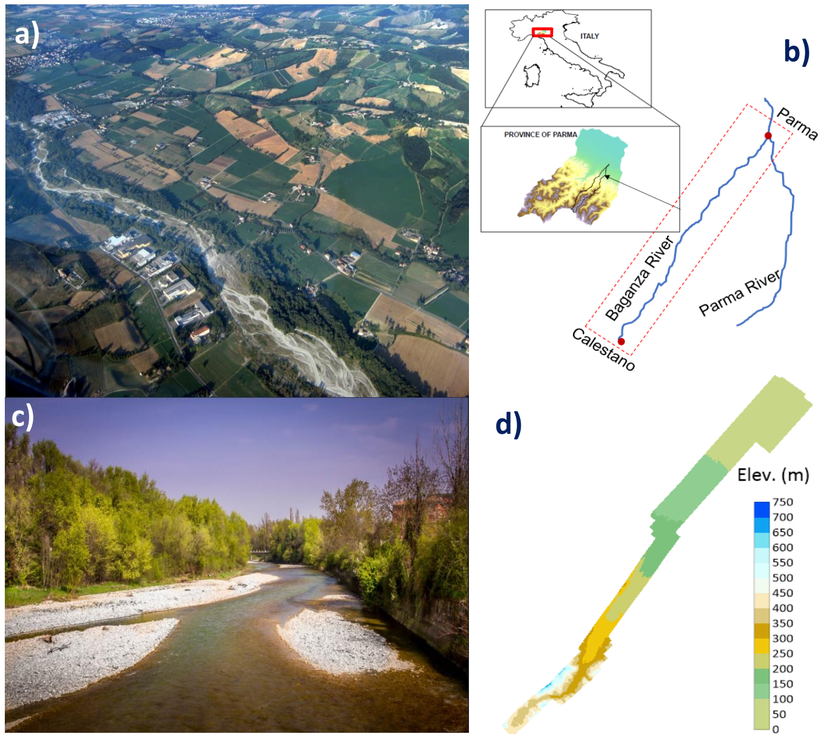
1. Introduction

Sediment transport models are crucial to simulate long-term morphological changes in rivers. The accuracy and reliability of these models are key for predicting geomorphological changes in river systems. However, many of these models have limitations including spatial and temporal scales, data requirements, model complexity, numerical stability and computational cost. In this study, we tried to address these limitations by testing a 2D weakly coupled numerical model for bedload transport in a real application.

2. Study Area

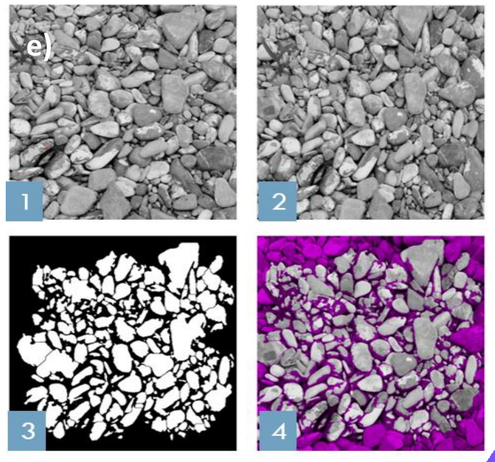
Baganza river is in Emilia Romagna region, northern part of Italy, with a basin area of 228 km^2. The total river length is 55 km, and it ends up intersecting Parma river, close to “Ponte Italia” bridge. This research focuses on the 28 km-long stretch between Calestano and Parma. Avg. river slope is in the order of 0.8-1.5% and grain sizes in the order of 2-30 mm as per field data.



a) *Aerial view of the Baganza river valley showing multithread braided river pattern.* ***b)*** *Study area of 28 km long stretch from Calestano to Parma.* ***c)*** *Visible morphological features in baganza river i.e., bars, riffle and pool pattern along with thick vegetation.* ***d)*** *High resolution DTM of Baganza River.*

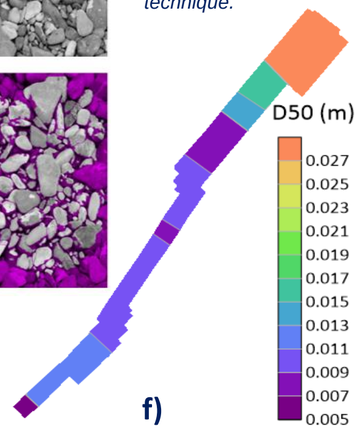
3. Grain size distribution

GSD data were obtained through a hybrid technique combining field sediment sampling and photogrammetry [1].



e) *Graphical illustration of key steps performed in Digital Gravelometer software for identification and measurement of different grain. 1) Grey-scaling 2) Projection transformation for camera adjustment 3) Grains selection 4) Grey scale image mask overlay on the selected grains in previous step.*

f) *D50 particle size raster map obtained from combining field sampling and photogrammetry technique.*



4. Numerical model

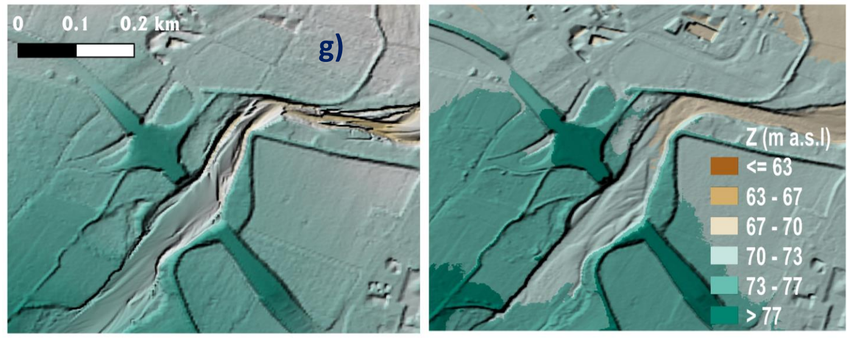
The 2D weakly coupled numerical model solves the Shallow water and Exner equations for the liquid and solid phases, respectively, based on previous works [2,3]. The solid discharge of the sediment is approximated using the Meyer-Peter and Muller formula. High computational efficiency is guaranteed by parallelization on Graphics Processing Units.

5. Application

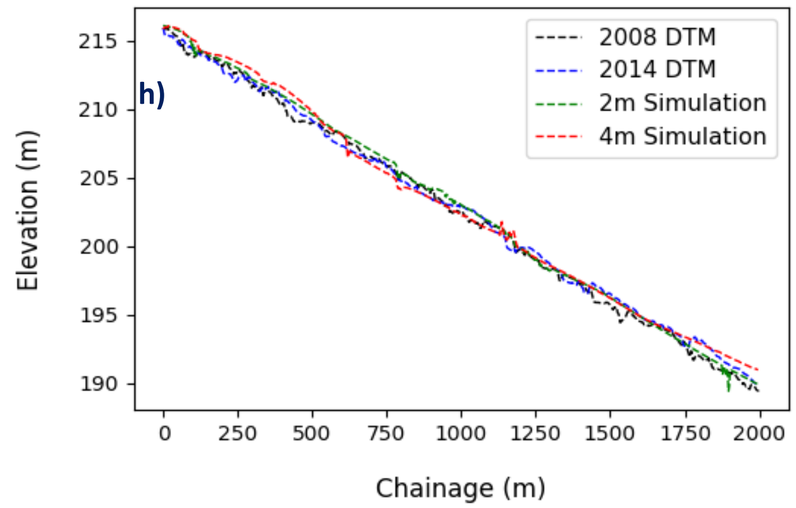
The numerical model is adopted to simulate the morphological evolution of the selected stretch in the period 2008-2014. Starting from the topography obtained from a high-resolution DTM carried out in 2008, the 2008-2014 series of floods was modelled. Two different mesh resolution (2 × 2 m and 4 × 4 m) were considered. The resulting riverbed topography was compared with the one extracted from a DTM carried out in 2014.

6. Results

The preliminary results are here reported. An overall fair agreement between surveyed and simulated bathymetries was obtained.



g) *Detail of the 2014 bathymetry: simulated (left) and surveyed (right).*



h) *Example of the longitudinal profile (first 2000 m) extracted along the initial (2008) and final (2014) DTMs and the final numerical results obtained using 2 m and 4 m resolution.*

7. Conclusions

The overall agreement between the measured and simulated results suggests the usefulness of 2D weakly coupled model for simulating hydro-geomorphological processes in the Baganza River. Moreover, the hybrid technique adopted for the grain characterization provides realistic representation of the sediments and increases the reliability of the model predictions.

This presentation participates in OSPP
Outstanding Student & PhD candidate Presentation contest

[1] Khan, U. A., & Valentino, R. (2022). Investigating the Granulometric Distribution of Fluvial Sediments through the Hybrid Technique: Case Study of the Baganza River (Italy). Water, 14(9).
[2] Vacondio, R., Dal Palù, A., & Mignosa, P. (2014). GPU-enhanced finite volume shallow water solver for fast flood simulations. Environ Model Softw, 57.
[3] Juez, C., Murillo, J., & García-Navarro, P. (2014). A 2D weakly-coupled and efficient numerical model for transient shallow flow and movable bed. Adv Water Resour, 71.

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