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BEDFLOW: integrating river morphodynamics in the Sillaro River across spatial and temporal scales

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Anthropogenic disturbance is one of the main drivers of contemporary river adjustment. In mountain streams, information and prior work on post-disturbance recovery rates is limited, compared to lowland counterparts. The BEDFLOW initiative aims to investigate fluvial morphodynamics along the mountain portion of the Sillaro River (138 km^2), Northern Apennines, to guide local strategies of sediment management at the basin scale and improve environmental quality of this fluvial system. Of particular interest is the understanding of the historical and contemporary response of the Sillaro River to gravel mining activities, which focused in the mid-to-lower portions of the river between the mid-1940s and the early 1980s. To this end, BEDFLOW adopts a multi-scale approach that integrates: (1) historical analysis of planform channel changes across the entire montane channel main stem over the past 100 years; (2) hydraulic and bed texture characterization of 14 representative reaches that encompass drainage areas comprised between 2.7 and 113 km^2; and (3) flood-event scale, RFID bedload monitoring in two reaches, complemented by topo-photogrammetric surveys of the subaerial and submerged channel bed.

Analysis of historical channel changes was conducted by mapping active channel width on historical topographic maps (1928) and across 11 sequential aerial photo sets (1954, 1969, 1976, 1988, 1996, 2000, 2008, 2011, 2014, 2016 and 2018), along a valley segment of about 26 kilometers (i.e., 35 homogeneous reaches). Vertical channel adjustment was assessed by comparison of long profiles extracted from 1928 and 1976 topographic maps.

Preliminary results indicate that the river has experienced intense channel narrowing between 1969 and 1996. This pattern has progressively slowed down, even though narrowing continues until today. Cumulatively, reduction in active channel width has been highest in the distal most unconfined reaches, where median width has decreased from >120 m in 1954 to about 20 m in 2018, intermediate in semi-confined reaches (from 99 m to 28 m), and least in the upper confined reaches (from 30 m to 15 m). In the semi-confined and unconfined reaches, where most of the gravel mining took place, channel pattern has changed from braided to wandering and/or from wandering to single-thread. Today, after about 35 years since in-channel gravel mining became interdicted, the river still exhibits signs of incomplete recovery, as bedrock sporadically outcrops

amidst mid channel bars, formerly occupied by braided plains.

The two monitoring reaches, which are active since February 2020, have contrasting morphology and degree of hillslope coupling. The upper one (drainage area = 35 km^2) is a riffle-pool, uncoupled reach, characterized by a fine-to-coarse gravel texture and a channel slope of 0.8 %. The lower one (50 km^2) is a transitional reach with dominantly plane-bed morphology and lesser riffle-pool and step-pool stretches; it is characterized by fine gravel to boulder texture, and by a channel slope of 1.5 %. The b-axis of deployed tracer stones spans from 36 to 180 mm.

The Sillaro River basin functions also as a training site for students. This work, as part of the projects BEDFLOW and BEFLOW PLUS, is partially funded by Fondazione Cassa di Risparmio in Bologna.

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