BEDFLOW: Integrating fluvial and hillslope morphodynamics in the Sillaro River basin across spatial and temporal scales

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https://site.unibo.it/bedflow/en

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Introduction

BEDFLOW aims to evaluate fluvial dynamics along the mountain portion of the Sillaro River, in order to improve the stream channel quality.

Action 1 and Action 2

• Investigation of the historical (1920’s – 2018) channel changes in relation to natural and anthropogenic forcing
• Compilation of a multi-temporal earthflow inventory

Action 3

• Evaluation of the downstream hydraulic geometry and monitoring of bedload transport
Study Area

The Sillaro River, is located in the Northern Apennines. It originates from Monte Tre Poggioli (966 m a.s.l.), near Piancandoli (Tuscany) and flows through Castel San Pietro (75 m a.s.l.).

Study area: 139 km²

Elevation ranges from 996 m to 56 m a.s.l.

Geology is dominated by siltstones and argillites

Dominant hillslope processes of sediment supply: earthflows
Methods – Action 1 and Action 2

**Action 1**
Channel changes in relation to natural and anthropogenic forcing

**Action 2**
Reconstruction of landslide sediment supply

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**Geomorphological mapping in GIS environment**

**Historical orthophoto sets:**
- 1954
- 1969
- 1976
- 1988
- 1996
- 2000
- 2006
- 2008
- 2011
- 2014
- 2016
- 2018

- Active channel width
- Subdivision into 35 channel reaches
- Earthflow total disturbed area
  - Mapped all earthflows observed
- Reconstructing historical channel changes
- Multi-temporal earthflows inventory

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**Products**

**Mapping**
Methods – Action 3

Data acquisition

- Photogrammetric survey of Ground Control Points (UAV)
- Topographic survey of Ground Control Points (Total Station and GNSS System)

Data processing through Agisoft Metashape

- Photos with high overlap (90-95%)
- Aligning photos
- Sparse point cloud
- Georeferencing
- Dense point cloud
- Digital Surface Model (DSM)
- Orthorectification
- Filtering

Products

- Orthophoto mosaic
- DTM
RESULTS: Action 1 - Reconstructing historical (active) channel changes

Example of morphological changes observed in study reaches #19 and #20 in: A) 1954, B) 1976, C) 1996, and D) 2016.
RESULTS: Action 1 - Reconstructing historical (active) channel changes

Multi-temporal representation of the average channel width changes
RESULTS: Action 2 - Compilation of a multi-temporal earthflow inventory

- **Dominant geology:** argillites & siltstones of the Ligurian domain
- **Dominant landslide type:** earthflows
RESULTS: Action 2 - Compilation of a multi-temporal earthflow inventory

Total earthflows number = 1085

Total disturbed area = ~ 6 km$^2$

Single movements = 319

Recurring movements = 766
Action 3 - Downstream Hydraulic Geometry & Bedload monitoring

The characterization of the downstream hydraulic geometry and shear stress at bankfull is based on field-base measurements of 5 channel cross sections conducted in 11 reaches of the main course of the Sillaro River and along 3 sections of two tributaries, for a total of 70 cross sections. The drainage area of the reaches spans from 2.7 km² up to 112 km².
Action 3 – Downstream Hydraulic Geometry & Bedload monitoring

Both study reaches are equipped with a water pressure transducers recording water level every 10 minutes

Detail of cross section D3 (looking upstream)
Reach 1

Detail of cross section G1 (looking upstream)
Reach 2
Topographic characterization of the study reaches is was conducted by UAV photogrammetric surveys, complemented with total station georeferencing of Ground Control Points (GCPs). Bedload transport will be monitored through RFID technology, via deployment of PIT tagged tracers particles.
Action 3 - Bedload transport monitoring

Reach 1: Riffle-pool morphology, channel slope 0.8%
Action 3 - Bedload transport monitoring

Reach 2: Plane-bed morphology, channel slope 1.5%
FUTURE WORK - post COVID-19 lockdown

100 PIT-tagged tracers are ready for deployment in Reach 1

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<th>Passing (mm)</th>
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<th>Weight (g)</th>
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<td></td>
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</table>

Additional 100 tracers are being prepared for Reach 2

A new photogrammetric UAV survey is scheduled at time of PIT tracer deployment

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