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Alternative approach for works controlling stony debris flows

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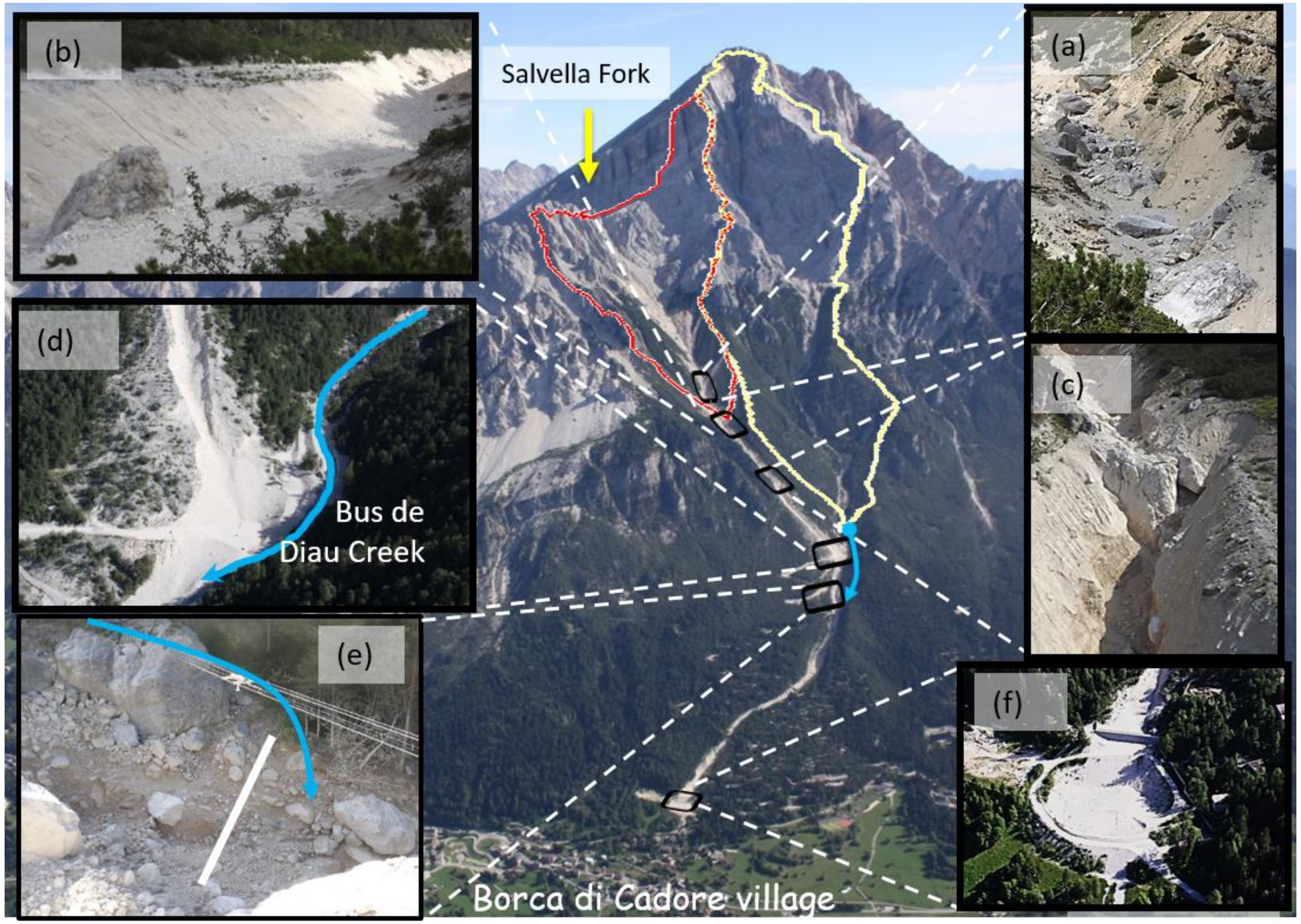
Wien, 5 May 2020

Outline

- Introduction to the study area (Rovina di Cancia – BL) and existing control works
- Presentation of the planned control works
- Performance analysis
- Results
- Final remarks

Study area – 1

Rovina di Cancia basin



a) upper part of channel
b) initiation area
c) rocky drop
d) deposition area with mouth of Bus de Diau Creek
e) open dam and new mouth of Bus de Diau Creek (under construction)
f) retention basins

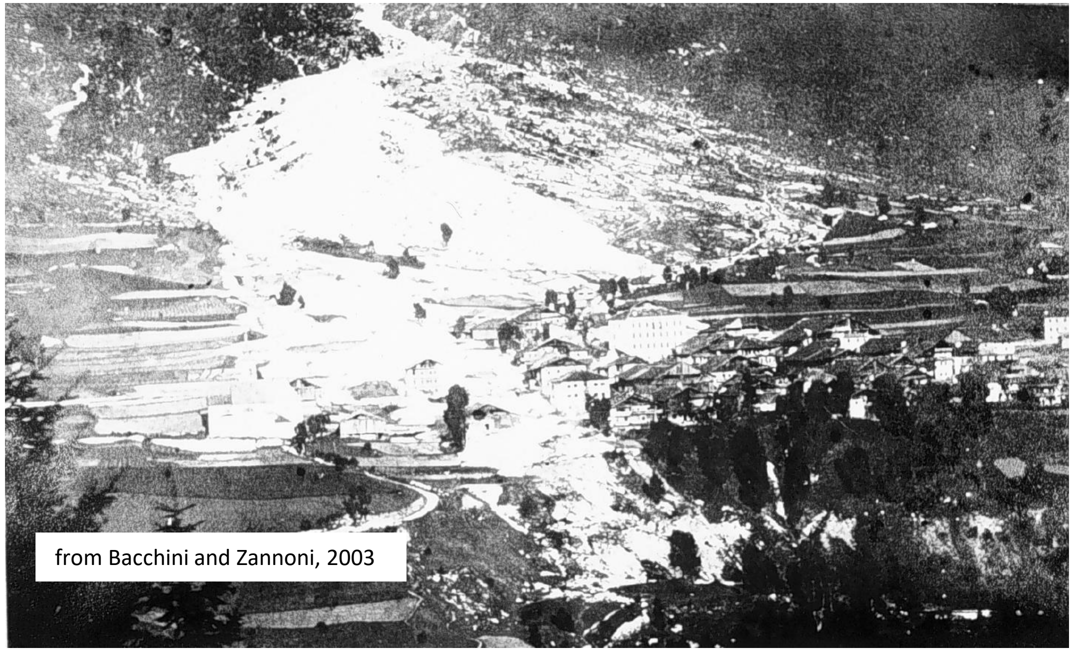
__ boundary of sub-basin closed at the initiation area

__ boundary of sub-basin of the Bus de Diau Creek

Study area – 2

Hystorical debris-flow events

The village of Borca di Cadore hit by the debris flow of July 27st 1868 (100000 m^3 and 12 victims)


from Bacchini and Zannoni, 2003

Historical data about DF activity are relatively abundant at Cancia and include a catastrophic event occurred on 1868 that buried the small village. DF are usually triggered by intense and short rain storms.

Bacchini M., and Zannoni A. (2003). Relations between rainfall and triggering of debris-flow: case study of Cancia (Dolomites, Northeastern Italy). Natural Hazards and Earth System Sciences (2003) 3: 71–79.

Study area – 3

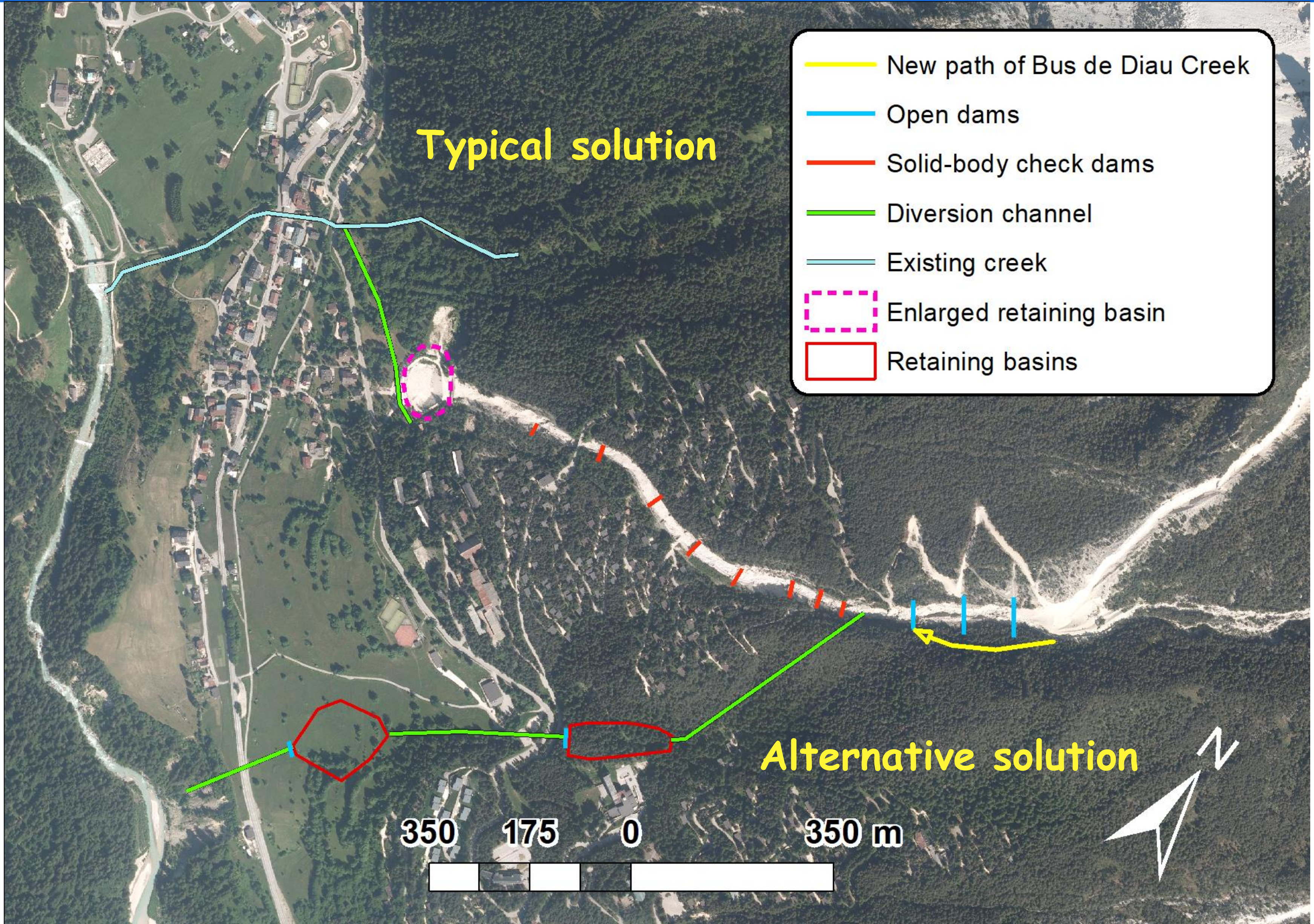
Critical points

1) The channel, downstream the upper deposition area, is locally subject to uncontrolled erosion and deposition phenomena that increase the volume of the transported sediments and could cause possible uncontrolled overflow respectively.

2) The ending retention basins are not sufficient to retain all the sediment volume transported by debris flow including the liquid queue.

Debris-flow event of July 18st 2009 (2 victims)

Planned works



Performance evaluation of the planned works 1

The performance evaluation of the planned works is carried modelling the phenomenon and its interactions with the proposed works following the methodology proposed by Bernard et al. (2019):

1) Determination of the design rainfall that maximizes the peak runoff discharge through the depth-duration frequency curve corresponding to a 300-year return period.
2) Modelling runoff hydrograph by the model of Gregoretti et al. (2016)
3) Determination of the solid-liquid discharge upstream the routing area through the method proposed by Gregoretti et al. (2019)
4) Downstream routing of input solid-liquid discharge by the model provided by Bernard et al. (2019).
5) Analysis of the maps of the maximum flow depths and of the deposition-erosion depths and of the discharge hydrographs

Gregoretti, C., Degetto, M., Bernard, M., Crucil, G., Pimazzoni, A., De Vido, G., Berti, M., Simoni, A., Lanzoni, S., (2016). Runoff of small rocky headwater catchments: Field observations and hydrological modeling. Water Resources Research.

Gregoretti, C., Stancanelli, L., Bernard, M., Degetto, M., Boreggio, M., Lanzoni, S. (2019) Relevance of erosion processes when modelling in-channel gravel debris flows for efficient hazard assessment. Journal of Hydrology, 569, 575-591

Bernard, M., Boreggio, M., Degetto M., Gregoretti C. (2019) Model-based approach for design and performance evaluation of works controlling stony debris flow with an application to a case study at Rovina di Cancia (Venetian Dolomites, Northeast Italy). Science of the Total Environment, 688, 1373-1388,

Performance evaluation of the planned works 2

Precipitation input

Rainfall-runoff model →

↓

Runoff hydrograph

Triggering model →

↓

Solid-liquid hydrograph

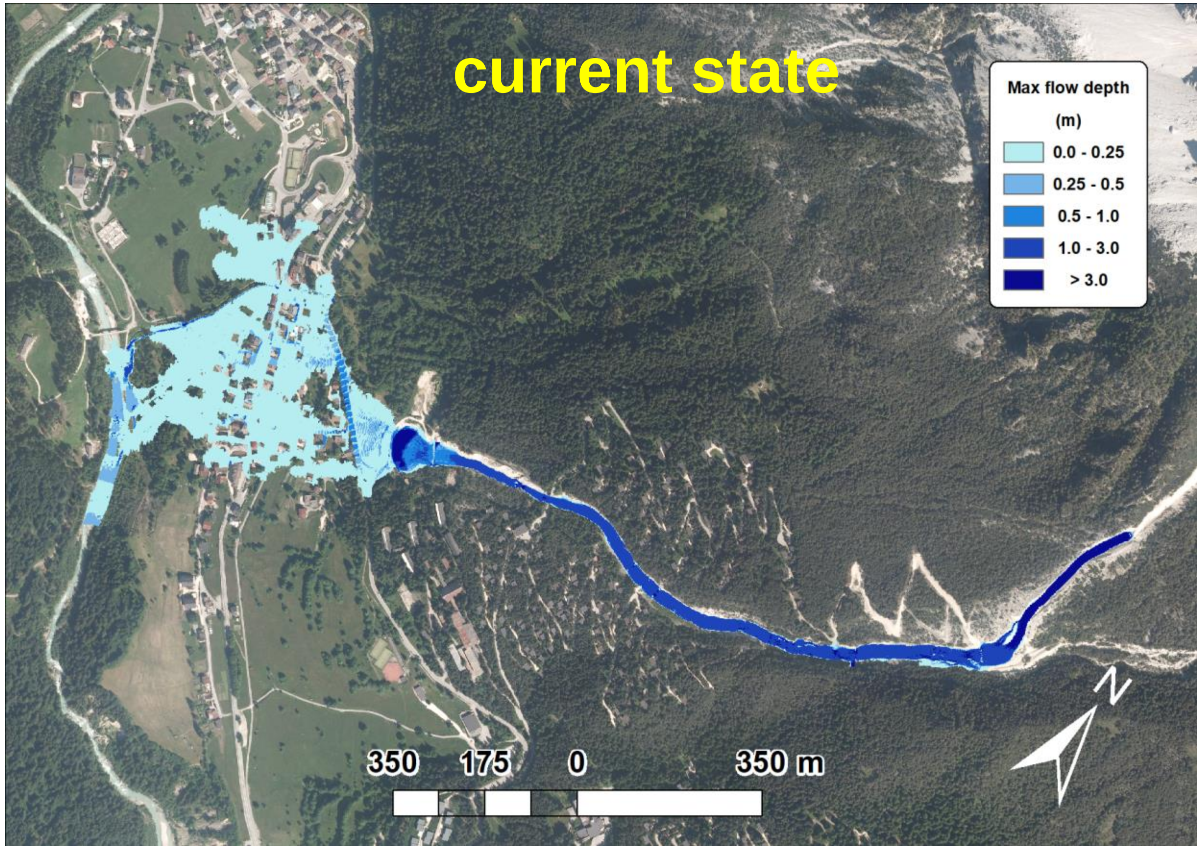
↓

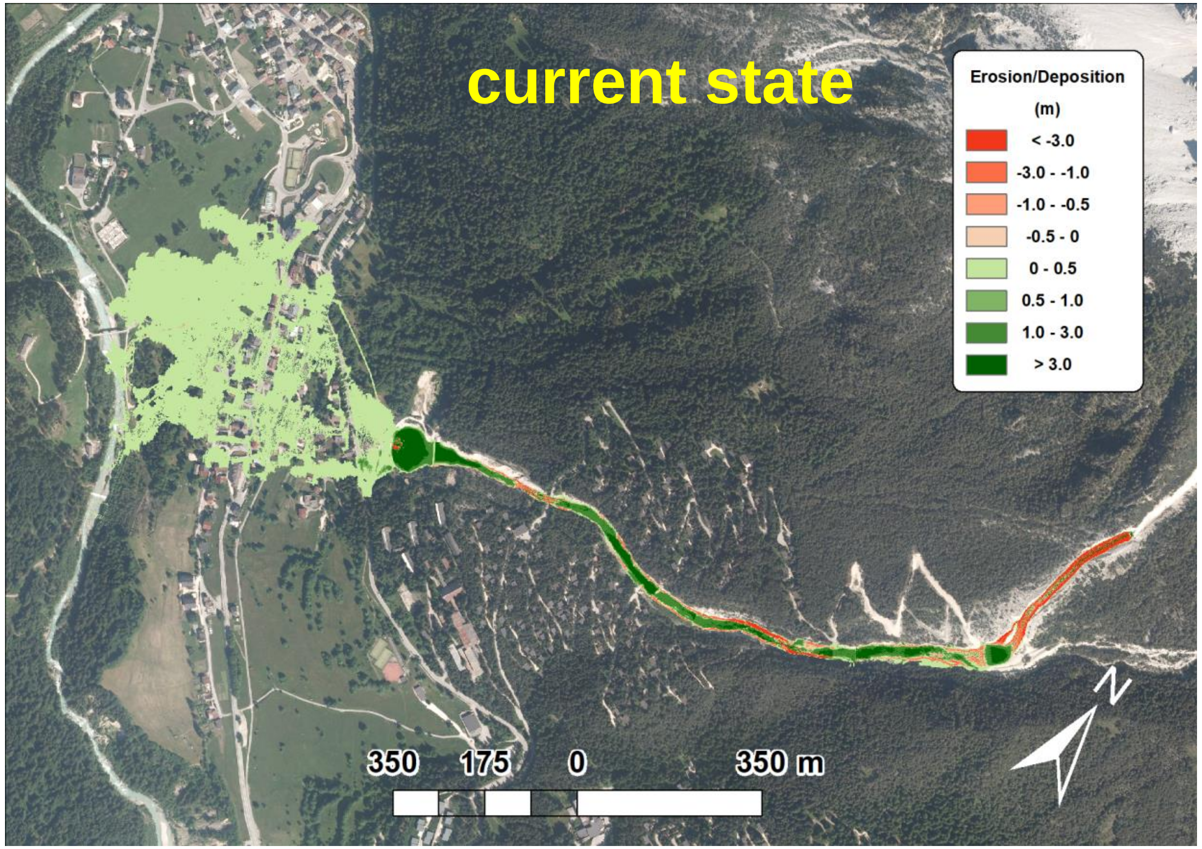
← Routing model

Map of the erosion and deposition-depths - discharge hydrographs

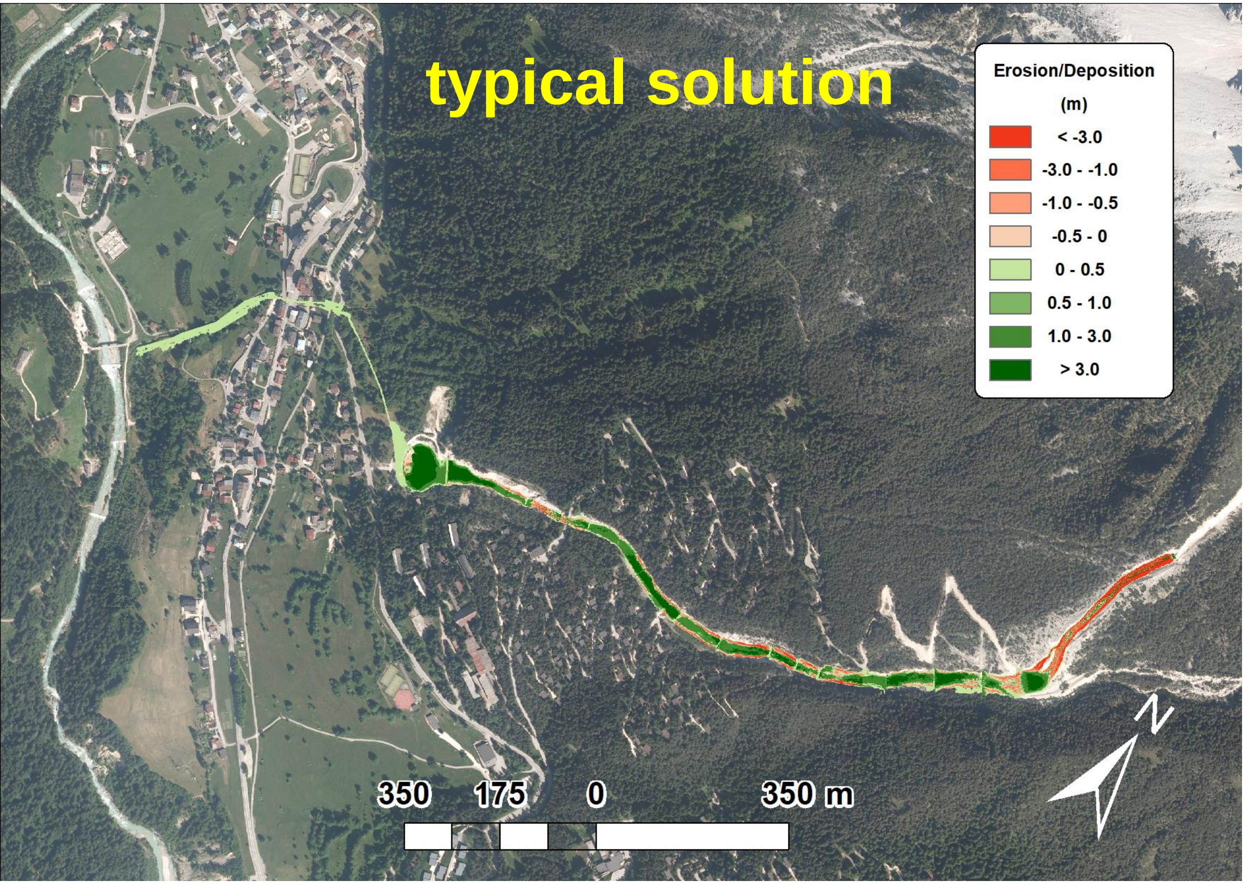
Results – 1

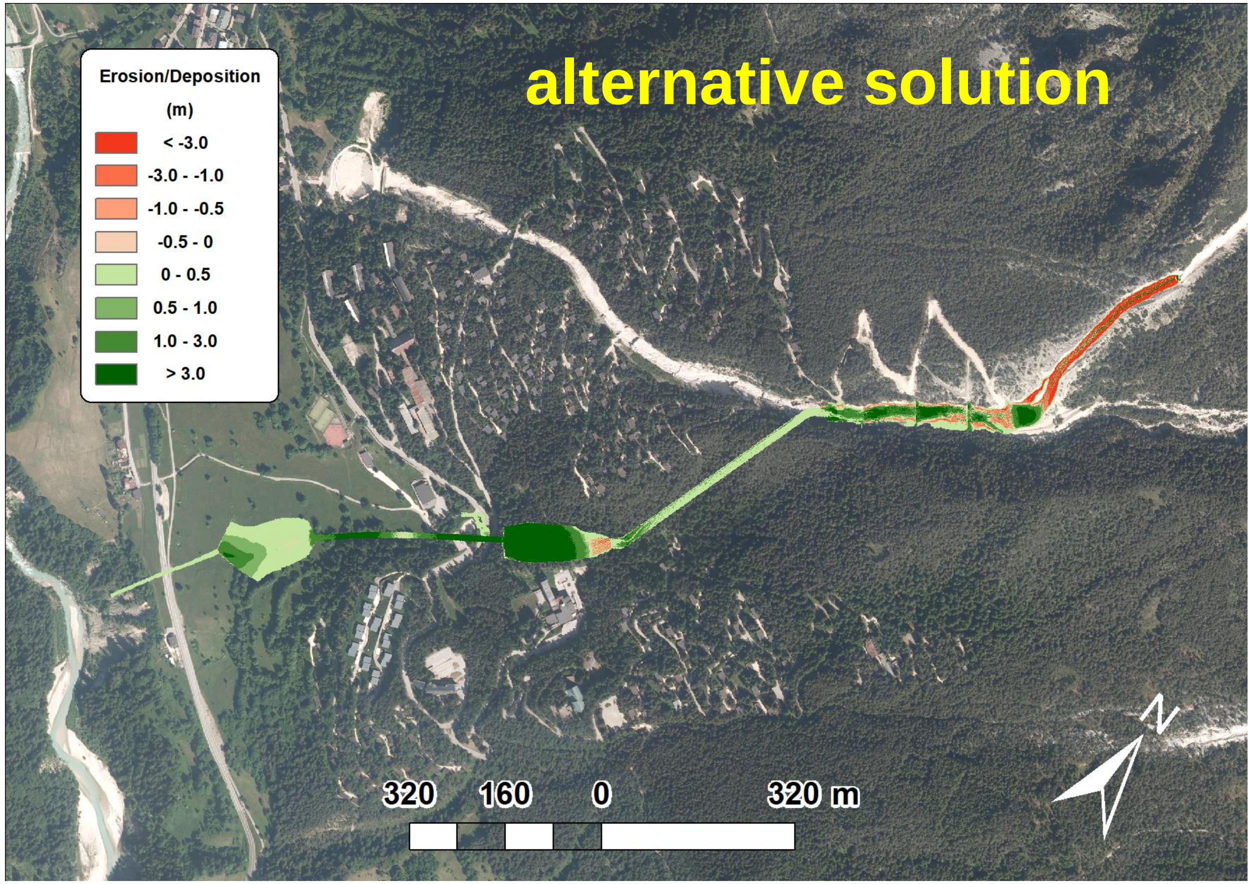
Results are shown in terms of map of max flow-depth, deposition-erosion depth and hydrograph discharge.





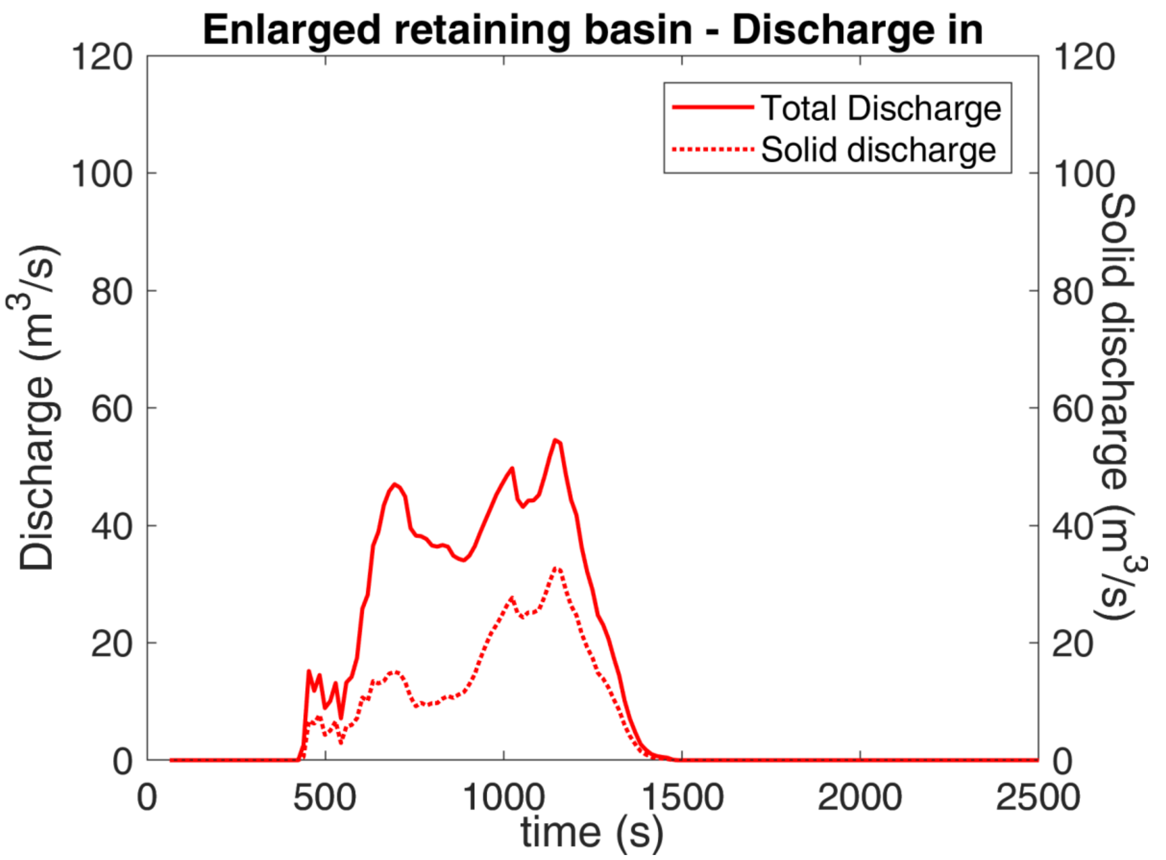
Results – 2

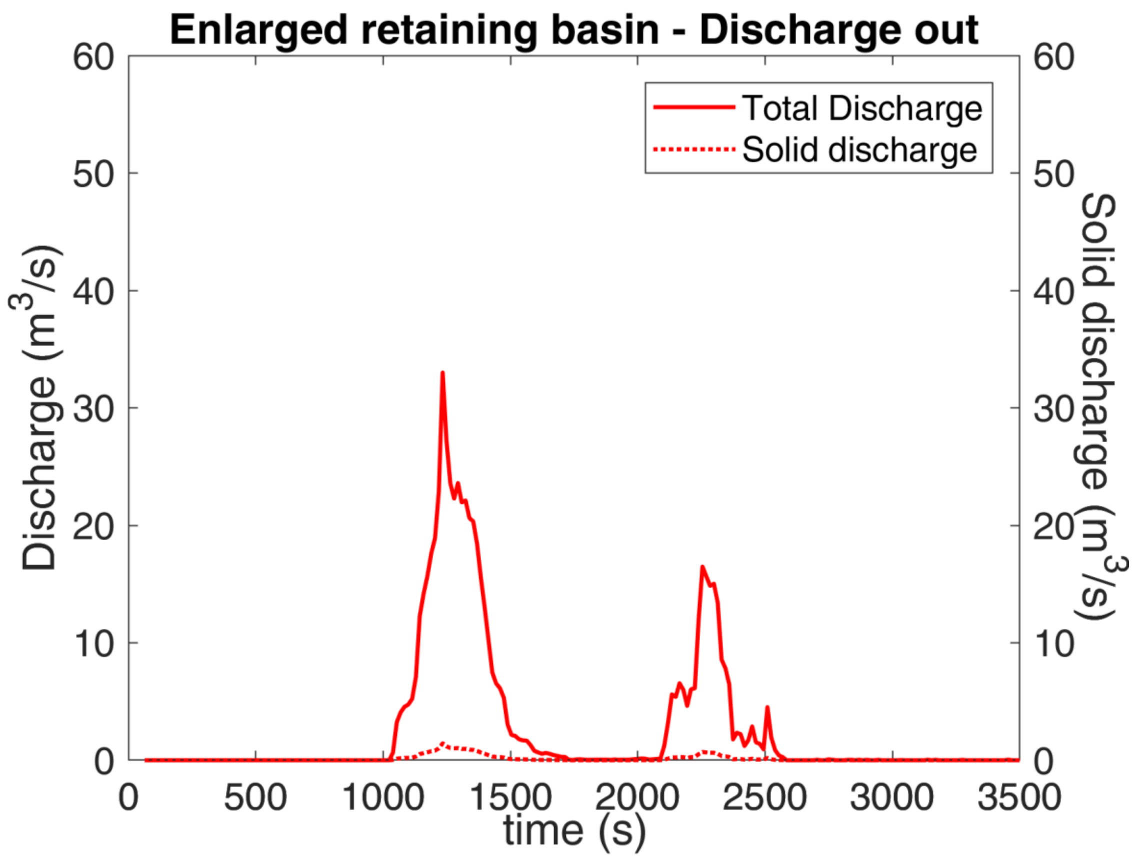

typical solution
Erosion/Deposition
(m)
< -3.0
-3.0 - -1.0
-1.0 - -0.5
-0.5 - 0
0 - 0.5
0.5 - 1.0
1.0 - 3.0
> 3.0
350 175 0 350 m
N


alternative solution
Erosion/Deposition
(m)
< -3.0
-3.0 - -1.0
-1.0 - -0.5
-0.5 - 0
0 - 0.5
0.5 - 1.0
1.0 - 3.0
> 3.0
320 160 0 320 m
N

Results – 3

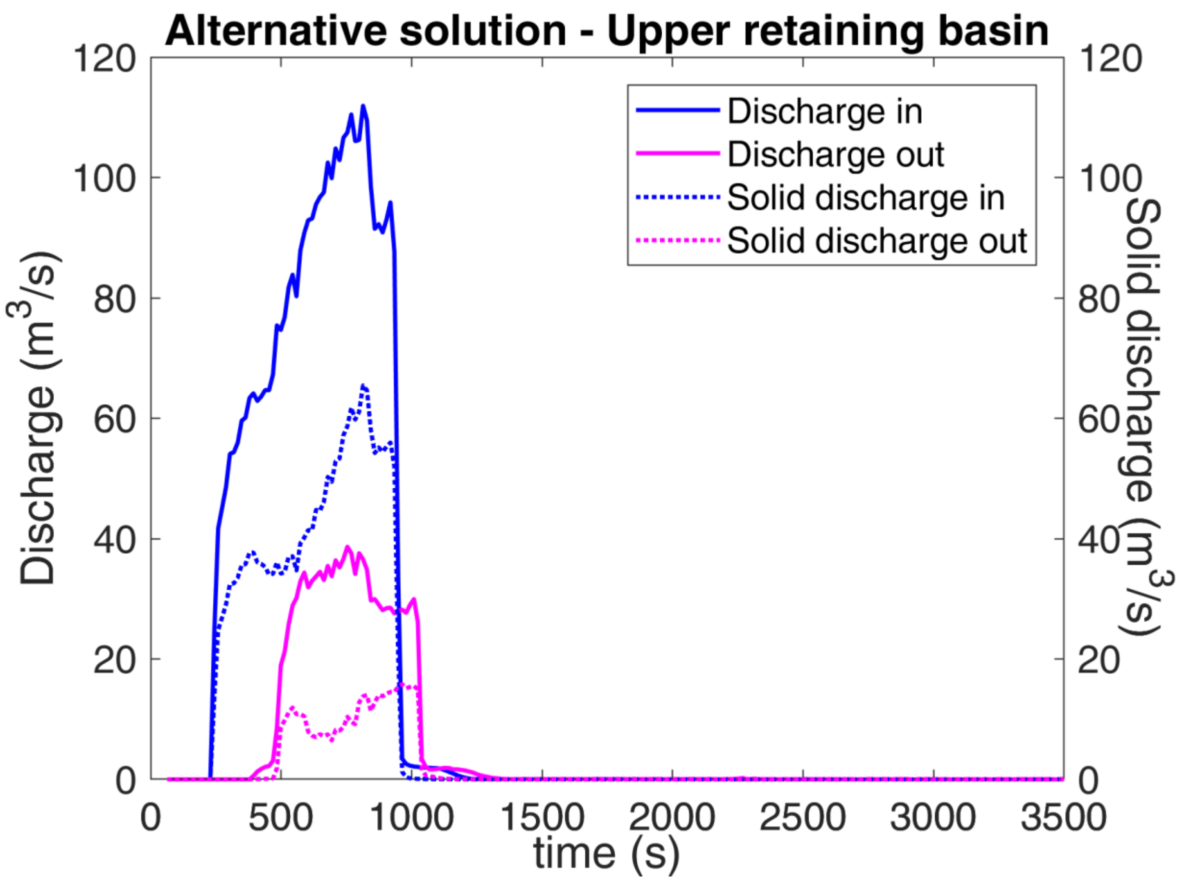
Typical solution

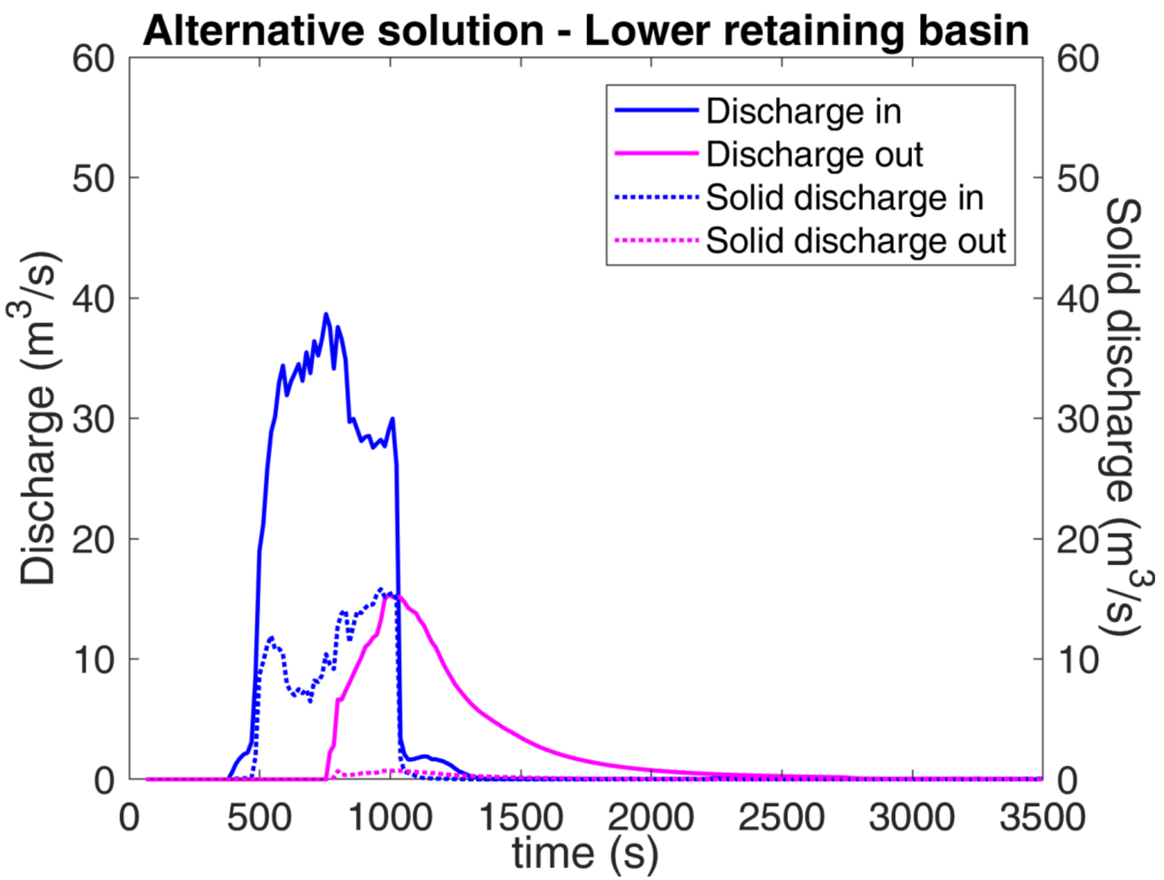




Results – 4

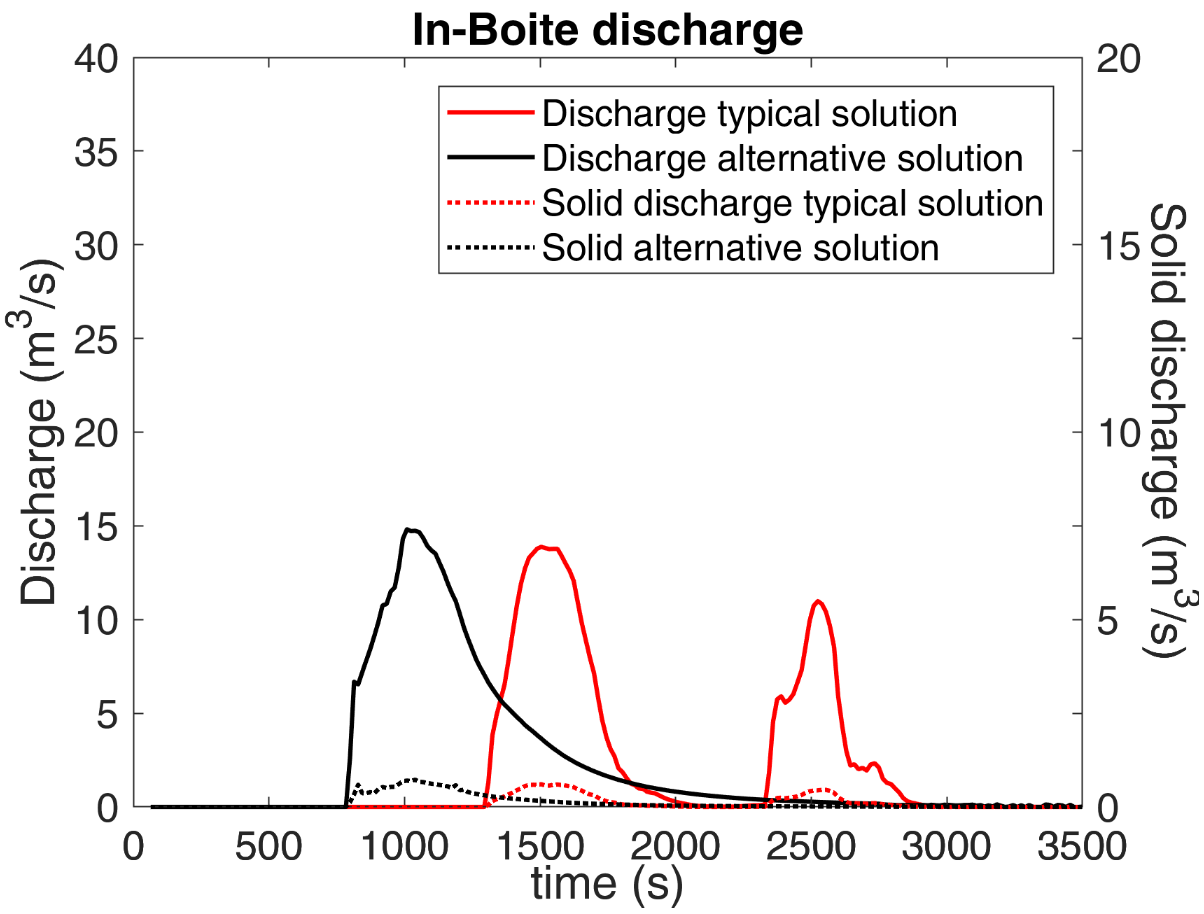
Alternative solution





Results – 5

Comparison between typical and alternative solutions for the in-Boite discharge



Final remarks

1) Both the planned works secure the village of Borca di Cadore.
2) The typical solution has the following drawbacks:
   a) high cost of construction and maintenance
   b) high impact on the village and main road
   c) presence of residual risk due to the filling of the channel and of the retaining basins in an inhabited area

3) The alternative solution that use morphological features shows:
   a) lower cost of construction and maintenance
   b) neglegible impact
   c) neglegible residual risk because constructed in an unhabited area with only two roads


Thank you for your attention