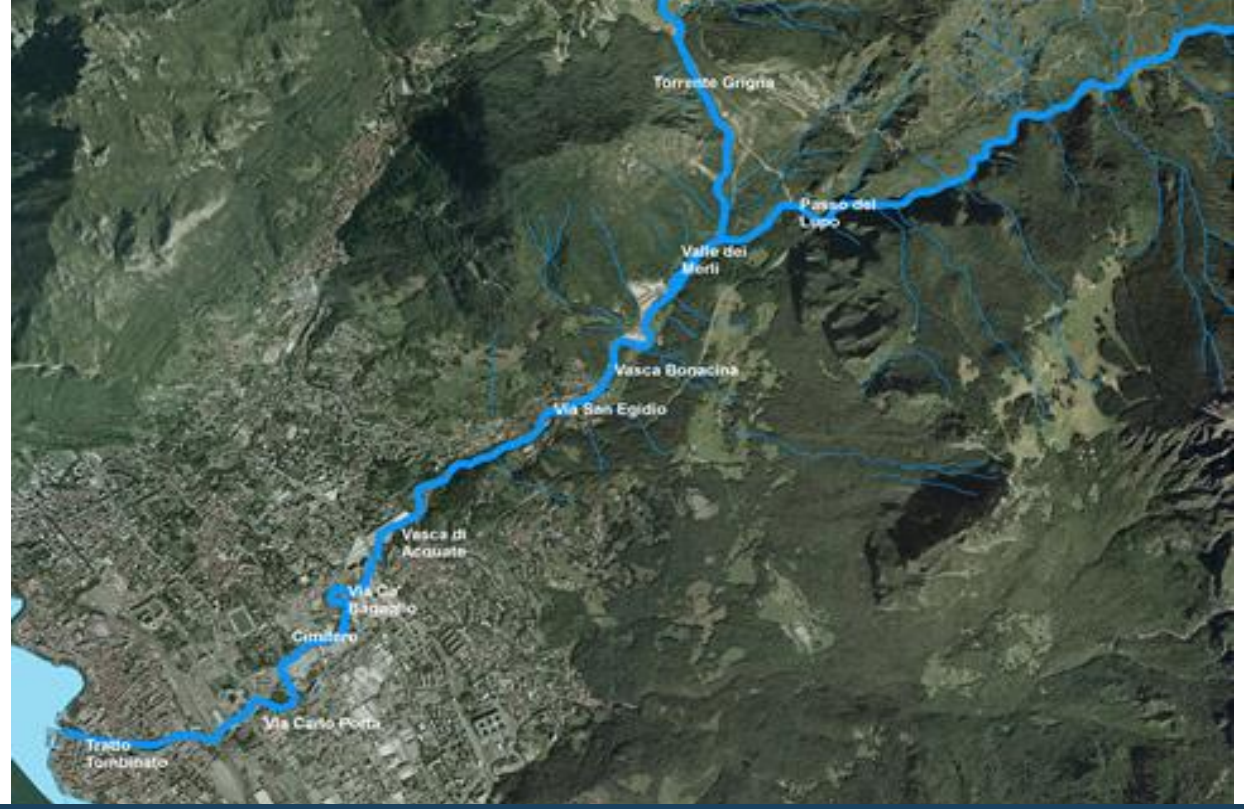
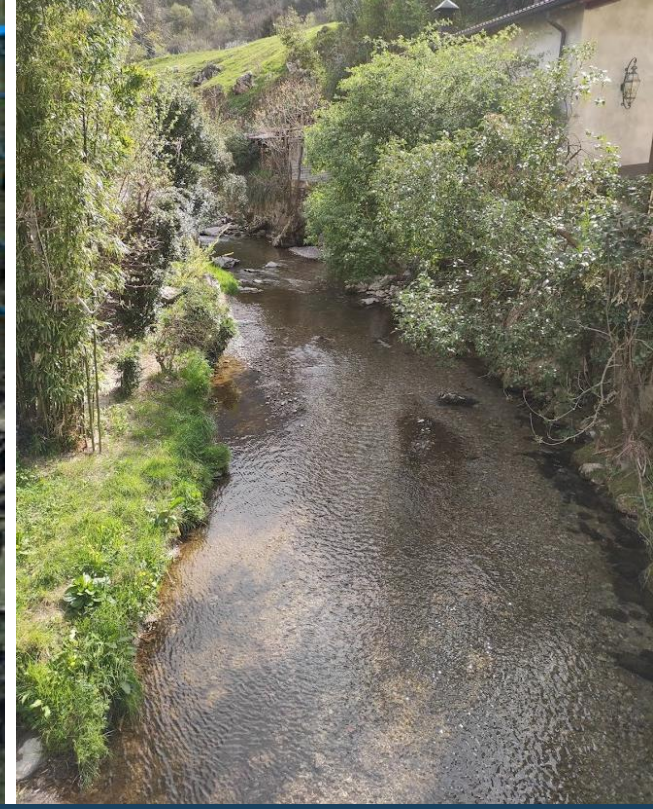




Applicability of SMART-SED, a new sediment erosion and transport model, to Alpine scenarios

Corti M.[1*], Gatti F.[2], Abbate A.[1], Papini M.[1], Longoni L.[1],

[1] Department of Civil and Environmental Engineering, Politecnico di Milano, Milan, Italy

[2] MOX - Department of Mathematics, Politecnico di Milano, Milan, Italy

POLITECNICO MILANO 1863

This presentation participates in OSPP

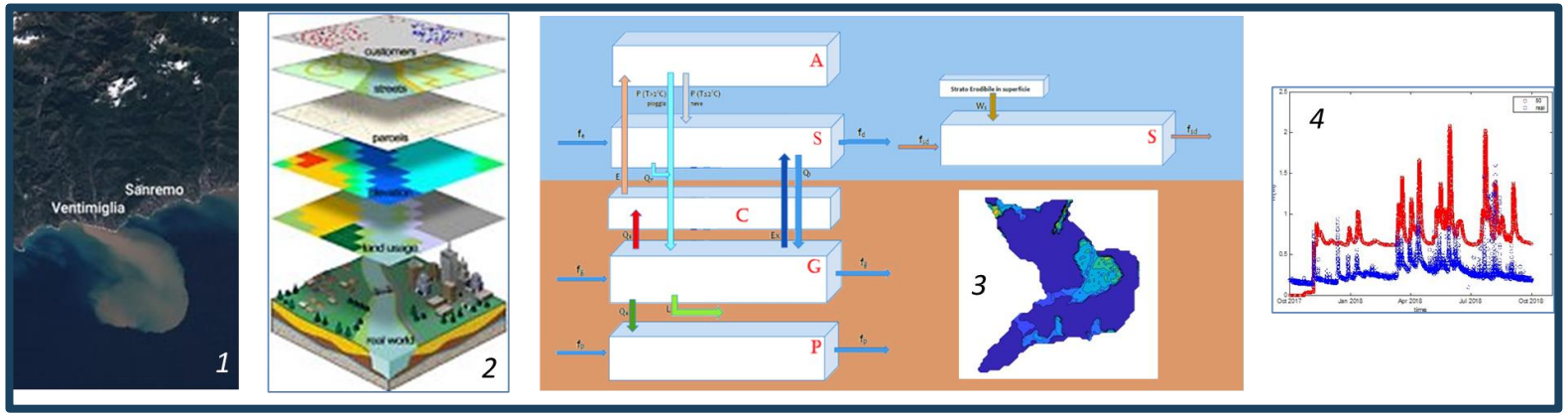
EGU

Outstanding Student & PhD candidate Presentation contest

Introduction

- Natural disasters → critical problem both in terms of **economic losses** and **casualties**.
- Frequency of landslide and flooding events expected to increase in relation to **climate change**.
- Italy 2020: 12 victims, over 3’000 evacuated people (CNR & IRPI, 2021).

SEDIMENT EROSION AND TRANSPORT MODELS




LA STAMPA

Un doppio Nobel per la pace
Premiati Malala e Satyarthi
i paladini dell’infanzia ferita

L’INCAPACITÀ DI CONTROLLARE LE EMERGENZE

Un morto e gravi danni nel centro invaso dal fango. Polemiche per i lavori non realizzati dopo la tragedia di tre anni fa

Genova, il dolore e la rabbia

Città in ginocchio per l’alluvione. Il sindaco: dalla Protezione civile nessun allerta

I SERVIZI

CORRIERE DELLA SERA

Como
Tronchi, rifiuti e fango
Il lago ferito dall’alluvione

Domani su 7
Morandi, Jova & Rossi
Tre amici e una hit:
l’allegria è una scelta

SCARPA

The SMART-SED model

SMART-SED: Sustainable Management of sediment transpoRT in reposnSE to climate change conditions (Project funded by Fondazione Cariplo).

Few simple inputs → open data

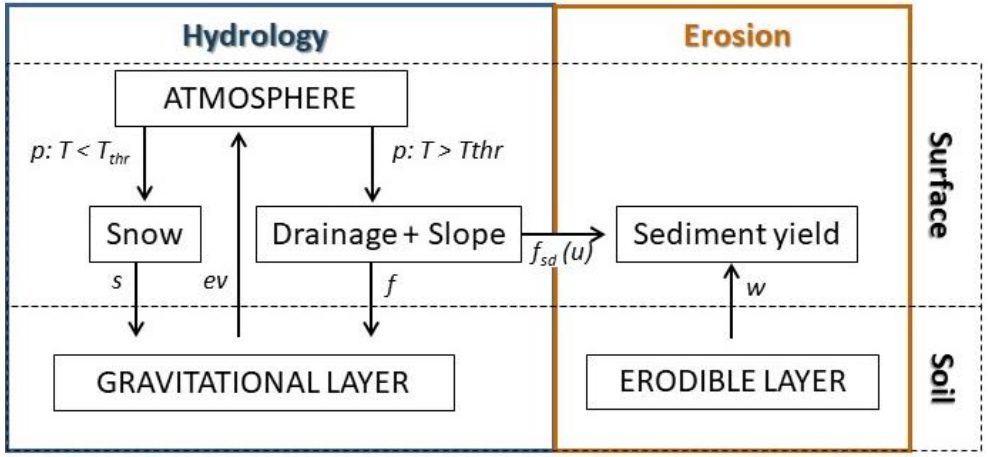
- Raster maps: DEM, land cover, granulometric composition of soils,
- Meteorological data (rain and temperature).

Outputs:

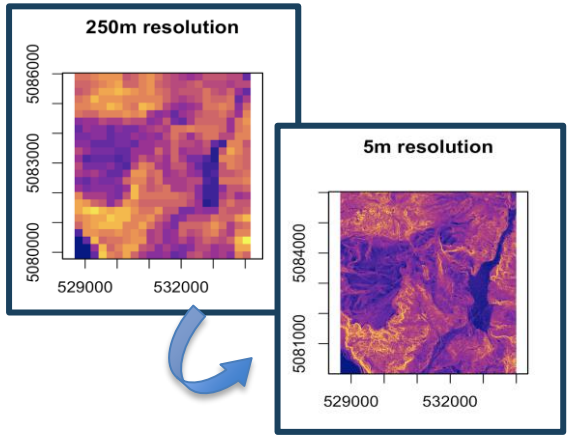
- **Liquid and solid discharge** at selected outpoints per time-step,
- **Raster maps** (per simulated day): water velocity components, sediment and water heights, infiltration, erosion.

Peculiarities:

- **Downscaling** of an online open-access soil database (SoilGrids) → particle size fractions necessary to model infiltration f and hydraulic conductivity k_c;
- Automatic determination of the drainage zones;
- Adaptive time step;
- Automatic handling of a wide range of transients.



(from Bonaventura, L., Gatti, F., Menafoglio, A., Rossi, D., Brambilla, D., Papini, M., & Longoni, L. (2021). An efficient and robust soil erosion model at the basin scale.)



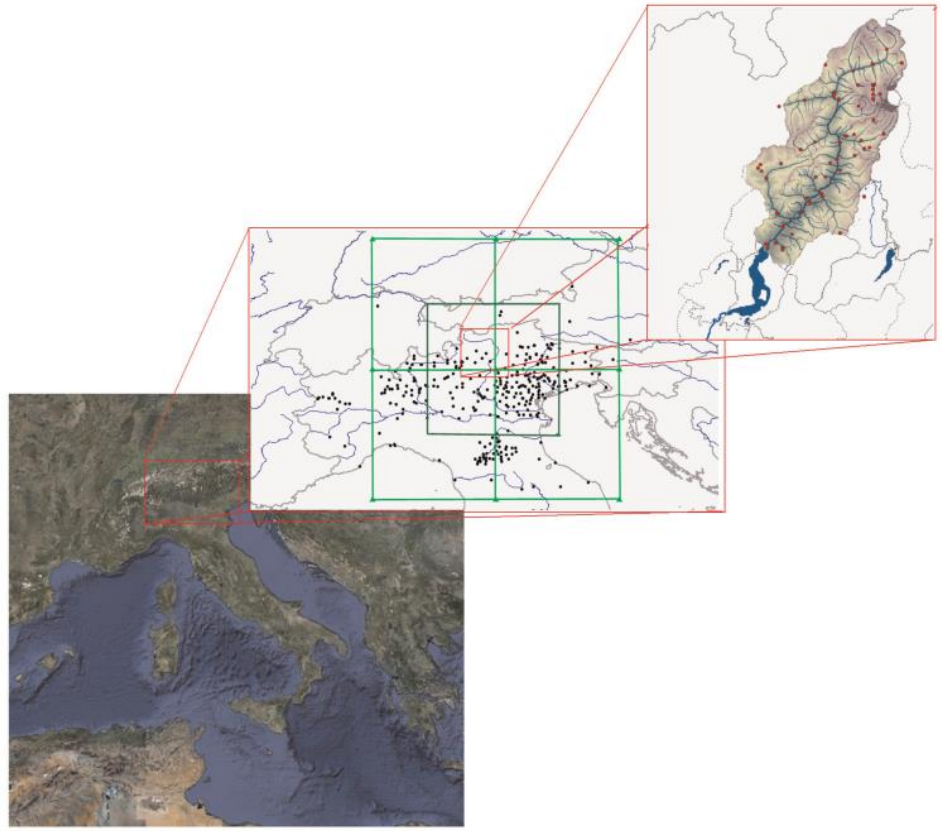
CONCEPTUAL MODEL:

- **Arrows**: vertical and horizontal fluxes,
- **Erosion model**: Gavrilovic EPM
- **Solid flux**: Smart and Jaeggi formula,
- **Infiltration**: SCS-CN method,
- **Snow-melting rate**: Degree-Day approach,
- **Evapotranspiration**: Hargreaves model.

Applicability of Smart-SED: work flow

1. **Calibration** of the model parameters → empirical parameters for erosion, runoff, infiltration,
2. **Validation** → field surveys and monitoring of a case study in Southern Alps,
3. Evaluation of the effects of **climate change** on the catchment

→ temperature and rainfall data after statistical downscaling of General Circulation Model scenarios.

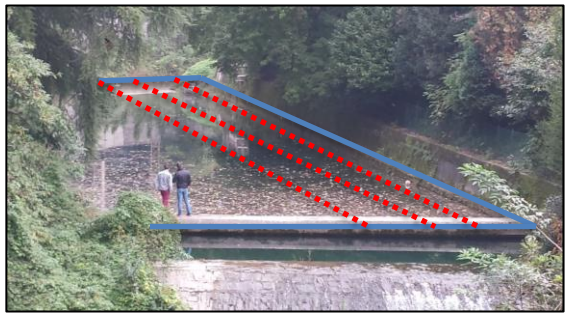


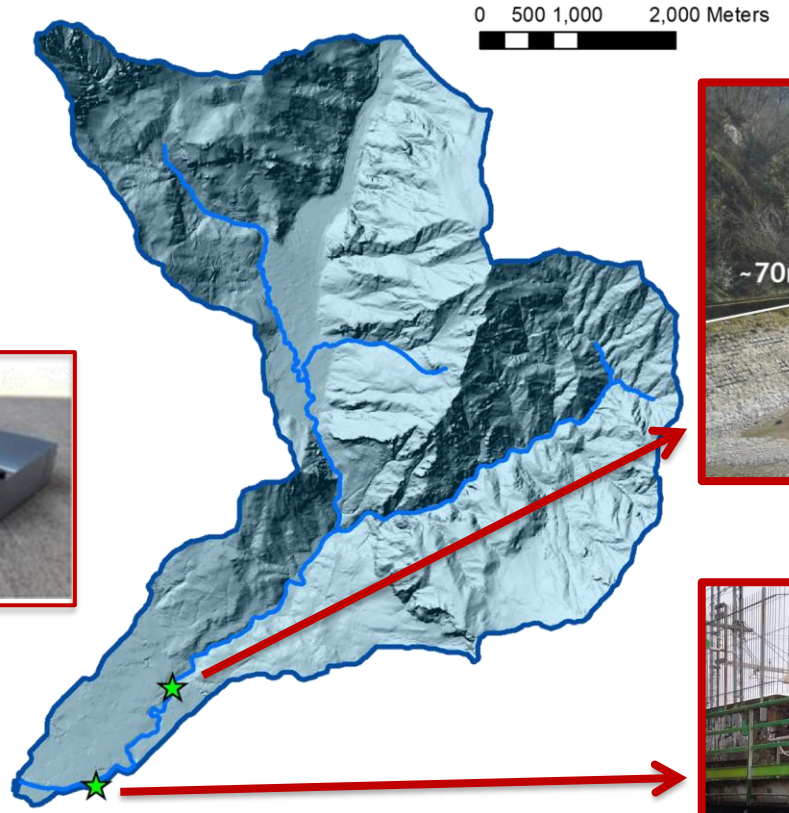
Downscaling technique from "Groppelli, B., Bocchiola, D., & Rosso, R. (2011). Spatial downscaling of precipitation from GCMs for climate change projections using random cascades: a case study in Italy. Water Resources Research, 47(3)".

Calibration and validation of the model

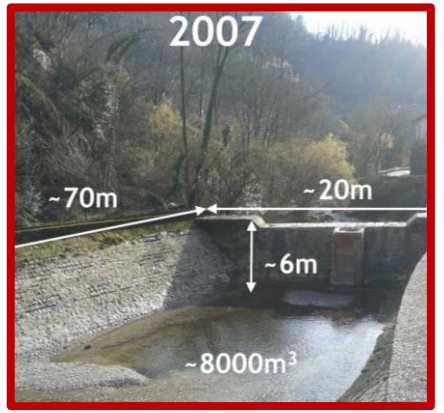
- **Case study:** the Caldone catchment, in Northern Italy.
- **Calibration and validation** of the model allowed by the presence of two ''control points''.

Tank filling measures → total station + aquatic drone

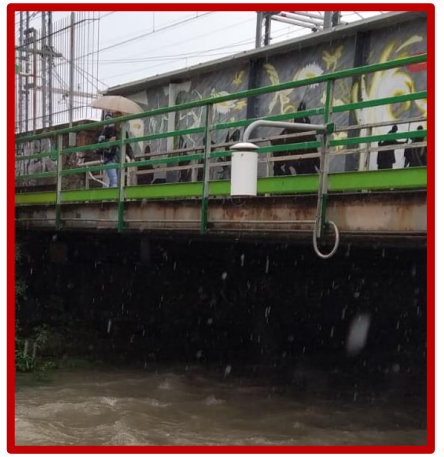




Sediment tank



Hydrometer



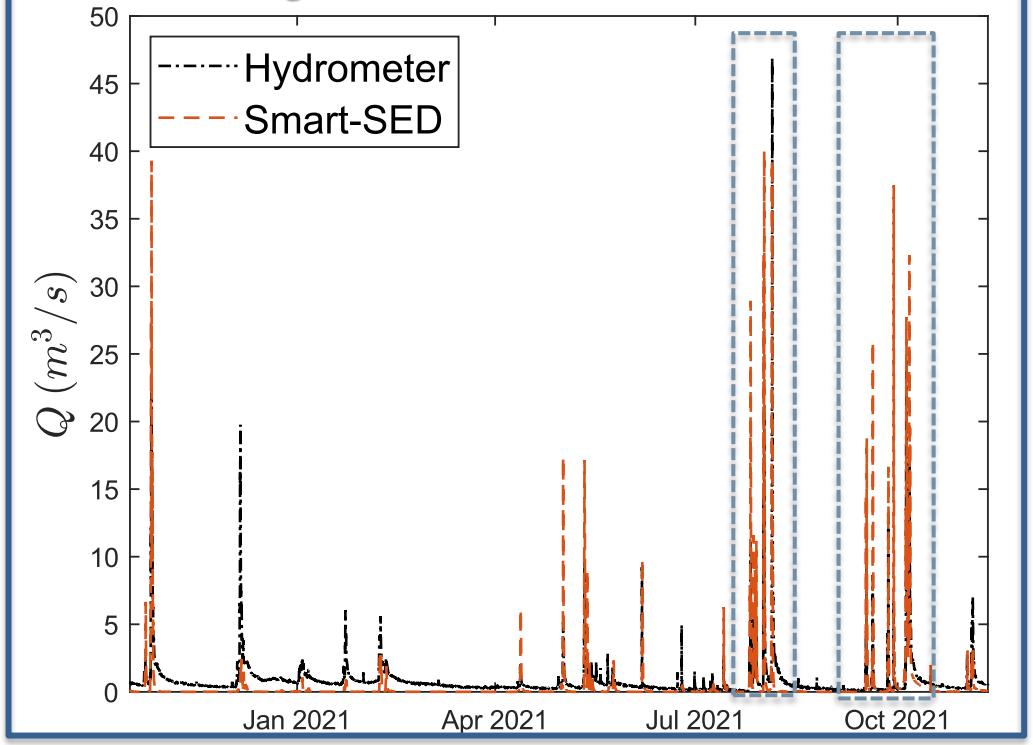
CATCHMENT AREA	MAX ELEVATION	MIN ELEVATION
28 km^2	2'170 m asl	197 m asl

Validation results

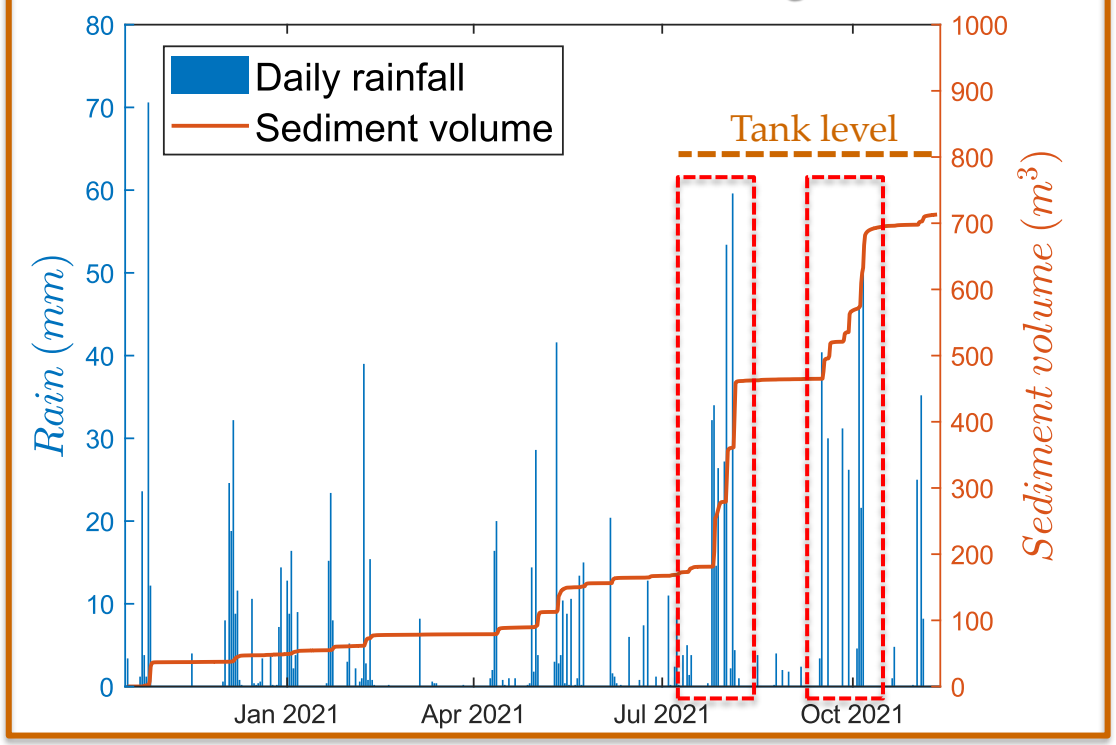
- **Water discharge** → **good results** compared to the data from the hydrometer (0 < NSE < 1),
- **Sediment discharge** → evaluated from sediment tank filling → **solid volume,**

→ Reliable tank filling estimation.

Water discharge



Cumulative sediment volume → Tank filling



Nash-Sutcliffe Efficency Index

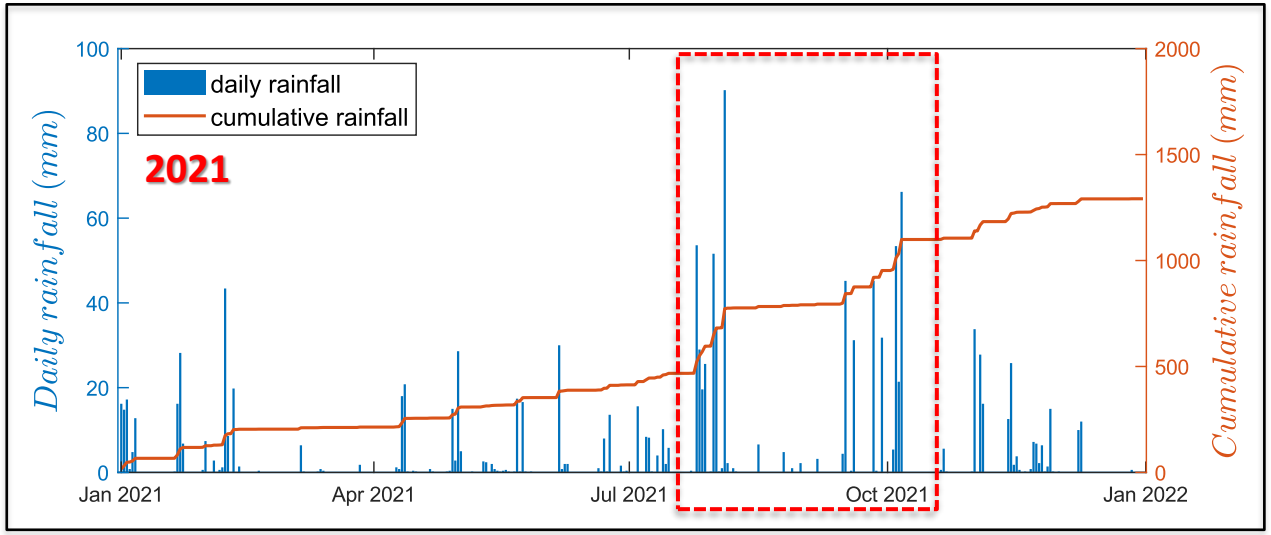
NSE
0.43

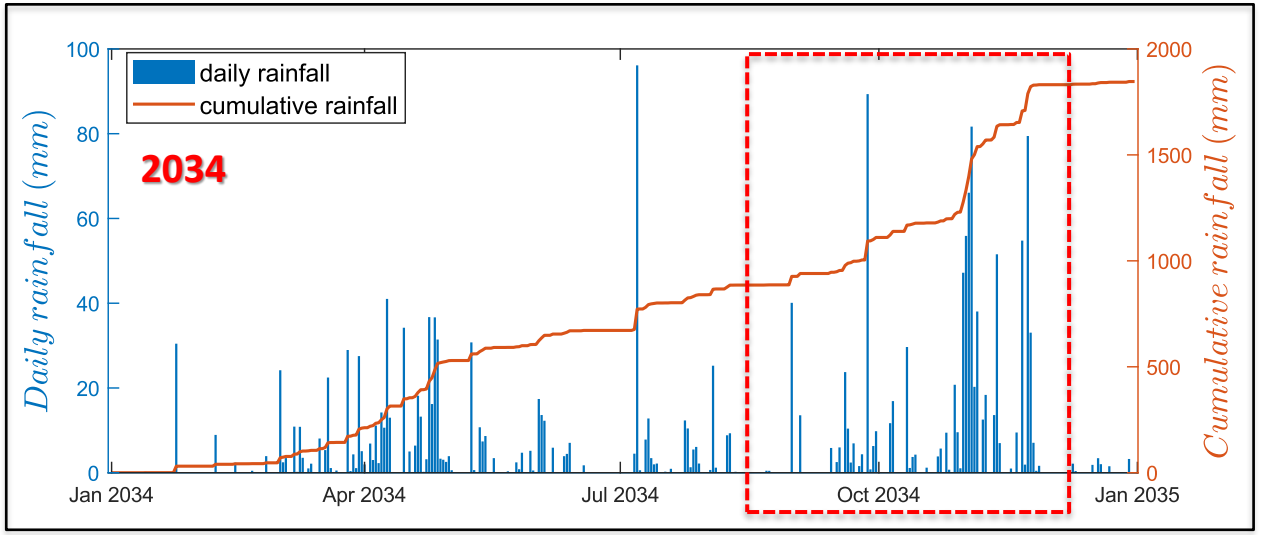
$$NSE = 1 - \frac{\sum_{i=1}^{nobs}(Q_{mod} - Q_{obs})^2}{\sum_{i=1}^{nobs}(Q_{obs} - \overline{Q_{obs}})^2}$$

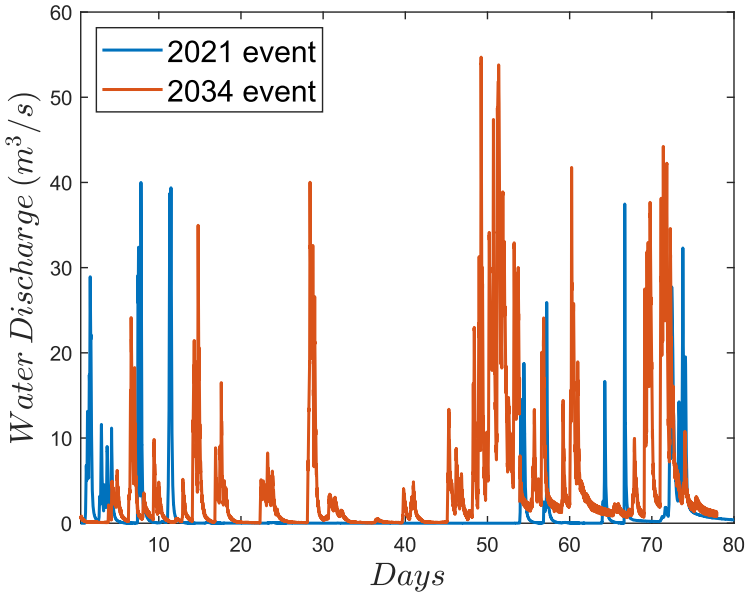
Sediment volume relative error
- 11%

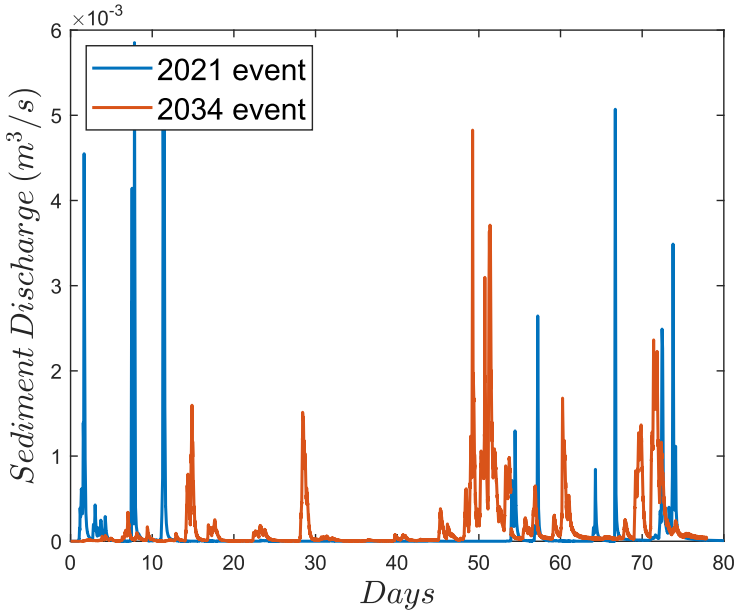
POLITECNICO MILANO 1863

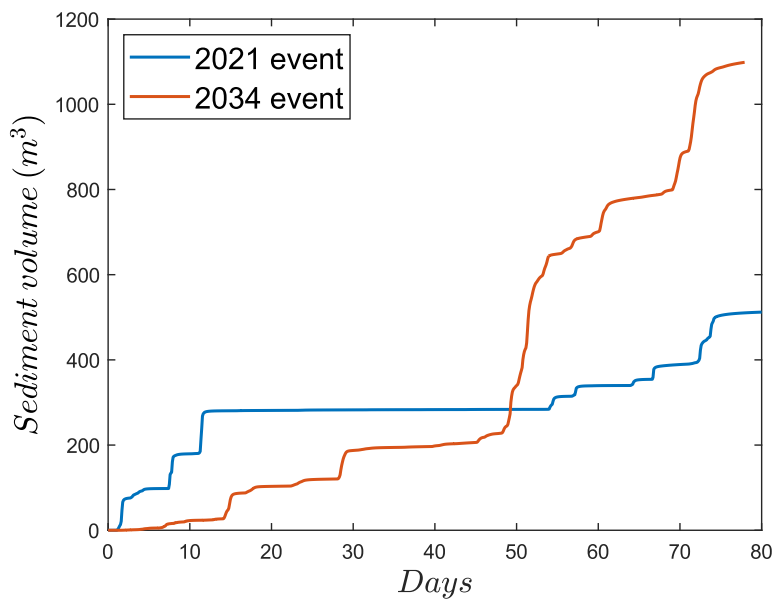
Climate change scenario - results





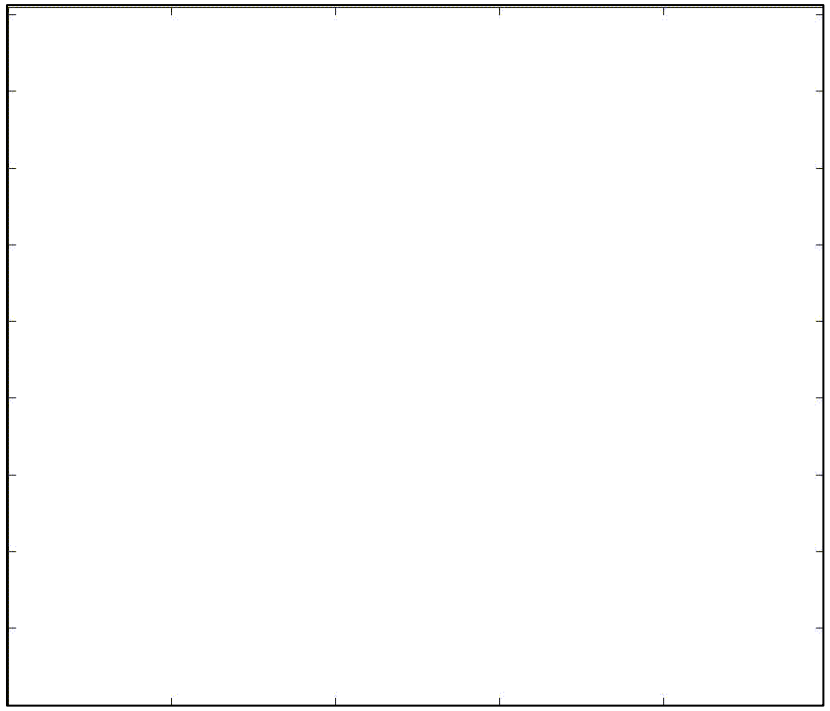






Conclusions and future work

- After the calibration of the model parameters, the application of Smart-SED on a catchment in Southern Alps gave **realistic results** both in terms of water and sediment discharge,
- In a **climate change** scenario, Smart-SED shows a great increase of the sediment discharge that may result in a higher risk for the city downstream the river.



FUTURE WORK

- Implementation of **groundwater table** and **slope processes**,
- Research on gully and rill erosion and on bar dynamics,
- Improvements of the numerical framework (adaptive mesh).


This presentation participates in OSPP
EGU
Outstanding Student & PhD candidate Presentation contest
Thank you for your attention
POLITECNICO
MILANO 1863